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MACHINERY'S New Product Index

22

TURRET LATHE
Horizontal

(Name of Firm) [illegible]

(Address)

NOMINAL SIZE 3 X 36 — Cable Address

Chuck capacity (round)	1 To 3"
Chuck " (hex. across flats)	1 To 2 9/16
Chuck " (square " ")	1 " 2 1/16
Swing (over bed)	19"
Swing (over ~~cross slide~~ SADDLE)	14 1/2
Maximum turning length	36"
Threading capacity	1/4 To 3" WITH AUTO DIE; 1" 11" X 4" LONG WITH CHASING ATTCH'MT.
Turret type (hex., square, round, or flat)	Flat
Turret hole diameter (regular type turret)	
Turret hole diameter—in holder. (Flat type turret)	3 7/16
Top of turret to center of spindle. (Flat type turret)	4"
Turret hole center to top of turret slide	4 1/2
Turret " " " " " cross "	—
Turret face to end of spindle (maximum)	—
Spindle hole diameter	3 1/8
Operating sleeve hole diameter	—
Spindle speed changes (number)	9
Spindle " range (min.—max.)	13 To 284
Belt width (cone pulley type)	—
Belt width (constant speed single pulley type)	3"
Motor Drive (H. P. of motor)	5
Feeds—turret slide (longitudinal)	9
Feeds—cross slide, turret or head (transverse)	9
Floor space (without rod feed)	4' X 11 1/2'
Floor " (with " ")	4' x 20'
Net weight of machine (pounds)	5700
Crating material (domestic, approximate weight)	600
Boxing " (foreign " ")	1000
Box (cu. feet)	215

Remarks [illegible]

SAMPLE FORM

The form photographically reproduced on the right, about half size, is typical of the mass of data collected by MACHINERY, for incorporation in the New Product Index designed to greatly facilitate the selection and purchase of machine shop equipment.

The large number of MACHINERY'S readers directly or indirectly responsible for the purchase or selection of machine shop equipment, will be specially interested in the plan devised by MACHINERY to furnish buyers with specific information in condensed form covering all American machine tools. The data will appear in MACHINERY'S Product Index and represents a radical and very important development in trade journal service. The form reproduced above, one of many returned to us by manufacturers early in July, indicates the thorough and definite character of MACHINERY'S plan.

Under each heading in the Product Index there will be a concise description of the machine, and data which will enable the buyer to determine whether or not the tool is suitable for the work to be done. This new service is intended to aid both buyer and seller and to save needless correspondence and wasteful calls of salesmen.

For more than a year we have been working on this Amplified Index, which was held up pending decision as to a condensed catalogue plan proposed by the National Machine Tool Builders' Association. In July we began sending out our forms to manufacturers. The work involves the detailed examination of hundreds of catalogues, etc., and the careful preparation of many forms like the foregoing. This basic work is now practically finished and we believe that our readers will welcome the news.

Mechanical Production of Drop Forging Dies*

by Edward K. Hammond†

With the constantly growing demand for drop forgings, there has been a relatively decreasing number of men able to make drop forging dies. There are several reasons for the scarcity of drop forge die-sinkers, among which may be mentioned the increasing use for drop forgings and the fact that men possessing the required ability are likely to find more remunerative employment in some broader and more congenial field. These were the general conditions when the large orders for military rifles required by the belligerent European powers were placed in this country. They created an unprecedented demand for dies required for the production of drop forged rifle parts. The supply of competent drop forge die-sinkers was practically fixed and the time required to learn the trade made it out of the question to attempt to train more men. The problem was to find some method by which the difference between the output of the existing supply of die-sinkers and the demand for drop-forge dies could be made up, and a solution of the problem was found in the automatic profiling machine. The following article gives a description of the Keller machine and method of operation, together with detailed information concerning its use in the production of drop-forge dies. While the use of this machine in making dies for the manufacture of rifle parts is referred to, the fact should be clearly understood that the method is applicable to the making of all classes of drop-forge dies and that it can also be employed in the production of other work.

THE extensive industry which has developed in this country during the past year in manufacturing rifles for the belligent European powers has lead to a great demand for drop-forgings, and hence for the dies used in their production. This demand has been further stimulated by the fact that these war orders are taken on contracts calling for such early deliveries, that the process of manufacture must be carried on as rapidly as possible. This introduces two factors which tend to shorten the operating life of the dies: First, the intensive use of the dies themselves; second, the close limits to which the drop-forgings are held, in order that they may fit the jigs in which subsequent machining operations are performed, and that the amount of metal to be removed may be reduced to a minimum so that the machining operations may be conducted as rapidly as possible.

The actual requirements of rifle manufacturers for drop forge dies, and the number of die-sinkers which would be required to produce them by hand, will be readily appreciated from the following figures. The average military rifle contains about 25 drop-forged parts, and when several of the large factories which are manufacturing rifles for the European powers get into full swing, they will have an aggregate production of 15,000 rifles a day. A good die-sinker would require about six days to produce an average pair of dies, and their life is for making not more than 12,000 forgings.

From the preceding figures it will be seen that 188 die-sinkers are required to work at their maximum rate of production at all times in order to replace the dies as fast as they are worn out.

The supply of good die-sinkers in this country has been steadily decreasing owing to the fact that it takes a mechanic of a high order to make a really efficient die-sinker. It is well known that the supply of high-grade mechanics has been inadequate for several years, and the exceptional men who have ability to become good die-sinkers are likely to find more remunerative employment in some broader line of work. As a result, there are only a limited number of competent die-sinkers available.

The demand for drop-forging dies resulting from the manufacture of rifles led to quite a lively competition in bidding for the services of die-sinkers. This was merely the means of enabling a certain manufacturer to obtain the required amount of labor by inducing men to come from some other factory; it did not have any affect on the total supply of drop-forge dies which could be turned out in a given length of time. But the use of drop-forgings in place of other materials has been steadily increasing, notable examples of their use being in the construction of automobiles, sewing machines, typewriters, and a great variety of other machinery and mechanisms. This increasing demand would soon have led to a similar condition as regards the scarcity of die-sinkers, which has been emphasized by the present rush of war business in this country.

How the Making of Dies controls a Factory's Output

In any industry where drop-forgings are used, the making of the dies and the forgings produced in them are the first of

* For other articles on the making of drop forge dies published in MACHINERY, see also "Making Duplicate Drop-Forging Dies," by C. H. Wilcox, August, 1911; "Drop Forge Die Sinking," by Chester L. Lucas and J. W. Johnson, published in three installations in July, August, and September, 1911, and other articles there referred to.

† Associate Editor of MACHINERY.

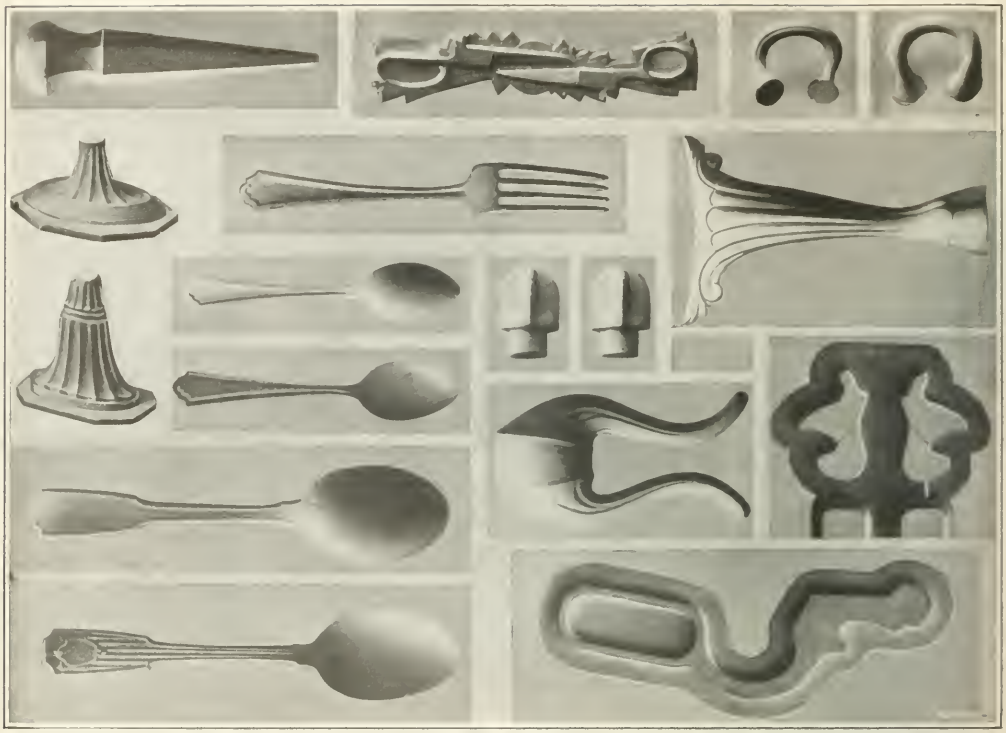


Fig. 7. Collection of Plaster Casts of Dies made on Keller Automatic Profiling Machine

provides the reciprocating motion of the work-table. For this purpose, there is a horizontal shaft *J*, Fig. 2, at the base of the machine, fitted with a pair of friction disks. These are set tight enough to drive, but loose enough to slip readily, after the feed motion for each reversal has been obtained.

When the motor is running in one direction, the friction disks on the shaft *J* rock the link *K* back, and after this has been done the disks slip until the motor is reversed. Then the link *K* is carried forward and the hardened steel pawl carried at the top of the link engages the ratchet on the feed-screw and rotates it the required amount to give the feed that is desired for each reversal of the motor, after which the friction disks on the driving shaft slip until the motor is again reversed. The pawl may be set by means of the screw *L*, Fig. 1, to obtain the required feed motion, the feeds employed ranging from 0.001 to 0.004 inch. A graduated wheel at the end of the feed-screw shows the rate of feed which is being employed. Handwheels *M* and *N* are provided for use in controlling the feed by hand.

Construction of the Special Reversing Switch

The reversing switch which controls the driving motor is of a special design developed by the Keller Mechanical Engraving Co. The important feature is the provision of pivoted contacts which engage the switch and afford a full contact at all times so that arcing is done away with. Hand operated controlling switches are provided at the right-hand side of the machine, where they are in a convenient position for the operator. A separate motor *O* is provided to drive the cutter; and this motor also drives the tracing point in cases where rotation of the tracer is required. The power is transmitted from the motor by means of an endless rope belt and in order to give the required rotary speed for the cutter, different spindles are provided which have pulleys of the required diameters upon them. These spindles are interchangeable in the bearing box, which can be readily opened for the purpose of substituting a spindle with the required size of pulley.

Two general forms of cutters are used on this machine. For taking the roughing cut, or "hogging out" the stock from the die-blank, different forms of fluted end-mills are employed; and after this preliminary operation has been performed, intermediate and finishing cuts are taken with special cutting tools which are made from drill rod. Different forms of fluted milling cutters are used for taking the roughing cut. The form of cutter generally used is shown in Fig. 3 at *A*, but when the sides of the die are perpendicular the cutter employed is of the form shown at *B*. The tools used for

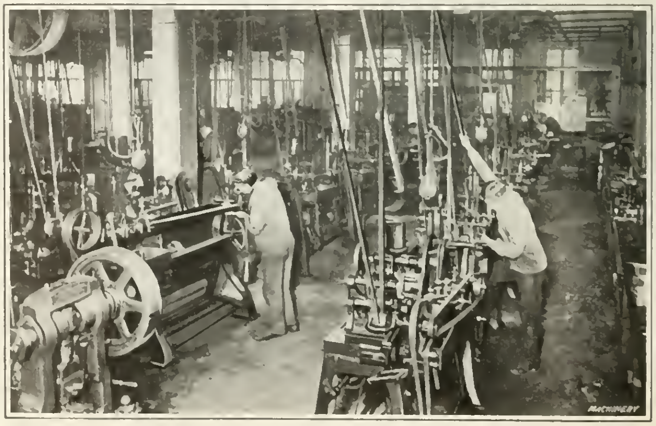


Fig. 8. General View in Shop of Keller Mechanical Engraving Co.

taking the intermediate and finishing cuts are shown at *C* and *D* respectively; and cutters of this character are easily made by grinding them out of a piece of drill rod. In order to get the proper relation between the movement of the tracing point over the pattern, and of the tool which is cutting the die, it is necessary to have the tracing point of exactly the same form as the cutter which is being used. In Fig. 3, suitable tracing points are shown beside their respective cutters. This illustration also gives a good idea of the way in which different speeds of the cutter are obtained by substituting spindles with suitable sized pulleys mounted on them.

The cutters are inexpensive, and owing to the sensitiveness of the machine, they last for an astonishing length of time before they require regrinding. It is important to note that the Keller automatic profiling machine is so designed that the cutter works on both the up and down strokes of the work-table; there is no idle return stroke, and as a result, there is no time when the machine is running that it is not doing useful work. Hence, its productive capacity is correspondingly high. An idea of the rate at which the machine works may be gathered from the fact that a ⅜ inch cutter will take a cut 9/16 inch in depth under a feed of 0.012 inch and a cutting speed of 5 inches per minute. Cutters used on the machine range from ½ to 3/16 inch in diameter.

After the roughing out of the work has been done by the fluted milling cutter, the special cutting tools are employed for taking the intermediate and finishing cuts. Each of these tools has the same taper at its point that there is on the tracer, the limit being 12 degrees. For cutting dies with very steep sides, an angular adjustment has been provided on the machine, which enables the pattern and the work to be set in such a way that the cut taken by the angular side of the tool is at the required angle to the work. This adjustment is only necessary where the sides of the work are required to be at an angle of less than 12 degrees with the perpendicular. In the case of steep sided work of this character when the work is not tilted, it is necessary to revolve the tracer point in order that it may be readily cleared from the pattern. By rotating the tracer, its action upon engaging the side of the work is similar to that of a screw in its nut, and as a result the tracer moves out of the pattern with very little resistance. When the tracer is required to be rotated in this way, it is carried in a special spindle provided with a pulley, and the endless rope drive from the pulley on the cutter spindle is carried up to this pulley to give the required rotation.

Making a Right-hand Die from a Left-hand Pattern

In some cases it is desirable to be able to make a right-hand die from a left-hand pattern, or *vice versa*. A case in point is shown in Fig. 4, which illustrates the three parts of a die used for pressing a sword grip. The two parts *A* and *B* make the sides of the grip, while part *C* fits into the socket in the die-block for making the lower part of the grip. For the two parts *A* and *B* only a pattern of the right-hand side was made. Then in sinking the two sides of the die from this pattern, one was made direct while the reversing attachment on the machine was used for the other. It has already been explained that the work-table is given a vertical reciprocating motion so that the tracing point passes back and forth over the pattern and causes the cutter to follow a similar path over the work. This motion of the table is obtained from a feed-screw. For use in making a left-hand die from a right-hand pattern, or *vice versa*, the work-table is in two parts, which are engaged by a feed-screw threaded right-hand at one end and left-hand at the other end. It will be evident that the rotation of this screw causes the two halves of the table to have reciprocating motions in opposite directions. Then the movement of the tracer point over the pattern causes the tool to follow the same path but in the opposite direction, so that the work is the reverse of the pattern.

Method of Setting-up and Operating the Machine

It has already been mentioned that the dies produced on this machine require no preparatory roughing out. In preparing to sink a die, the first step is to set the model up on the work-table. Then the die blank is located in the proper relation to this model by means of a suitable gage, and the fluted milling cutter is set up in the machine. After this has been done, the cutter is allowed to drill into the work to the required depth for the roughing cut, this being limited by the tracer point which engages the pattern when the cutter has reached the required depth. Then the feed motions are started and the cutter is fed over the entire surface of the die for the roughing cut. The hand wheels *M* and *N* are used in operating the machine while taking the roughing cut, as shown in Fig. 5; and the automatic feed for finishing.

After this has been done, suitable engraving tools are substituted in the spindle and the intermediate and finishing cuts are taken, which completes the machine work. The die is then taken to the finishing department, where it is gone over by hand to remove tool marks and clean it up where such treatment is found necessary. Absolute uniformity in the work is assured by this method, there being no chance for errors in the depth of cut or in the outline followed by the tool. The perfection to which this method has been developed is chiefly due to the fact that the Keller Mechanical Engraving Co. does a large business in making dies, and that they used a number of their own machines for this work. Hence, the machines have been built with the users' requirements in view just as much as the machine builders', and all weak points of the design, which could only be discovered through an extensive experience in operating the machines, have been eliminated.

* * *

HEATING MOTOR TRUCK STEEL TIRES ELECTRICALLY

An ingenious and effective method of heating steel tires for motor truck wheels is employed in the works of the Pierce-Arrow Motor Car Co., Buffalo, N. Y. The wheels are made of ash, and the tires are forced onto the fellocs while hot, using a hydraulic press for the purpose. The tires cannot be heated very hot, of course, for if heated to a high temperature the heat would char the wood and spoil the fellocs. They are heated to a temperature that just about makes the wood smoke. The heating is accomplished by means of a transformer, the tire to be heated being laid on its side in a sheet steel tub containing the transformer coil. When the current is turned on, the action in the primary coil causes the tire surrounding it to act as a secondary, and the currents traversing the rim heat it quickly and uniformly. The coil is not placed exactly in the center of the tire, being on the contrary, placed near one side but the heat is uniformly distributed. Three minutes only are required to heat a tire about one-half inch thick, ten inches wide and thirty-six inches in diameter to the required temperature. There are several advantages of the practice: the tires are heated quickly and uniformly; there is no danger of fire, an important consideration in a woodworking shop; they are heated without being sooted or oxidized, and the workmen are not subjected to the heat and discomfort incident to working near a large heating furnace of the usual type.

* * *

The United States supplies a large proportion of the gasoline used for motor cars in Germany. Russia and the East Indies also furnish considerable quantities. It is believed that these sources of supply have now been cut off, so that outside of the accumulated stock of motor fuel, the wells in Galicia are the only ones from which motor fuel can be obtained, and these wells can be depended upon for crude oils only in limited quantities. It is reported that at the present time alcohol and benzol are used exclusively by cars in the military service, but the supply of alcohol is also likely to be limited, as the grain, potatoes, etc., from which it is made must be carefully preserved for food purposes. In a machine-made war, such as the present one pre-eminently is, the question of motor fuel is an important item. Germany is a leader in the field of chemical science, and it will be interesting to see if her scientists will be able to solve the problem.

TURNING TOOL-HOLDERS—2

A STUDY OF LATHE TOOL-HOLDERS USED FOR TURNING, CUTTING-OFF AND SCREW CUTTING

BY JOSEPH HORNER*

THE Johnson tool-holder shown in Fig. 53 is made by the Pratt & Whitney Co. This holds the cutter in a recess at the side, which has beveled shoulders to fit the beveled edges of the cutter. The latter, as seen in the cross-sectional view, is concave on the sides, affording the greatest amount of clearance with the least reduction of area; and on account of the bevel it is necessary to grind the top square for a distance equal to the depth of cut. The clamping is performed chiefly by the tool-post pressure. A knurling tool is sometimes superimposed on the holder, and is pivoted to throw the knurl up out of the way when the cutting-off blade has to be used. The holder manufactured by the Billings & Spencer Co., Hartford, Conn., is made in two parts, as shown in Fig. 54, and united with a couple of screws, the one at the front being quite heavy. The pressure of the tool-post screw is also of assistance in binding the blade with additional firmness. An English style of holder with one clamping bolt is shown in Fig. 55, the blade making a close fit throughout the length of the holder, and being pinched for a distance of about one-third the length by the squeezing-in action of the bolt and elastic end of the holder.

The Western Tool & Mfg. Co., Springfield, Ohio, makes straight and offset holders of the types shown in Fig. 56, embodying the principle of vertical pressure induced by a screw, and transferred to a grooved clamp that forces the cutter downward and firmly into place. A slight amount of backward and forward movement is allowed to permit of variations in the widths of cutter, and to insure a correct wedging action. The offset holder is made right- and left-hand, the one shown being right-hand, that is, when facing the headstock. Fig. 57 illustrates the straight and offset holders made by the Ready Tool Co., in which the beveled-section cutter is secured by a screw on top, and a lateral screw. The metal in the holder is carried forward and downward at the nose to give proper support where it is most needed. The pressure of lateral bolts is also utilized in the Armstrong tool-holders, Fig. 58; in the holder *A*, the screw bears directly against the face of the cutter, and a wedging action by one bolt is employed in more recent designs *B* and *C*. Fig. 59 represents a holder of European design, using the pressure of a bolt head in conjunction with a short beveled clamp which fits angular seatings under the head and in the bottom of the holder groove. The cutter has an enlarged top to increase the side clearance. A clamp pulled in the vertical direction may be noted in the succeeding illustration, Fig. 60, this being an English design. In at least one type of holder, a clamp is passed right across the cutter, and is pulled up by a couple of bolts, see Fig. 61. This is known as the Slate tool-holder, and is also made offset.

Cutting off is an operation that is likely to give some trouble in the breakage of cutters or damage to work, because of the great liability of the tools "digging in." This is induced by either of two causes—one, the tendency of the rest, especially if of weak construction, or loosely fitted, to lean toward the work; the other, the tendency of the work to climb up over the cutting edge. A device that is introduced to prevent these happenings is the addition of a steadyrest to touch the top of the work and prevent it from rising. The Slate holder of this type, Fig. 62, carries an extension to the cutter clamp, and this receives a slotted rest adjusted to suit the diameter of the bar being cut off. Another style, made by F. Burnerd & Co. of Putney, London, England, Fig. 63, has the steadyrest clamped by two bolts which draw clamps against its beveled edges. The cutter is jammed firmly in place by a clamp drawn up by the set-screw. This holder is also found advantageous for cutting square-threaded screws, particularly long ones which would be likely to give trouble. Cutting-off cutters may be mounted in duplicate for cutting out rings to uniform widths. The Mingst holder, Fig. 65, for this class of work has a widened head adapted to receive two blades and one or more spacing blocks to space them apart to an exact distance, the hole and the spacing blocks having tapered sides to keep the beveled cutters upright. A set-screw binds the whole arrangement in place.

* Address: 45 Sydney Bldgs., Bath, England.

Screw-cutting Holders

Holders for screw-cutting represent a special class, having two requirements that distinguish them. One is the desirability of using a cutter which will preserve its edge profile during repeated sharpenings, the other the need for a swiveling action to twist the nose of the tool so as to make it go into the angle of the thread groove. This is particularly necessary for threads of short pitch, and for deep threads. The swivel action saves special grinding of the cutter nose, and also adapts the cutter for cutting either right- or left-hand threads equally well. A good many of the holders illustrated are suitable for threading, within certain limitations, but none of them embody any special provisions for this class of turning. A distinction which may be noted is whether the holder is of the fixed-top-rake or the fixed-front-rake (clearance) style. The former is not so well adapted for threading purposes because the nose of the cutter has to be ground to shape, and this shape is soon lost in sharpening, whereas a fixed-front-rake cutter may be made of the correct profile and will retain this although ground repeatedly on the top, until the stump is too short to be of use. On the other hand, the shallower depth of a fixed-top-rake cutter is preferable in certain instances where a deeper cutter would foul the sides of the thread groove. Both types are illustrated in the examples following.

A simple holder with fixed-front-rake is shown in Fig. 65. This is made by the Ready Tool Co., and the cutter is of a section ground to suit the thread to be cut, only the top being sharpened. By the addition of serrations and a wedge, the cutter is held rigidly without exerting excessive pressure with the set-screw. The same design of holder is also made in offset style. A heavy tool-holder of English design, Fig. 66, includes a set-screw below for adjusting and maintaining the cutter to the correct height, clamping being effected by tightening the grip of the split nose of the holder. Another style of tool-holder designed on the same principle is also manufactured with a wider opening to receive a chaser including several threads, for finishing. A method of fastening the cutter or chaser, which is adopted in many cases, is to leave it exposed at one side, so that threading may be done up to a shoulder. Sometimes the cutter is formed with an under-cut vee on the inside, matching the side of the holder, and is secured with a clamp bearing against a beveled edge at the back (see Fig. 67). Grinding is done on top, and the chaser can be used as long as there is enough of it left to be gripped firmly in the holder. To prevent risk of slipping, the side of the chaser in some holders is serrated, and the serrations engage with similar ones on the holder.

A popular style of holder includes a fine screw adjustment for the cutter (see Fig. 68). This is a heavy type of straightforward holder. Holders with bent shanks are also made as shown by the dotted lines in the plan view. Different types of cutters are shown in Fig. 69, comprising single-point standard forms *A* and *B* for U. S. standard threads, and Whitworth threads respectively; the one-sided, or "single offset" as it is sometimes called, shown at *C*; and the offset or "double offset" *D* for working up to shoulders. The last-named cutter can be reversed in the holder, to bring the threading point to the right or left. There is a point of interest in connection with the shape of the profile of a cutter for cutting screws on the so-called S. I. system, or metric "Système Internationale." The cutter is different in outline according to whether a screw or a tap is being threaded; if the former, the point appears as at *A*, Fig. 70; if the latter, the point is as shown at *B*. The reason becomes obvious on examining the fit of this

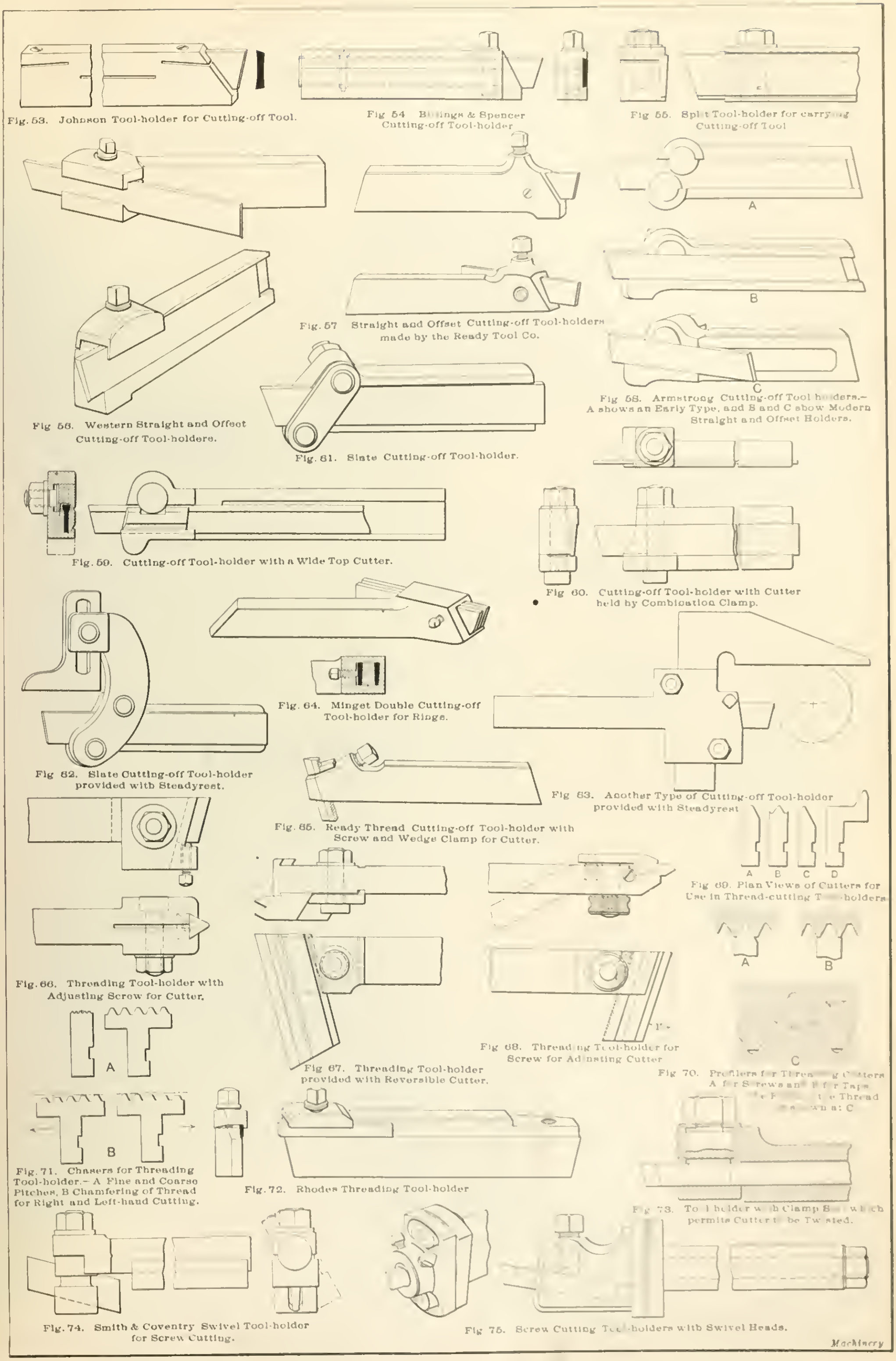


Fig. 53. Johnson Tool-holder for Cutting-off Tool.

Fig 54 B[illegible]ings & Spencer Cutting-off Tool-holder

Fig 55. Spl[illegible]t Tool-holder for carry[illegible] Cutting-off Tool

Fig 56. Western Straight and Offset Cutting-off Tool-holders.

Fig. 57 Straight and Offset Cutting-off Tool-holders made by the Ready Tool Co.

Fig 58. Armstrong Cutting-off Tool h[illegible]ders.– A shows an Early Type, and B and C show Modern Straight and Offset Holders.

Fig. 59. Cutting-off Tool-holder with a Wide Top Cutter.

Fig 60. Cutting-off Tool-holder with Cutter held by Combination Clamp.

Fig. 61. Slate Cutting-off Tool-holder.

Fig 62. Slate Cutting-off Tool-holder provided with Steadyrest.

Fig 63. Another Type of Cutting-off Tool-holder provided with Steadyrest

Fig. 64. Minget Double Cutting-off Tool-holder for Rings.

Fig. 65. Ready Thread Cutting-off Tool-holder with Screw and Wedge Clamp for Cutter.

Fig. 66. Threading Tool-holder with Adjusting Screw for Cutter.

Fig 67. Threading Tool-holder provided with Reversible Cutter.

Fig 68. Thread[illegible] Tool-holder for Screw for Ad[illegible]sting Cutter

Fig 69. Plan Views of Cutters for Use in Thread-cutting T[illegible]-holders

Fig 70. Pr[illegible] f[illegible]r Thre[illegible]g C[illegible]tters A f[illegible]r S[illegible]rews an[illegible] f[illegible]r Taps [illegible] t[illegible]e Thread [illegible] n a: C

Fig. 71. Chasers for Threading Tool-holder.– A Fine and Coarse Pitches, B Chamfering of Thread for Right and Left-hand Cutting.

Fig. 72. Rhodes Threading Tool-holder

F[illegible] 73. To[illegible]l holder w[illegible]h Clamp B[illegible] which permits Cutter t[illegible] be Tw[illegible]sted.

Fig. 74. Smith & Coventry Swivel Tool-holder for Screw Cutting.

Fig 75. Screw Cutting T[illegible]-holders with Swivel Heads.

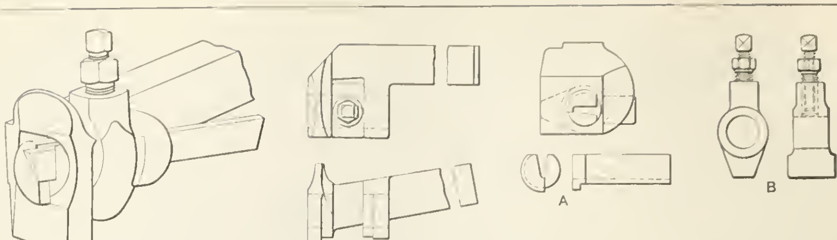


Fig. 76. Taylor Swivel Type of Screw-cutting Tool-holder and its Parts.

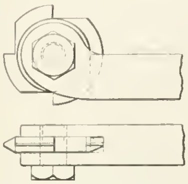


Fig. 77. Threading Tool-holder provided with Disk Cutter.

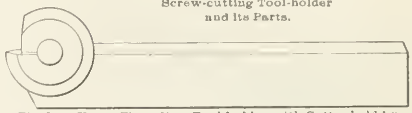


Fig. 78 Union Threading Tool-holder with Cutter held by a Taper Socket in Shank.

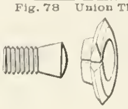


Fig. 81. Armstrong Threading Tool-holder provided with Screw Adjustment.

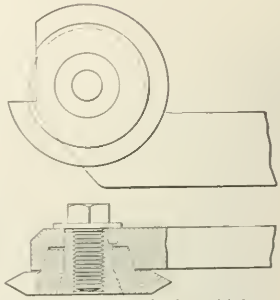


Fig. 79. Threading Tool-holder with Cutter held by Double Friction Clamp.

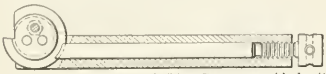


Fig. 80. Tool-holder with Disk Cutter provided with Means for Adjusting Height of Cutter.

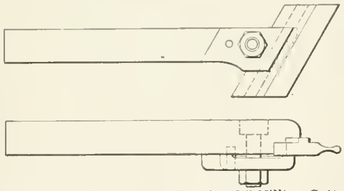


Fig. 83. Tool-holder used for Backing Off Milling Cutters.

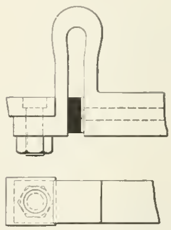


Fig. 84. Spring Tool-holder with Rubber Pad in Gooseneck and End Pressure Rod.

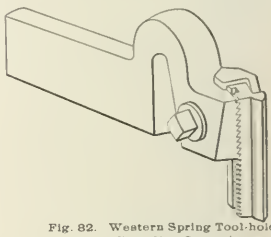


Fig. 82. Western Spring Tool-holder for Threading Operations

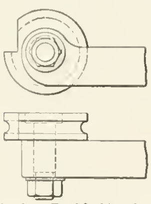


Fig. 85. Tool-holder for Circular Forming Tools.

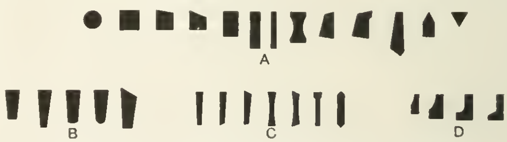


Fig. 86. Sections for Turning, Side Cutting and Screw Cutting Tools are shown at A, Deep Sections for Turning, and Similar Operations at B, Special Sections for Cutting-off Tools at C, and Sections for Cutters for Chamfering, etc. at D.

Machinery

type of thread, see Fig. 70 at *C*. The bolt has flat thread tops and rounded roots, but a tap to cut the nut threads is the reverse style, *i.e.*, rounded tops and flat roots.

Threading can be done more rapidly with a chaser than with a single-point cutter, and the finer pitches can also be cut at one traverse. The objection to the chaser is that slight differences in pitch are likely to occur between the chaser and the correct pitch of the screw that is required to be cut; hence it is desirable for very accurate work to use a single-pointed tool, or a compromise may be made, roughing out more rapidly with the chaser to a diameter slightly over size and finishing finely with a single-point cutter. Two examples of fine and coarse pitch chasers are illustrated in Fig. 71 at *A*. It is best to chamfer the chasers off as illustrated at *B*, for right- and left-hand threads, respectively. The first point only takes a very shallow cut, and the succeeding ones gradually deepening cuts until the complete form is finished by the last tooth. Another use for holders of this kind is to receive cutters for special operations, as chamfering, rounding, and profile turning; the blanks are prepared to the same outline as those for ordinary threading operations, but the faces are milled to the desired profile, and as sharpening is done only on the top the profile remains unaltered during the life of the tool. The Rhodes square-threading tool-holder, made by the Pratt & Whitney Co., is of the type without top rake, and uses a cutter ground with suitable side clearance, and held by a strap and set-screw, Fig. 72. The strap has an elongated hole and adjusts itself to varying widths of cutters. Right-hand threads are cut with the cutter placed at one end of the bar, and left-hand when it is transferred to the other end. A narrower roughing cutter is sometimes employed to rough out the thread preparatory to completing it with one of full width.

Some of the holders illustrated earlier in these articles possess an axial swiveling motion which is very useful for tilting a thread-cutting tool, and there are also some holders especially intended for screw-cutting, which also have this feature. An example is shown in Fig. 73, utilizing a round-section cutter passing into a hole in the shank, and gripped by a drilled bolt which pulls it up against a collar. The Smith & Coventry holder previously illustrated is also built with a cylindrical shank, Fig. 74, to rest in a concave block on the slide-rest, and so be swiveled at any angle for right- or left-hand square threads. Fig. 75 shows two other English designs of threading tool-holders with swivel heads, one of which is locked by a bolt passing through the shank, the second by two bolts sunk flush with the swivel plate. Messrs. Charles Taylor, Ltd., of Birmingham, England, have for many

years past manufactured a swivel holder, Fig. 76, carrying a cutter of vee-section pressed down into a socket or barrel *A* by the small inner screw in the loop-piece *B;* the latter binds the barrel in the holes in the holder when the larger hollow screw is tightened, and the angle of the barrel may, of course, be varied according to the amount of swivel of the tool point demanded by the thread angle. As the cutter is only locked by the inner set-screw, it can be removed for sharpening or substitution without altering the angle at which the barrel is set. The perspective view shows the appearance of the assembled holder.

The idea of using a permanent section of cutter which will remain unaffected by repeated sharpenings is very attractive, as may be noted from the examples of fixed-front-rake (clearance) screw-cutting holders already shown. Another device, not adopted to the same extent, is that of embodying the section in a circular or partly circular cutter, which is revolved as metal is removed by grinding. This gives a compact tool that is easily produced and very stiff and strong. The simplest way to attach the disk to the holder is to draw it against the side of the latter with a bolt or set-screw, a method open to the objection that very hard tightening is required to insure freedom from slipping under the cut. A greater degree of frictional grip may be obtained in the manner seen in Fig. 77, by pulling the sides of the holder against the disk. The latter, it will be observed, is notched out in four places, giving the choice of more than one edge to apply to the work that is to be threaded. This is convenient for three reasons; it provides a reserve of edges in case of breakage, it also gives a reserve to obviate the need for stopping to sharpen a dulled edge, and it offers the choice of one edge for roughing and another for finishing. Such a holder cannot work close up to a shoulder; hence there are several holders with the disk located on the side, and an improved means of binding with the exercise of but moderate power on the screw. One such is shown in Fig. 78, which is made by the Union Caliper Co., having a tapered boss on the cutter, and the latter split through in order that the action of tightening the bolt may expand the cutter firmly into the hole in the shank. Another design incorporating a taper fit, illustrated by Fig. 79, is manufactured by the Machine Tool Attachment Co., of Manchaster, England. The disk is solid and is drawn in by the set-screw fitting in a bushing with tapered head. As this bushing is prevented from rotating by a plug, the effect is to enhance the frictional hold, securing the cutter inside and outside.

Another solution of the problem of securing a circular cutter is shown in Fig. 80. This is rather an old idea which was originally evolved for general turning. The pin on which the disk is held is so placed that the pushing forward of the plunger rod by the screw at the rear has the effect of raising the cutting edge. The other two holes are used subsequently after frequent sharpening has carried the edge a considerable way around the circumference. The Armstrong threading holder illustrated by Fig. 81 utilizes specially shaped cutters backed off behind the edge, and adjusted through the medium of the small stop-screw, after which the nut on the end of the pivot bolt is tightened. The dotted lines indicate the radial course of future grindings. Multiple-threaded cutters or chasers, on the same principle as those shown previously in Fig. 71, are also made in the circular form and bolted to the side of a shank. Spring threading tool-holders are preferred in many shops, and some types of these incorporate one or the other of the methods already shown of holding cutters, together with a gooseneck shank. Fig. 82 is an instance, this tool being made by the Western Tool & Mfg. Co., Springfield, Ohio. Just sufficient spring is afforded to prevent chatter while cutting the thread.

Forming Tool Holders

Forming, when it has to be done in an ordinary lathe, may be accomplished with cutters held in some of the holders already shown, the chief limitation soon reached being that of width. But certain designs, shown in Figs. 47 and 48 for example, will carry forming tools of generous width. Relieving lathes require a considerable variety of shapes to suit various profiles of milling cutters, and a useful holder for this class of service is that represented by Fig. 83, which is made on a similar plan to threading holders previously shown, and receiving blanks with standard bodies. The cutter shown is a narrow delicate one, but the holder is equally capable of carrying a width of working edge equal to two or three times the width of the shank. Spring holders for plain turning, or for forming are employed to a limited extent, and one form is shown in Fig. 84. This has a rubber pad adjusted by a screw to regulate the amount of elasticity. Circular profiling cutters, similar to those employed on the cross-slides of turret lathes, are often used for ordinary lathe service, and a typical design is that utilizing a simple bolt fastening, Fig. 85, to draw the cutter against the side of the shank.

It has already been mentioned that the various cross-sections of tool steel that are used for making the cutters for tool-holders can now be bought in the open market. Fig 86 shows a variety of these sections, together with a note concerning their particular functions. While all these sections are in common use, there are, of course, special sections which must be forged to shape. These are not illustrated for the reason that they are not standard forms obtainable in the open market; and such special sections for handling a single class of work are of little interest to those who have not had occasion to use them.

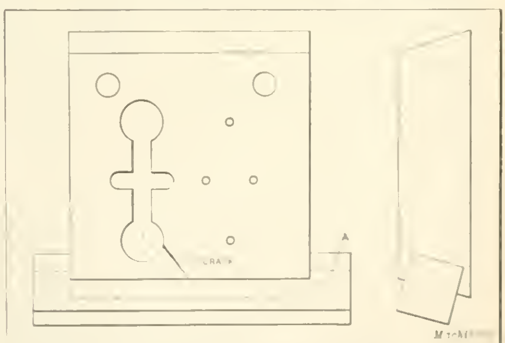
* * *

REPAIRING CRACKED DIES

BY ROBERT J. ALBRECHT*

Even where the greatest care is taken, blanking dies will occasionally be cracked in hardening. When the crack is parallel with the angular sides of the die, the binding screws in the die-block will close up the crack; but when the crack is at right angles to the angular sides, it is much more difficult to make the die fit for use. In some shops it is the practice to grind the sides of the cracked die square and at right angles to the top, after which the die is inserted in a solid shoe. While this method gives fairly satisfactory results, it adds considerably to the original cost of the die.

The accompanying illustration shows a cheap method of repairing a cracked die known as the "hot patch" method. For this purpose a piece of machine steel of suitable size has a slot milled in it to one-half its depth, the width of the slot being about 0.010 inch to the inch less than the length of the cracked die-block. This piece of steel is heated to a dull red heat, and the die-block is placed in a vise in such a way that the crank will be closed up tight. The heated clamp is then



"Hot Patch" Method of repairing Cracked Die

taken from the furnace and slipped over the die as shown at *A* in the illustration. When the clamp cools, it will contract and secure a very tight grip on the die, which will be quite adequate to keep the crack closed. It is important to note that the cooling of the clamp should be hastened by dropping a little water on it, and as soon as the clamp has secured a preliminary grip on the die, the die and clamp are removed from the vise and quenched in water to prevent the hot iron from drawing the temper of the die.

* Address: 1928 No. Chatham St., Racine, Wis.

SNAPSHOTS ON THE ROAD

ECONOMY OF SODA ASH VS. SODA ETCHING FIRM NAMES ON PRODUCT—BRAZING HIGH-SPEED STEEL TIP TO CARBON STEEL SHANKS—SAVING TIME ON SLOTTING NUTS—BURNHAM'S "WRITE-UP"

THE field service men run across many time and money-saving ideas in the shop, and some of them are not purely mechanical at that. For instance, one of the large automobile manufacturers of the Middle West turned an engineer loose in its factory to see what he could find in the way of leakage and how it could be stopped. Some of the places where there was found a chance to save money were rather surprising. One of them was at the top of the soda tank where the oil accumulated from dipping work for cleaning. It had been customary to skim the oil from the top of the tank from time to time and throw it away. The object was to keep a clean surface on the soda tank, and it was not thought that the oil accumulated was worth saving. When the engineer discovered this fact, the skimmings were ordered saved and the oil cleansed, thereby effecting a saving of several dollars a year.


—"that little suggestion you have just made is worth all the information I have given you in the last half hour"

Another more important leakage discovered and incidentally one that may be found in almost any shop of any size, was in the use of soda. The matter was very simple. One day he saw a box of soda ash in the shop and not being very familiar with the different forms of soda he investigated and found that soda ash was merely common soda with the "water of crystallization" driven off. Following this investigation, it was found that all the soda used in the factory was commercial soda, which cost approximately eighty cents per hundred pounds; soda ash cost about a dollar per hundred pounds. Less soda ash than commercial soda was required for a soda solution and the results obtained were identical.

"Of course," said the engineer, "you see that soda ash costs us slightly more per hundred pounds than the commercial soda, but then, we don't have to pay for all the water we used to use and we are saving several hundred dollars a year on this item alone. So there you are."


"For brazing, this little tablet is 'meat and drink in one'"

Etching Firm Names on Product

"Say," said the shop superintendent, "that little suggestion you have just made is worth all the information I have given you in the last half hour."

The field service editor had been looking around the shop for a half hour getting a few pointers for his journal and incidentally listening to the description of kinks that every live shop man has up his sleeve. And then, when going through the assembling department, the superintendent lamented because the marking of the firm name on the finished product looked so poorly. This condition was due to the unevenness of the stamping, particularly in regard to the depth of the letters. After hardening, the surface grinding operation accentuated the trouble, and the result was a very ragged looking firm name marked on the finished product.

The field service man suggested etching, but this to the shop man had always been considered a very slow method, and one only to be used in emergencies. In a few minutes time, however, he was shown how by using an inexpensive engraving machine on the market, he could with a few changes, cut the desired letters in a wax coating on the product and then etch the legend quickly and neatly. The result leaves little to be desired.

It was just another case of reciprocation in the exchange of shop ideas—and it proved to be a half hour well spent for both parties.

Brazing High-speed Steel Tips to Low-carbon Steel Shanks

There is a user of heavy planers in New England who has cut his high-speed steel tool bill materially by using planer tools with low-carbon steel shanks and high-speed steel tips brazed thereon. A heavy planer tool, say 1¾ by 2½ inches in cross-section, represents a number of dollars on the high-speed steel tool bill, but the same number of pounds of low-carbon steel adds but little more to the total cost of the tool.

But it took him some time to discover a good method of holding the tip to the tool shank. He now accomplishes it by brazing, and the little kink is in the method of applying the flux and spelter. Anyone who has done brazing realizes that it is "some job" to control the flux and the spelter while the two pieces to be joined are at the brazing heat.

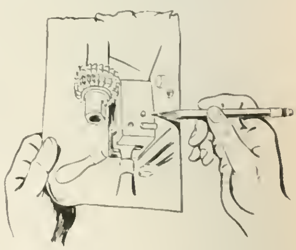
This manufacturer uses a foreign welding preparation composed of flux and the spelter pressed into sheet form. The sheet is scored with grooves, dividing it into small diamond shape sections. The workman breaks off a piece of the right size and inserts it between the tool bit and the shank when they have been heated to brazing temperature, and then presses them firmly together. Thus the flux and spelter are applied just where he wants them and at just the right time. For brazing, this little tablet is "meat and drink in one."

Saving Time on Slotting Nuts

"Sure you may go out in the shop and see if you can find anything of interest for your paper," said the superintendent.

The field service man started off, but just as he was leaving the superintendent's office, he was halted with, "And if you see any place where we can increase production or improve our methods, be sure and tell us about it because we are not thin-skinned around here; we like to know of all the points that will help us."

The first thing that the editor saw after he entered the shop was a couple of boys running hand milling machines and slotting nuts. The vise jaws were cut away so as to hold the nuts at an angle, and after each cut the boy unscrewed the vice, turned the nut and repeated the milling operation. Ninety-nine per cent of the time was spent in turning the handle of the vice.


"The advantage of this jig is that it is operated and loaded entirely by one hand, while the milling machine table is operated with the other hand"

The field service man secured his material, and when he went back to the office, told the superintendent of the hand milling job and supplimented it with a description of a little jig that is shown in the illustration. The advantage of this jig is that it is loaded and operated entirely by one hand, while the milling machine table is operated with the other hand.

"Say, that looks good to me," said the superintendent,

"and I'm going to make one right away. Come in again when you're in town. We like to have visitors like you—it pays!"

Burnham's "Write-Up"

Once in a while we run across a manufacturer of the old school who thinks the chief function of a technical journal is to publish "puffs" and "write-ups." These fellows generally are proprietors of shops so far behind the times that none of their working methods would look well in print.

One of these fellows of the old school runs a shop in a city not far from New York. When interviewed, he thought it would be a fine idea to have an "article" written about his factory, and after some deliberation he turned around with the remark, "Can you take shorthand?" The visiting editor replied that he regretted that he could not take shorthand, but he was a fairly rapid writer. This did not seem to satisfy the shop owner, and he reached over for a slip of paper and wrote the following "article"—just as we have reproduced it:

"Can you take shorthand?"

> "Oscar Burnham of ——, N. J., has a very interesting factory. He is a manufacturer of plumbers' tools and metal specialties. Started in business in 1876. He makes a specialty of tinners' torches for all the trade. The goods are made for gasoline, kerosene, alcohol, electricity, natural gas, crude oil, etc. In this factory can be seen casting, machining, soldering, brazing, stamping, drawing, etc."

It took a little argument to convince Mr. Burnham that this was not the kind of an article that MACHINERY cared to publish, and he reluctantly consented to take the visitor through the shop. Fortunately, or unfortunately for MACHINERY's readers, the shop was so uninteresting and so far behind the times that no space could be devoted to any of the work or methods.

* * *

HOW WE CAME TO HAVE THE MICROMETER CALIPER

BY W. D. FORBES*

L. D. Burlingame contributed an interesting and valuable article on the origin of the micrometer caliper in the June number. It assembled in convenient form, that which has heretofore been scattered knowledge. I believe that which follows will be of interest to MACHINERY's readers when read in connection with Mr. Burlingame's article.

In 1887 I was doing some special work for A. C. Hobbs, Superintendent of the Union Metalic Cartridge Co., Bridgeport, Conn. Mr. Hobbs was famous as a lock picker, having gained the prize offered in England to anyone who could pick the lock made by the Bramah Co. in a given time. He also opened the vaults of the Scottish Bank in Edinburgh, but he never picked the lock of the Bank of England, as commonly reported.

I was in Mr. Hobbs' private office comparing some punches with him, using a 1-inch Brown & Sharpe micrometer for the purpose, when A. D. Laws came into the office. He was, at the time, I think, connected with E. P. Bullard in the manufacture of lathes. Mr. Laws was followed into the office by S. Wilmot, who with a Mr. Hobbs (no relation of A. C. Hobbs I believe) was rolling sheet metal by a new process invented by Mr. Wilmot. Seeing the micrometer in my hand, Mr. Laws put his hand into his pocket and drew forth a micrometer and extending it, he shook it at me and said: "There's the first micrometer ever made." Mr. Wilmot immediately pulled a counterpart of Laws' micrometer out of his pocket and then Mr. Hobbs cried out, "Hold on," and opening a drawer in his desk he fished out a third micrometer. Mr. Laws' name was stamped on the frame of his micrometer. Mr. Laws and I had been employed at the same time by the Eaton, Cole & Burnham Co. in Bridgeport, my position there being superintendent, and very often in sport, I had stolen the micrometer, always to be found out and abused by Mr. Laws in his peculiarly fantastic language, the style of which was never paralleled, as those who knew him, will agree.

Mr. Wilmot then told something of the history of the micrometer. He said that he and Mr. Hobbs had disagreed over the gage of a lot of brass supplied by the Bridgeport Brass Co., where Mr. Wilmot was Superintendent, and both got pretty warm discussing the matter. Mr Hobbs finally said that there ought to be a better way of determining the thickness of sheet metal than by using a slot in a piece of steel. Mr. Wilmot said; "Yes, and I will make something that will do it, and tell us what is the percentage above and below any nominal thickness asked for." Mr. Hobbs replied: "If you can, you will save the world a lot of trouble" Mr. Wilmot then stated that he had seen in the plant of R. Hoe & Co., New York City, some years before, a measuring machine that had given him the idea of the micrometer now before us. He made a sketch and showed it to Mr. Laws, who gave it to Hiram Driggs to make. Six micrometers were made by Driggs from the sketch.

Mr. Laws always insisted that he had specified forty threads to the inch for this tool and twenty-five graduations on the thimble and Mr. Wilmot claimed the same suggestion. I never knew a better toolmaker than A. D. Laws, and I knew his bent of mind thoroughly. I am sure he never could, and never would have thought that $40 \times 25 = 1000$—that was not in his line. I was told by Mr. Driggs that Mr. Laws wanted the screw cut and the barrel divided so as to read to sixty-fourths inch and finer. Knowing Mr. Laws as I did, I believe the statement true.

Of the six micrometers made, four can be accounted for as being in the possession of the persons named in the foregoing. Where the others went, I have tried in vain to find out. I understand that W. F. Durfee had one and that Isaac Holden was at one time in possession of the other. It may be possible that some of your old subscribers in Bridgeport could tell us where these tools are.

Mr. Wilmot showed me a key-ring which Mr. Driggs had made for him and which, with the measuring instrument seen in the Hoe plant, gave him the idea of the micrometer. The key-ring was of the wire link type with a piece of tubing provided to close the gap on one side where the keys were inserted. A light spiral spring inserted in the tube held it in position. Mr. Wilmot's first idea was to graduate the part of the ring over which the tube slipped, and to insert the metal to be measured between the abutment and the end of the tube, making the spring produce the required contact. But this did not give fine enough measurements, and in talking the matter over with Mr. Laws, he suggested using a thread instead of a spring, and graduating the tube, as was done later on the micrometer. Mr. Driggs suggested dividing the other parallel side of the key-ring micrometer into tenths, enlarging the end of the tube to a disk and dividing this in order to obtain larger and more visible divisions. A central or revolution line, of course, was required on the coarser division side

But the Brown & Sharpe Mfg. Co. undoubtedly gave to the world this most valuable measuring instrument, no matter whether it originated in France or in Bridgeport, Conn.

* Address: 236 Hempstead St., New London, Conn.

* * *

Experiments undertaken to determine the hardening quality of various oils used for quenching baths indicate that mineral oils are superior to cotton-seed and fish oils in their hardening effect. If the hardening effect of water is assumed to be 1, the hardening effect of mineral oils varies from 0.16 to 0.24, while the hardening effect of cotton-seed oil seldom exceeds 0.16, or of fish oil, 0.15. Rosin has a hardening effect of from about 0.13 to 0.14

PROVIDING FOR UP-KEEP IN DESIGNING JIGS AND FIXTURES*

THE INCORPORATION OF FEATURES WHICH REDUCE THE COST OF MAINTAINANCE OF TOOLS

BY ALBERT A DOWD†

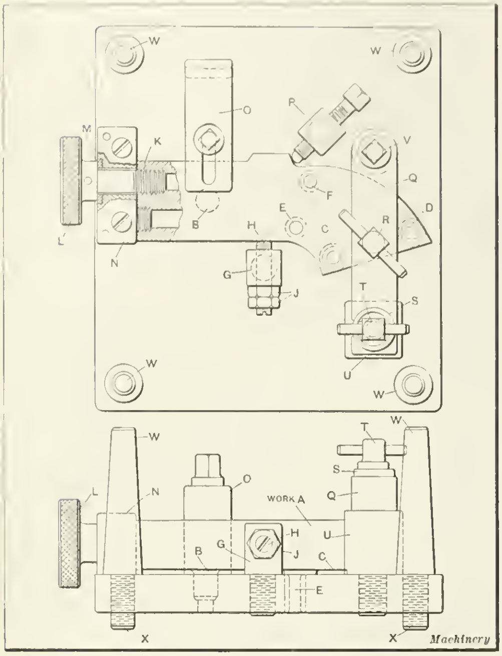


Fig. 1. Jig used for drilling Receiver of Air Rifle

THE importance of providing for up-keep in the design of every sort of fixture used in manufacturing work cannot be over-emphasized, and the designer should not fail to take precautions which will cover this point. In many cases provision for up-keep can be incorporated in the design without increasing the first cost of the fixture to any great extent, while in other instances considerably extra outlay may be necessary. Much depends upon the accuracy required in the finished product and the number of pieces which are to be machined. For example: In gun work, when great quantities of parts are to be produced, no expense is spared in making the fixtures in as durable a manner as possible, and in making provision for the replacement of worn locating points, surfaces, or the like. On machine tool work, however, discretion must be exercised, so that the expense of fixtures may be consistent with the required rate of production and accuracy of the work.

Many factors influence design in this regard. The size and general character of the work determine the type of machine on which the fixture is to be used, and, therefore, the need for stability and strength. The number of pieces to be machined is a factor which must be considered, for it is apparent that a small number does not require any special care to be taken in regard to the matter of up-keep while a large number may possibly need several fixtures in order to produce the necessary amount of work. In drill jig work, the locating points, bushings, and feet may be made so that they can be readily replaced when abuse or wear of these parts tends to cause imperfect work. The probable necessity for replacements is naturally determined by the rate of production that is required. Another condition which is especially prevalent in drill jig work is the abuse which this class of tool frequently receives. If of too light a construction, the rough handling to which these tools are subjected is often the cause of breakage, and it will be found of advantage to make sure the amount of metal in the jig is sufficient to ensure freedom from breakage in the event of careless handling. Milling fixtures are frequently required to stand very heavy cutting so that great rigidity is an important feature in their construction.

In the case of horizontal turret lathe fixtures or others which revolve about a fixed center, it may frequently be found desirable to make locating rings, points, or surfaces in such a way that adjustment can conveniently be made about this center. A few noteworthy points of construction are given herewith. First:—Location of the work. This is of primary importance and the various fixed points provided in the fixture should be made in such a way that they can either be readily replaced or adjusted, according to circumstances. Second:—The number of pieces to be machined should receive proper consideration in the design, both in regard to cost of the fixture and in regard to probable necessity of replacements. Third:—Weight and rigidity of the fixture. This point is naturally somewhat dependent on the class of work for which it is intended, and the convenience of handling. Fourth:—Gibs. In the case of indexing or sliding fixtures, suitable provision should be made for adjustment by means of gibs or straps, in order that natural wear may be taken up. Fifth:—Cutting lubricant used. This seems a small point to consider in regard to up-keep, but a considerable difference will be found in the life of a fixture used with soda water or some kindred cooling compound, and one on which mineral lard oil is used. A drill jig used for a large number of pieces, and having cast iron feet, will be found to suffer considerably in accuracy when the soda water compound is used for drilling. Hardened steel feet should be used in cases of this kind. Sixth:—Revolving fixtures. Fixtures which revolve about a fixed center, if subjected to hard usage or used for a great number of pieces, may be advantageously provided with means of adjustment about the center of revolution. This is a refinement that is very infrequently

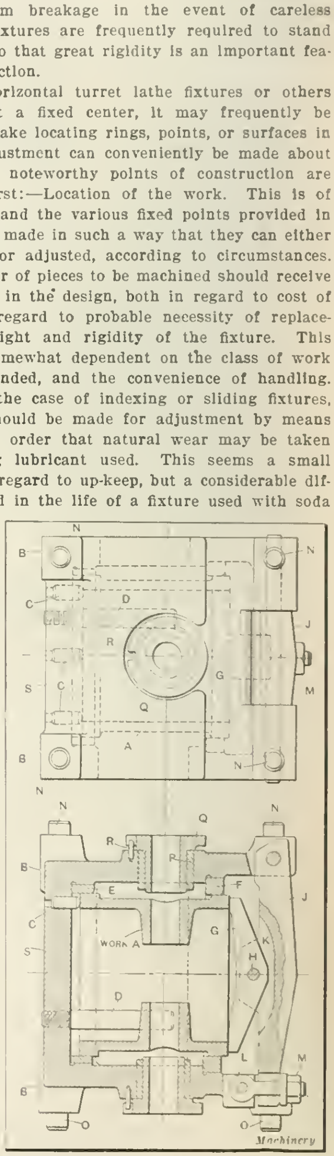


Fig. 2. Jig with Interchangeable Bushings for Different Tools used in machining Cylindrical Part A

* For additional information on the design of jigs and fixtures published in MACHINERY see the following articles by Albert A. Dowd: "The Floating Principle as Applied to Fixture Work," May, 1915; "Machining Irregular Contours," March, 1915; "Compensating and Quick-acting Clamping Devices," January, 1915; "The Influence of Chips on the Design of Tools and Fixtures," October, 1914; "Methods of Holding and Machining Thin Work," August, 1914; "Counterbalanced Indexing Fixtures," April, 1914. See also the following articles: "Clamping Work in Jigs," December, 1913; "Economy in Tool Design," by E. H. Pratt, September, 1913; "Some Jig and Fixture Designs," by Franklin D. Jones, January, 1911; "Improved Method of Dimensioning Jigs and Fixtures," October, 1910; "Pertinent Points in Jig and Fixture Design," by C. Nosrac, August, 1910; "Standard Designs of Jigs and Fixtures for the Manufacture of Small Interchangeable Parts," by F. P. Crosby, published in two parts in July and August, 1909; "Proper Designing of Milling and Drilling Fixtures and Jigs," by R. B. Little, May, 1909; and "Jigs and Fixtures," by Einar Morin, published in thirteen parts from April, 1908, to April, 1909, inclusive.

† Address: 221 Grove St., Bridgeport, Conn.

used, and it is not necessary in the majority of cases unless extreme accuracy is required. There are few points in construction which are applicable principally to individual cases. These will be noted in due course, in subsequent paragraphs of this article.

Drill Jig for an Air Rifle Receiver Forging

The work *A* shown in Fig. 1 has been previously faced, milled and bored, and tapped at the end *K*, leaving four holes *C*, *D*, *E* and *F* to be drilled on the jig shown in the illustration. This type of jig is "built up" entirely from steel parts, a rectangular plate forming the base of the jig. The work is laid down on the hardened pin *B* and the heads of the two jig bushings *C* and *D* which are ground to a uniform surface. The threaded plug at *K* is provided with a knurled head *L* and draws the end of the receiver up against the steel block *N* which is screwed and doweled to the jig base. A thrust washer is provided at *M* and a slight float is allowed between the block and the plug. The stud *G* is screwed into the plate and the set screw *H* running through it forms an adjustable stop for the side of the receiver, check nuts being provided at *J*. After the work has been drawn up by the threaded plug at *K*, the set-screw in the stud *P* is used to push the work over against the point *H*.

The steel clamp *O* is slid into position and tightened, and the set-screw *R* in the swinging clamp *Q* at the other end of the work is brought to bear at that point. The clamp *Q* is pivoted at *V*, and slotted at the other end where it is locked by an application of the screw and washer *T* and *S*, a steel stud *U* acting as a support for this end. The four legs of the jig *W* are made of hardened steel, screwed into the plate and protruding through the other side to act as a rest when placing the work in position. It will be noted in the construction of this jig that all parts are easily replaceable or adjustable for wear, and that although the jig is somewhat expensive in first cost, the provision for up-keep is excellent. It is obvious that drilling is done *against* the clamps, so that these must necessarily be made somewhat heavier than would be necessary if they were simply required for holding the work.

Drilling and Reaming Jig for an Electrical Casting

The work *A* shown in Fig. 2 is part of an electrical machine, and has been previously turned and faced. It is required for this operation that the work be located by the previously turned and faced surfaces. The jig body in this instance is made of cast iron and is of box section, as shown at *S* in the illustration; it is bored out to receive the two hardened and ground locating rings *E* and *F*. There are three pins *C* 120 degrees apart, which act as stops for the end of the casting, the ends of the pins being rounded so that dirt or chips cannot find lodgement thereon and cause faulty locating. The pin *D* simply acts as a stop for locating the internal bosses on the work; and feet are provided at *B* so that jig casting can be set up on this end for loading purposes. A swinging clamp *J* is provided at the open end of the jig, and this clamp is provided with a rocker *G* which pivots on the pin *H*, slot *K* being cut for its reception.

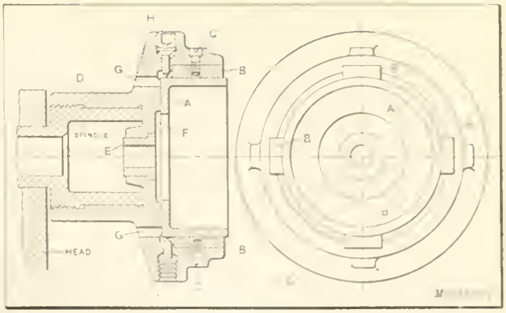


Fig. 4. Fixture provided with Interchangeable Jaws for holding Different Sizes of Work

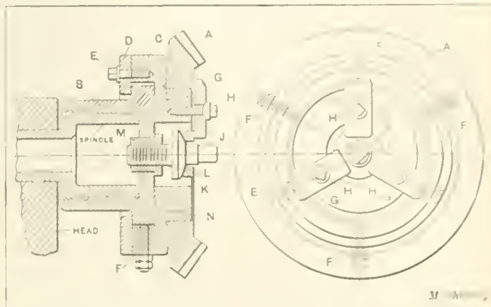


Fig. 5. Ring Bevel Gear holding Fixture provided with Adjustable Clamps

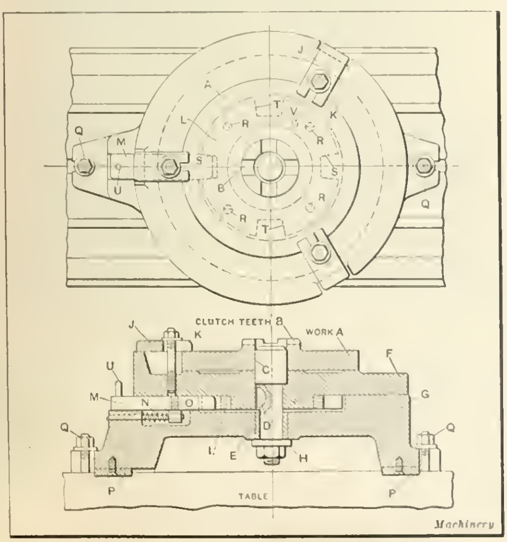


Fig. 3. Indexing Fixture used for milling Teeth in Clutch Gear

A swinging clamp-screw is located at *L*, which works in the slot on the end of the clamp *J*, the nut and washer at *M* being used to draw it up firmly. It will be seen that an equalizing action is obtained in this manner on the swivel *H*, so that pressure is equally distributed on the end of the casting. As it was necessary during the machining of this piece to use several sizes of tools and to work from both sides of the casting, it was found advisable to use liner bushings *P* in order to prevent undue wear. These bushings are hardened and ground, and forced into position; and the slip bushings *Q* are slotted to receive the pin *R* to prevent them from turning. The steel studs *N* and *O* on opposite sides of the jig body are ground to a uniform surface and act as feet for the jig. In connection with this jig it is well to note that all parts subject to wear are readily replaceable, thus making the life of the jig almost indefinite.

Indexing Fixture for a Clutch Gear

In every kind of indexing mechanism one of the chief points in design is to prevent variations in the spacing due to wear on the mechanism. The fixture shown in Fig. 3 is of a type which the writer has used in a number of instances and which is so arranged that wear on the indexing points is automatically taken up by the construction of the device, so that the provision made for its up-keep is excellent. In addition to this feature, the design is not very expensive and it may be made up at much less cost than many other kinds of indexing devices. The work *A* is a clutch gear, the clutch portion *B* of which is to be machined in this setting. As the work has been previously machined all over, it is necessary to work from the finished surfaces.

The body of the fixture *G* is of cast iron and it is provided with two machine steel keys at *P*; these keys locate the fixture on the table by means of the T-slots, and the hold-

down bolts Q lock it securely in position. The revolving portion of the fixture F is also of cast iron and gets a bearing all around on the base, while the central stud C is used as a locator for the work at its upper end, and holds the revolving portion down firmly by means of the nut and collar at H. The fitting at this point is such that the fixture may be revolved readily and yet is not free enough so that there is any lost motion. A liner bushing of hardened steel is ground to a nice fit on the central stud at E and will wear almost indefinitely, while an indexing ring L is forced onto the revolving portion F of the fixture, and doweled in its correct position by the pin V and held in place by the four screws R. The work is held down firmly on the revolving portion by means of the three clamps J, these being slotted at K to facilitate rapid removal.

A steel index bolt M of rectangular section is carefully fitted to the slot in the body of the fixture, and beveled at its inner end S so that it enters the angular slots S and T of the index ring. It will be noted that clearance is allowed between the end of the bolt and the bottom of these slots so that wear is automatically taken care of. A stud O is screwed into the under side of the index bolt and a stiff coiled spring at N keeps the bolt firmly in position. The pin U is obviously used for drawing the bolt back and indexing the fixture. Points worthy of note in the construction of this fixture are the liner bushing at E, the steel locating ring L, and the automatic method of taking up wear by the angular lock bolt M.

Fixture with Inserted Jaws for Steel Casting

The work shown at A in Fig. 4 is a steel casting which has to be finished on the inside. These castings are made in two sizes, one of which is 1 inch larger than the other. It was desired to use the same fixture for both pieces in order to avoid the expense of making two fixtures. (The larger piece of work is shown in the illustration.) For this purpose a fixture D was designed to be screwed to the end of the lathe spindle in the usual manner. There are four jaws B which rest in slots around the inside of the fixture, these jaws being drawn back into their seats by the screws C in order to be ground in place to the correct diameter. Beyond the ends of the jaws, the pointed hollow set-screws H are so placed that they will come opposite to the web portion of the casting. By placing them in this manner it is evident that the entire width of the web will resist the strain of the screws so that they will not distort the work. Further than this, the screws H act as drivers, as they sink slightly into the work when set up. Two holes G are drilled at opposite sides of the fixture, these holes being utilized to force the work out of the jaws when removing it from the fixture.

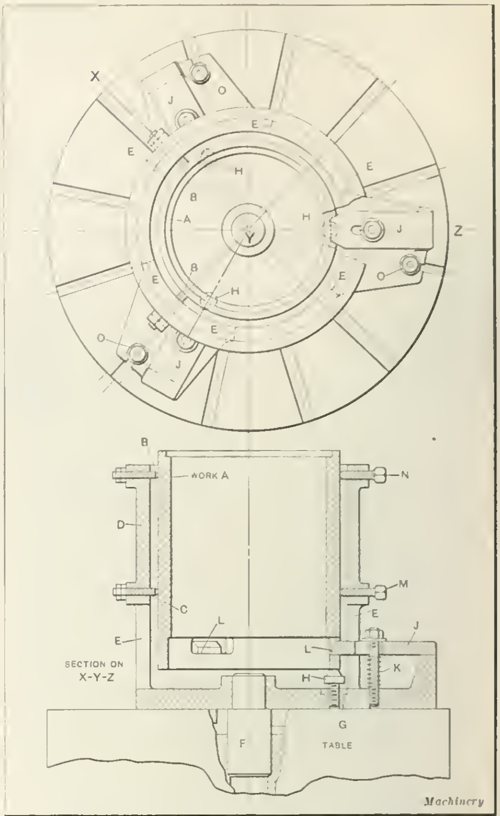


Fig. 7. Fixture for holding Casting A which is to be finished by a Single Operation

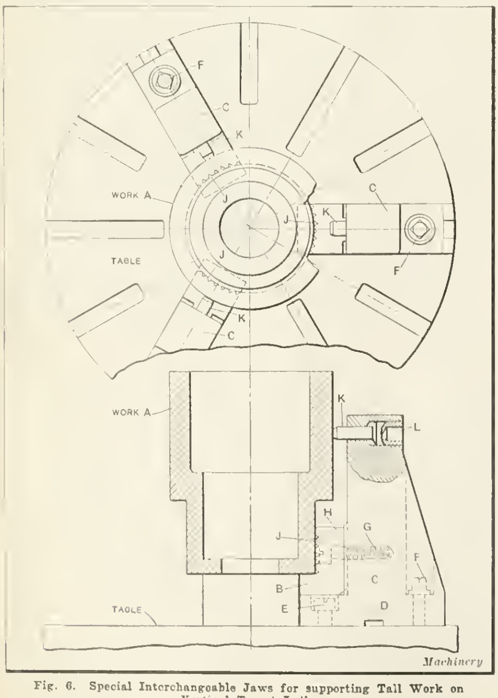


Fig. 6. Special Interchangeable Jaws for supporting Tall Work on Vertical Turret Lathe

A hardened and ground tool steel bushing E is placed in the fixture, and acts as a pilot for the cutter-head used in machining the work; and it will be noted that the surface F of the fixture is relieved to permit the passage of the tools through the work. In machining the smaller piece, it is only necessary to remove the jaws B and hollow set-screws H, and substitute those suited for the smaller piece. Therefore, one fixture was found sufficient to handle both pieces and replacements were made easy by the construction. Adaptations of this type of fixture may be made for many varieties of work, when several pieces are to be handled, and it will be found both efficient and economical in up-keep.

Bevel Gear Fixture with Adjustable Features

The work A shown in Fig. 5 is a ring bevel gear blank of heavy section, which has been partly machined. In this instance the fixture is really composed of two separate pieces, one of which B is screwed to the nose of the spindle while the other C is adjustable on the first piece. It will be seen by reference to the illustration that the piece C is clamped firmly against the body B of the fixture by the steel clamping ring D and the screws E, and it will further be noted that there is a slight clearance between the outside diameter of the body B and the inside of part C. Three set-screws F are equidistantly placed around the periphery of the ring C

and these set-screws are furnished with check nuts as shown. By loosening the collar *D* and manipulating the set-screws *F*, the working portions of the fixture can be readily trued up when they become slightly out of true through use or abuse. A steel locating ring *N* is forced on to the ring *C* and is ground to the size of the interior gear.

The method of clamping is somewhat out of the ordinary, consisting of the use of three clamps *G* and an operating screw *J* and a floating collar *K*. The three clamps are placed 120 degrees apart and have slightly oversize holes through which the screws *H* pass. These screws have a ball surface on the under side of the collar corresponding to a similar depression in the clamps themselves. A steel bushing *M* is fitted to the body *B* of the fixture, and is threaded with a coarse pitch thread which corresponds to that on the operating screw *J*. After the clamps *G* have been swung into place on the ring gear, a few turns of the screw *J* sets all three of them with a uniform pressure through the medium of the spherical collar *K* which bears against their inner sides. It

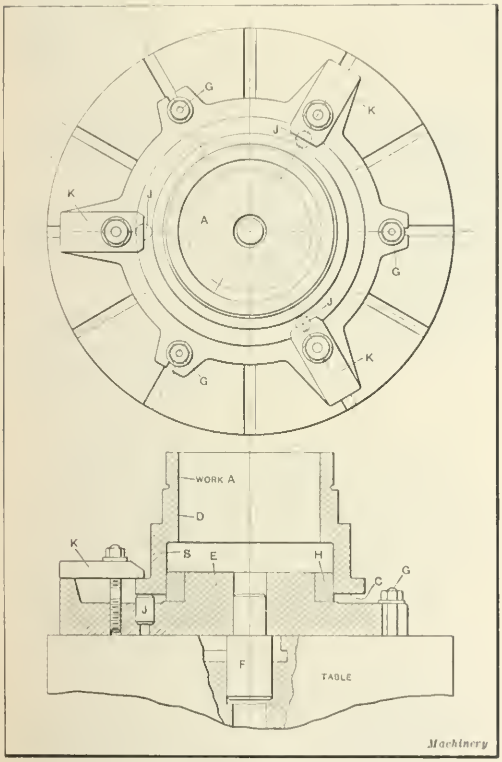


Fig. 8. Fixture for performing Final Machining Operations on Partially Finished Casting A

will be seen that although a fixture of this kind is somewhat expensive in first cost, all the parts can be readily replaced at a minimum expense and the fixture may also be kept true with the center of rotation of the spindle with very little trouble.

A Set of Jaws with Replaceable Features

The heavy hub casting shown at *A* in Fig. 6 is to be bored to the three diameters shown in this illustration, the vertical turret lathe was selected as the machine on which the work was to be done. As the casting was somewhat long, it was necessary to give it more support than would ordinarily be possible with the regular jaws, so that the special jaws shown were designed for this purpose. The body *C* of these jaws was made of steel, and was tongued to the sub-jaws of the table at *D*, being secured in place by the screws *E* and *F*. The auxiliary jaws *B* were shouldered and serrated at *J* to hold the lower portion of the hub. They were tongued at their outer end *H* and drawn up against the surface of the main jaws by the screws *G*. The upper portion of each of the jaws *C* was furnished with hollow set-screws *K* which were of the cup variety, a socket wrench being used at *L* to operate them. In use these screws are pulled back out of the way and the work centered by means of the auxiliary jaws after which the screws are tightened lightly against the upper portion of the casting in order to prevent vibration. As these castings were of steel there was considerable wear on the inserted jaws due to the sand and grit in the castings, but as both jaws and set-screws were readily replaceable the provision for the up-keep was excellent.

Pot Fixture for an Electrical Piece

The work shown at *A* in Fig. 7 is part of an electrical machine, which is required to be finished in one operation. Three holes are provided in the casting at *L* for clamping purposes only. The body of the fixture *D* is of cast iron, and is centered on the table by the plug *F*. Three screws *O* are provided to hold the fixture in place The vee principle is used in locating the work; the four set-screws *B* and *C* form the angle of the vee, and the casting is pushed firmly over against these points by the screws *N* and *M* on the opposite side of the fixture. The work rests on the three screws *H*, these screws being adjustable for height so that they may be operated in such a way as to both tip the casting or to secure a firm support. The pot casting which forms the body of the fixture is cored at the three points *E* both for the removal of chips which would naturally accumulate on the interior, and also to provide access to the adjusting screw *H*. In order to provide against wear, the bushings *G* are set into the base of the fixture and are threaded to correspond with the adjusting screws. The clamping is accomplished by the three clamps *J* which draw the casting firmly down on the adjusting screws. The springs *K* simply keep the clamps up when they are not in use. By making the set-screws *B* and *C* adjustable, it is possible to take care of variations in a lot of castings by making suitable changes in the screws, and, as very frequently there are changes caused by two or more patterns being used, this point is very valuable.

Fixture for a Hub Casting

The work *A* shown in Fig. 8 is a hub casting which has been previously machined on the surfaces *B*, *C*, and *D*. The fixture *E* on which it is held for subsequent operations is made of cast iron; it is centered on the table by the plug *F* and held down by the screws *G* which enter the table T-slots. A steel locating ring *H* is forced on to the body of the fixture and forms the point of location for the work. Three studs *J* are set 120 degrees apart in the base; and they are surface ground to the correct height to support the work. This arrangement makes locations positive regardless of chips or dirt. The clamps *K* hold the work down on the pins *J*. Features of this fixture are the ease of replacement of the locating rings and points, and freedom from trouble which might be caused by an accumulation of chips or dirt.

* * *

The Pennsylvania R. R. operated 69,306 passenger trains in the month of June, 1915, and 90.7 per cent of them arrived at their destinations "on time." Ninety-four per cent made the schedule time on their runs. A train may leave one terminal 5 minutes late, make its schedule time over a division, and arrive at its destination 5 minutes late. Any train not over two minutes late is counted "on time." The Buffalo division operated 971 trains in June and 98 per cent of them were on time. The Allegheney and Monongahela divisions had 96.8 per cent of their trains on time, while the Bellwood and Baltimore divisions had records showing a fraction over 95 per cent on time. Ninety-nine per cent of the passenger trains on the Bedford and Bellwood divisions in June made schedule time, while the records for the Buffalo, Cresson, Renovo, Allegheny and Tyrone divisions showed that over 98 per cent made schedule time. Only one division was under 90 per cent. The records show there has been a steady improvement in the past year in the number of trains arriving on time and making schedule time over the divisions.

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THE SCIENCE OF MACHINE TOOLS

The undoubted lack of adequate knowledge of the principles underlying the cutting of metals is obvious to those who have tried to depart from the beaten path of machine-tool and cutting-tool development. In steam engineering, the principles governing the action of steam have been laid down mathematically. In electrical engineering, the refinement of scientific knowledge has been carried to such a degree that the efficiency curves of an electrical machine of a new type may be drawn before the machine is even designed on paper. In the machine-tool field, however, the design of a new machine is not based upon exact principles, but simply upon a knowledge of what it has been practicable to do in the past, and a reasonable judgment as to what might therefore be expected. Hence the many possibilities in the art of cutting metals are as yet far from being realized, even with the aid of the best modern machine tools.

Are these statements borne out by facts? In the most thorough experiments so far made in the cutting of metals, the investigator has developed a new kind of steel, and laid down certain laws as to the method of obtaining the best results, but he has retained essentially the old form of cutting tools, without questioning their value as compared with other possible forms. A later investigator finds that by a radical change in the cutting tool itself and also of the principle of removing the chips, cutting-speeds four times as high as the best previous results, may be obtained. How much more can be done is uncertain, as the theory of metal-cutting is practically unknown. We do not yet fully understand what takes place when a chip is severed from a bar, nor do we know why the chip and the tools heat up. We know very little definitely about cutting-angles of tools. A. L. DeLeeuw, who has made some interesting and valuable experiments along these lines, finds that a tool with an inclined angle of 25 degrees applied in a radically new way to the work (the tool being circular, and rotating as it cuts), will stand up for an unprecedented amount of work as compared with the best regular lathe-tools. In fact, these tools have so great a capacity for removing metal that no existing types of machine tools have the power and rigidity required for their regular use.

In steam engineering, which has been reduced to a science, it is possible to state within quite close limits what is the highest efficiency obtainable from one pound of coal of a given quality; in electrical engineering, the percentage of efficiency from the prime mover to the motor may be determined to a nicety; but in the removal of metal, we have not yet determined the fundamental laws of metal cutting. We cannot say how much power is really necessary, for example, to remove a pound of metal under certain conditions. We know little as to the limitations of efficiency of machine tools; but we know that a very large percentage of the power expended in driving a machine is wasted in friction before reaching the cutting point and we know that we have not reached the limit of efficiency in shaping cutters.

* * *

STANDARDIZATION OF DRAWINGS

One of the commonest causes of mistakes and misunderstandings in manufacturing is the lack of uniformity of practice in making drawings. The evil is particularly felt in jobbing shops which bid on contracts after having studied the drawings submitted. Frequently these drawings leave much to inference and imagination, but it is a serious matter to bid on a product in the belief that a certain standard of manufacture is required when a higher or a lower one is wanted. If the would-be contractor assumes that the standard is too high, he probably bids too high, and if he assumes that it does not call for high-grade work, his bid may be too low for making a living profit.

The paper "Reform in Drawings" read by Mr. Fish before the National Machine Tool Builders' Association Convention called attention to the mistakes which result from the misunderstanding of drafting-room conventions and practice, not in accord to commonly accepted methods. Here is an opportunity for the Society of Automobile Engineers to add to its already great work of standardization by fixing conventions —by the expression of limits and tolerances, the placing of dimensions, uses of dotted and broken lines, etc.—in short everything which makes a drawing a conveyor of specific instructions for making a part.

The work of standardizing drawing practice will doubtless be extremely difficult, but if a national body of engineers were to adopt a standard of practice, it would soon be used in the technical schools and in up-to-date manufacturing plants.

* * *

THE MACHINE TOOL INDUSTRY

Never was there a time when the machine tool trade looked brighter than it does at the present moment. The demand for engine and turret lathes, milling machines and other machine tools employed in the manufacture of shrapnel, explosive shells and rifles, is unprecedented; and the indications are that this will continue for some time. This boom in the industry recalls other periods of sudden and extraordinary demand like that which accompanied the remarkable development of the bicycle industry in 1896, and of the automobile industry in 1906. But, while the bicycle industry rapidly declined, the automobile business shows little indication of lessening in the immediate future.

The introduction of the automobile had a far-reaching effect upon the machine tool industry and machine tool design. The demand for high-grade materials capable of withstanding shocks and stresses of high-speed cars, made it necessary to design machine tools capable of working the metals at economical speeds and feeds. These demands, in turn, showed weaknesses in machine tool design and construction. For example, it showed that cast-iron gears were entirely inadequate in many cases. Consequently, the constructions which had been found reliable in automobile design, were adopted and used in modified forms in machine tools.

Under the heavy pressure of war orders from abroad, the builders of machine tools and other machines used in the manufacture of munitions of war were confronted with the problem—How may capacity be increased? To greatly increase capacity is not an easy matter. To build new plants or to add extensively to old ones if often inadvisable—especially when the demand for a product is abnormal. The safest policy for meeting the emergency is to utilize the present facilities more than ten hours a day; and this means probably the organization of a night force.

CARBURIZATION AND HEAT-TREATMENT*

THE CARBURIZATION OF STEEL AND THE HEAT-TREATMENT OF CARBURIZED PARTS

BY J. GERRISH AYERS, JR.†

FOR certain uses steel parts are required to resist wear and at the same time be sufficiently tough to withstand shocks. Unfortunately, toughness and hardness are two properties which are completely opposed to each other in steels. If we harden a 1.00 per cent carbon steel so that we obtain the hardness desired, it will be too brittle to withstand loads or shocks. If we then draw it back or temper it so that it possesses the requisite toughness, it will lose too much of its hardness to answer our purpose. On the other hand, if we choose a 0.20 per cent carbon steel, which would possess the desired toughness, it would be incapable of becoming hard enough.

It is obvious that the ideal steel for this purpose would be one which was high in carbon at the portions we required hard and low in carbon elsewhere, to obtain the requisite toughness. There is but one way to obtain such steel; this is by the carburizing process.

In this process, steel parts of low carbon stock are packed in metal boxes or pots with a carbonaceous compound. Those portions of the steel which are required to be hard are surrounded with the compound, while those portions which are to be soft and tough are surrounded with sand, or otherwise suitably insulated from the action of the compound.

These pots are then sealed and placed in a carburizing oven or furnace and maintained at a heat of 900 to 1000 degrees C. (1652 to 1832 degrees F.) for a length of time depending upon the extent of the carburizing action desired. By so doing, carbon derived from the carburizing compound is absorbed by the steel at the spots desired and the low carbon steel is converted into high carbon steel at these portions, while the insulated spots retain practically their original low carbon content.

We therefore have obtained exactly what we required—a steel of dual nature—a high carbon and a low carbon steel in the same piece. After the steel has been carburized it must be heat-treated to develop its properties of toughness and hardness to the fullest extent. As we now are dealing with a steel which is in reality two steels in one, a high and low carbon, it is obvious that to heat-treat it correctly we must give it two distinct heat-treatments, one to suit the high carbon portion or case, as it is termed, and one to suit the low carbon portion or core.

Fig. 1 shows pieces of steel so treated. Piece *A* shows poor heat-treatment resulting in an incompletely refined core; *B* and *C* show pieces perfectly treated with the case clinging to the core even after the pieces are bent double upon themselves; *D* and *E* show fractures of alloy steel with fine case and core. Having thus briefly described the process, we will be in a better position to proceed with its study in detail.

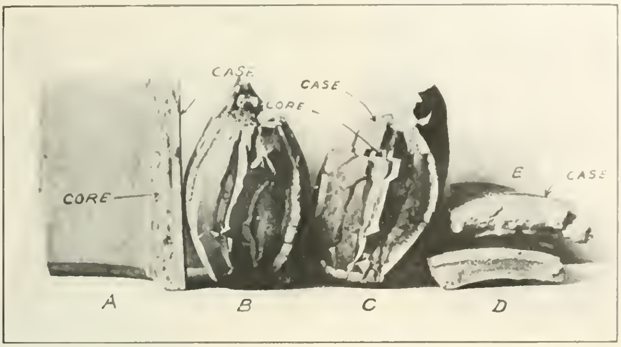


Fig. 1. Samples of Carburized and Heat-treated Steel showing Difference in Results obtained

Theory of the Carburizing Action

When it is difficult to explain the chemical or physical action involved in a process, there are generally a host of theories advanced. This is true in the case of the carburization of steel. We will not dwell here upon the many hypotheses and theories evolved in the past for the explanation of the carburizing action as we are more interested in present-day opinion.

The carburization of steel may be effected by gas, liquid, paste or solid preparations. The last medium is under discussion in this article, being in more general use. The fact that carburization can be effected by gases alone has led to a series of researches by various investigators as to just what gases play the major part in the process. It has in consequence been found that the carburization is effected chiefly by carbonaceous gases, principally carbon monoxide and volatilized cyanogen compounds.

The former gas results from the partial combustion of the carbon contained in the carburizing compound, the latter from the decomposition of cyanide compounds contained in the mixture or from a combination of atmospheric nitrogen with the carbon in the compound. Carbon by itself has practically no effect. As the carburizing gases mentioned diffuse through the metal converting the outer portion into higher carbon steel, there is at the same time a diffusion of carbon from these more highly carburized zones inward toward the lower carbon interior of the piece. In this manner, the penetration of carbon extends deeper and deeper as the time of the action is prolonged.

It must also be observed that not only does the heat of the furnace convert a portion of the solid carburizing compound into effective carburizing gases, but it also heats the steel to a temperature at which the iron has a pronounced affinity for carbon. Carburizing action may take place as low as 560 degrees C. (1040 degrees F.), but commercially not below 849 degrees C. (1560 degrees F.).

The Carburizing Compound

We have already observed the manner in which carburizing takes place. To one who is familiar with the theory, it is obvious that there must be many compounds which, from a chemical standpoint, will produce the desired action. It is perhaps due to this that so many different compounds are on the market and each is giving satisfaction to its own circle of adherents.

In different shops different classes of work are handled. Each must meet certain requirements. A mixture which would give satisfaction in one case might be entirely unsatisfactory in another. Where very small amounts of the compound are used each day, the cost per pound is not such a vital or impressive factor as where several tons are used. In the former case, rich cyanogen compounds, very active, giving rapid penetration, may find favor in spite of their short life due to rapid deterioration.

On the other hand, where large heavy pieces, requiring extreme depths of case, and hence, long runs in the furnace, are handled, a short-lived mixture would not be suitable. With solid work, such as shafts or arbors, which require no packing with sand or other insulating material, a finely ground mixture may be employed, but where sand is used

* For other articles on carburizing and the heat-treatment of steel see "Automatic Heat Control" in the December, 1914, number of MACHINERY; "Locating the Critical Range with the Brinell Ball Tester," December, 1914. "A Modern Heat-treatment Plant," September, 1914. "Some Recent Improvements in Casehardening Practice," August, 1914. "Hardening Bolts by the Ton," June, 1914; "Gas and Oil Fired Furnaces for Heating Steel," May, 1914; "The Accurate Heat-treatment of Roller Bearing Parts," April, 1914, and articles there referred to.

† Address: 191 Roseville Ave., Newark, N. J.

a coarser mixture which can be separated from the sand by screening is advantageous. It can therefore be readily seen that there is much diversity in requirements for compounds and this accounts in some measure for the diversity of opinion as to their respective values and efficiencies. There is no one compound which is ideal in all respects and only the uninitiated will recommend one particular compound for general application to all classes of work. As soon as investigators recognize this point their results will be of more practical value. Each metallurgist should study his own particular requirements and then strive to produce a compound to fulfill them.

When an extremely rapid rate of penetration is required cyanide compounds are frequently employed. A molten bath of potassium cyanide gives a very rapid penetration, but

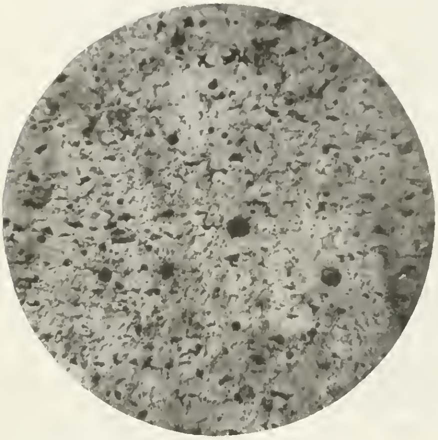


Fig. 2. Photomicrograph of 0.12 per cent Carbon Steel. Magnification, 300

only a superficial case. It is not effective for extreme depths of penetration and its use has many disadvantages, due to the dangerous nature of the gas given off. It is frequently added to compounds to aid them in giving rapid action and a very intense concentration of the carbon.

Even for this purpose it is not to be recommended, as due to its rapid deterioration, it soon constitutes an inert element in the mixture, particularly where it is customary to use a batch of the compound repeatedly with a certain renewal of fresh material. Compounds of cyanide such as prussiate of potash (potassium ferro-cyanide), while not quite so energetic in their action, are less dangerous to handle.

Wood charcoal is one of the best bases for a compound. It is a good carburizer and is to be particularly recommended on account of its long life. It should always be used in conjunction with some other element, as alone it has too slow a rate of penetration for commercial carburizing. In Europe it is frequently mixed with various proportions of barium carbonate and has found much favor. This mixture, however, requires a temperature of at least 1000 degrees C. (1832 degrees F.) to give its most efficient results. This temperature is higher than is considered good commercial practice and entails excessive deterioration of pyrometers, pots and furnaces, and in some cases the steel itself. When cyanide is added to the mixture there is also a tendency for fusion to take place at this temperature, and the ware does not come out of the pots clean and free from adhering particles. Some of the proportions recommended by various investigators are given below:

A 40 parts by weight barium carbonate.
60 parts by weight wood charcoal.

B 60 parts by weight barium carbonate.
40 parts by weight wood charcoal.

36 parts by weight barium carbonate.
C 54 parts by weight wood charcoal.
10 parts by weight potassium ferro-cyanide.

Of late, wood charcoal derived from poplar wood has been recommended, due to its low sulphur content. Mixture *A* gives a very high carbon content; mixture *B* produces a case lower in carbon and less likely to chip off, due to brittleness; mixture *C* gives perhaps the highest carbon content at the extreme outer zone of the case.

All of these mixtures compounded with barium carbonate require a minimum temperature of about 1000 degrees C. (1832 degrees F.) to act efficiently, as has already been noted. They also have a tendency to render the ware very dirty as it comes from the pot after cooling down. In some cases a decided blistering of the surface of the ware has also been noticed.

Mixtures of charcoal, burnt leather, charred bone, and bone-black in various proportions and combinations are frequently employed. There is apparently quite a latitude in the proportions which may be used to give satisfactory results. The charcoal acts as a base to which the other ingredients impart their respective properties. Compounds of the above nature are not likely to fuse at temperatures below 1000 degrees C. (1832 degrees F.) and generally produce ware which is free from any soot or other matter adhering to the surface.

Compound *D*, given below, would be a characteristic one of this class and gives very satisfactory results. When employed at a temperature of about 960 degrees C. (1760 degrees F.) it exhibits good penetration, gives a case which is not likely to chip off and ware which is remarkably clean and bright on the surface.

35 parts by weight wood charcoal.
D 30 parts by weight burnt leather.
35 parts by weight charred bone.

In making compounds we fortunately have a ready means for arriving at their particular advantages by actual comparative tests. This is really the best and most practical way to develop a compound suited for any particular case. If possible, the steel employed in these tests should be of the same analysis as that with which the compound is to be

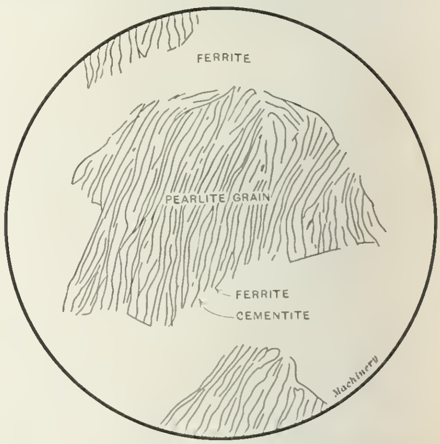


Fig. 3. Sketch illustrating Appearance of Pearlite Grains at a Magnification of 1000

employed. In addition to this, to make the test strictly comparable the specimens should be cut from the same bar of stock. If this is impossible, careful analysis should be made to insure that all specimens are from steel of practically identical analysis. Cylindrical pieces presenting a circular cross-section are more suitable than those of rectangular cross-section, as they absorb the carbon to a more uniform depth. In no case should extremely small sections be used to test the compound for deep penetration, as the case will then practically extend almost through the piece and it will be very easy to make an error in estimating its exact depth.

In a test of this nature we are particularly interested in determining the following factors: The rate of penetration, the quality of the case, and the cost per cubic foot of the compound.

Having obtained specimens meeting the requirements already mentioned and all of the same size, we may pack, say, about six each in pots containing the several mixtures under investigation. Round pots are to be preferred to rectangular ones, for they give a more uniform heat throughout their interior, and hence the test specimens will be acted upon more uniformly. The temperature of the carburizing furnace and the duration of the run should be the same as the practice in the shop. These factors are very important, as some carburizing compounds give very satisfactory results for short runs, but rapidly deteriorate as the time in the furnace is prolonged. The same variation in results may be caused by the effect of different temperatures on various compounds.

When the run has been completed, several courses of procedure are open for heat-treatment and examination of the specimens. It must be borne in mind that the long run in the furnace at a high temperature has given very favorable conditions for the formation of large coarse grains in the steel specimens, both in the case and the core, particularly the latter. If we quench directly from the pot we will be able to refine the core to a certain extent, but the case will be extremely coarse. The results, however, are often satisfactory enough to define the limits of the case and core. A better method is to follow this first quenching by a second heat-treatment and quenching at a temperature which is lower and suited to refine the case. The ideal method, from the standpoint of perfectly refining the case and core, is to allow the work to cool in the pot and then give it two heat-treatments, one exactly suited to refine the core and the second to refine the case.

After being satisfactorily treated, the test specimens should be broken in two and the depth of case given by each mixture determined. In breaking the specimens, one side is subjected to compression and the other to tension, and this often produces a great dissimilarity in the appearance of the fracture. In instances where the case heat has been very low and the specimen is of low carbon stock the core will be pulled over into the case and lead to the erroneous conclusion that the case is extremely thin at this point. Another heat-treatment of this specimen at a somewhat higher temperature with a fresh fracture will show the correct depth of the case. A little care and experience will soon prevent incorrect conclusions on this point.

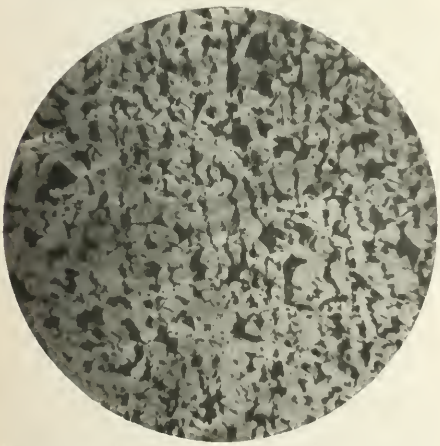


Fig. 4. Photomicrograph of 0.42 per cent Carbon Steel showing Greater Number of Dark Grains. Magnification, 300

Quality of the Case

The quality of the case is a very important consideration. Some compounds give a high carbon case for a short distance into the specimen, beyond which the case possesses a decidedly lower carbon content. Others give a fairly uniform carbon content over the greater portion of their penetration. The running temperature is also a factor which affects the distribution of the carbon in the case and it is for this reason that it is recommended to run the test at the same temperature as is in vogue in the shop.

The query naturally arises as to what constitutes a case of high quality. This point depends, just as should the nature of the compound, upon the requirements of the work. If a heavy load is to be carried by the article a deep case will be required, particularly if the core is of very low carbon steel. If the surface required must be extremely hard a case of high carbon content is essential. If the article has many sharp corners or very thin portions, which might give an opportunity for the case to chip off, we must lower the carbon content to suit this requirement.

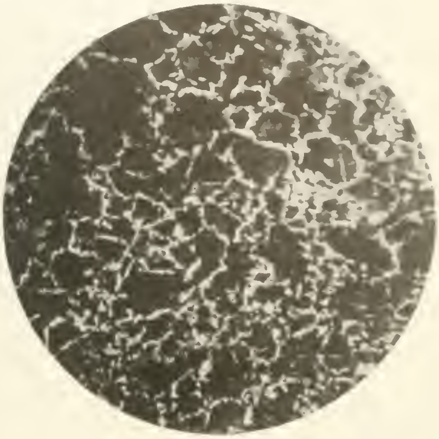


Fig. 5. Photomicrograph of 1.00 per cent Carbon Steel showing Excess of Carbide of Iron or Cementite Grains. Magnification, 100

We must also bear in mind that it is not the extreme outside surface of the piece as it comes from the carburizing furnace that must conform to the requirements as regards carbon content, but that portion which will be exposed after the finished grinding operations. For example, a piece might be carburized to 1.00 per cent carbon content for a depth of 0.015 inch after which the content might lower to about 0.70 per cent. If the grinding process should remove 0.025 inch, as is sometimes the case, we would then have exposed a 0.70 per cent carbon zone which would not give us the desired hardness.

To make an accurate determination of the extent and character of the different zones of the case would require a very careful and laborious analysis of successive layers. In this connection we may more wisely resort to the use of the metallurgical microscope which has proved of inestimable value for this purpose. Its efficient use, of course, requires a certain amount of experience and knowledge of the principles of metallography. We will only briefly outline the theory and procedure here, as this knowledge can best be acquired in the many excellent works on this subject.

Steel as it leaves the manufacturer may be in any number of different states as regards its microstructure. In order to study it under the microscope it should be heated to about 1000 degrees C. (1832 degrees F.) and then cooled very slowly. The different constituents then appear in what is called the normalized state and we can resolve one from the other. The steel must then be polished with successive grades of abrasives until a mirror-like polish has been given to its surface. The steel is then etched with a suitable reagent which acts unequally upon the different constituents, turning some darker than others, so they can be distinguished under the microscope.

If we now examine a piece of low carbon (about 0.12 per cent) steel under the microscope it will appear as shown in Fig. 2. The dark grains are called pearlite. The white background is called ferrite, and consists principally of iron with a few impurities.

If we examine the dark grains at a higher magnification,

they will appear as shown in Fig. 3. The white laminations are carbide of iron Fe_3C called cementite and the dark laminations are ferrite. In other words, a piece of low carbon steel, treated as mentioned, consists of a white background of iron or ferrite, interspersed with a few dark grains which consist also of some ferrite or iron in laminations or layers separated by laminations of carbide of iron, or cementite. We may summarize thus:

White background = iron = Fe = ferrite.
Dark grains = iron + carbide of iron = $Fe + Fe_3C$ = pearlite.

If we examine higher carbon steel, treated in the same way, we will notice that the chief difference in appearance is a larger number of dark grains, due to the increase of carbon. See Fig. 4. It is obvious that there must be a steel of high enough carbon content to be composed of all dark grains and no white background. This steel would, therefore, be composed wholly of pearlite. If now, we examine a steel with still more carbon, we will notice a re-appearance of the white grains, but in this instance they are carbide of iron or cementite grains, as this would naturally have to be the excess element when we increase the carbon. See Fig. 5.

Steel which is composed wholly of pearlite is called eutectoid and contains from 0.80 to 0.90 per cent carbon. All steel under this in carbon content is called hypo-eutectoid, and all steel over 0.80 to 0.90 per cent is called hyper-eutectoid. The foregoing facts should be thoroughly understood as they are the ABC of metallography.

If we take a piece of this normalized steel and heat it to, say 840 degrees C. (1544 degrees F.) and quench in water, it will become hardened. If we now repolish, etch and examine again under the microscope, we will be unable to observe any large dark and light grains, but a very fine structure lacking in any particular detail. It would seem as if this treatment had caused the grains we observed before, to become merged together into a solid solution. This is just what has occurred and the steel is in the state of a solid solution. The main difference between a solid solution and a liquid one is that the former takes place among the constituents of a solid. Heating the steel to this temperature has allowed the solution to form, and cooling it suddenly has locked the steel, so to speak, in this condition. If we now reheat the steel or draw it back, starting with a low heat of, say, 149 degrees C. (300 degrees F.) and increase it, the steel gradually returns to the normalized state if we heat it high enough. While doing so it naturally passes through several transition states. These are starting with the solid solution state, called: austenite, martensite, troostite, sorbite, and pearlite.

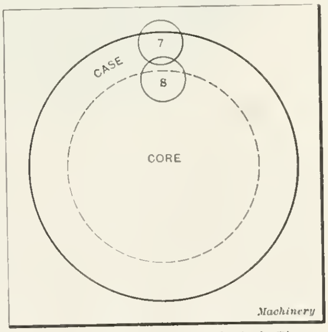


Fig. 6. Cross-section of Carburized Piece showing Location of Portions shown in Figs. 7 and 8

In other words, this reheating and cooling without any quenching, unlocks the structure of the steel and allows it to return closer to the normalized state. Having thus briefly described these points, let us examine microscopically a piece of carburized steel which has been normalized, polished and properly etched. We may naturally expect to find all variations of carbon content from hypo-eutectoid in the core through eutectoid to hyper-eutectoid in the outer zone of the case. In fact, actual examination shows this to be true.

Fig. 6 represents a cross-section of the carburized piece and will serve to make clear the locality on the piece of each photomicrograph.

Fig. 7 is a photomicrograph which shows a portion of the bar from the outer edge inward almost through the depth of the case. We note the outer hyper-eutectoid zone where the light network is excess cementite, the succeeding eutectoid zone consisting of pearlite with practically no excess constituent, and next the hypo-eutectoid zone with pearlite and light ferrite grains.

Fig. 8 is a photomicrograph taken at the spot indicated in Fig. 6 and shows a part of the same portion of the specimen as shown in Fig. 7. The two white lines ruled through each photograph show where they might be cut and joined to make a continuous view. We note in Fig. 7 that the hypo-eutectoid zone as it extends inward toward the center of the bar, possesses fewer and fewer dark grains until we arrive at a point which is representative of the steel before it was carburized. It will be noted that in addition to the jet black pearlite grains there are apparently other dark grains although of a considerably lighter hue. These are ferrite grains which, due to different orientation of their crystalline matter, etch to different shades. The darker shading around the edges of the photograph is due, however, to unequal illumination of the specimen while being photographed. These effects cannot cause confusion in determining the pearlite grains, as they are so much darker.

In photomicrographs, Figs. 7 and 8, is shown a specimen which represents a good carburizing process. The case will be hard when heat-treated and will adhere well to the core. It sometimes happens, however, when a very high carbon case is obtained that the cementite instead of surrounding the grains in the form of a network actually penetrates them and by thus breaking up the continuity of the structure forms a very brittle article.

By careful study, one may become able to judge of the quality of the case as regards the extent of its zones, their carbon content and the physical structure of the case and core. Unfortunately in the present state of the microscopy of iron and steel, no satisfactory test has been evolved for the determination of the sulphur or any occluded gases. Where possible this should be obtained by chemical analysis, as it has a very important effect upon the quality of the article. If in determining the quality of the case we have no microscopical outfit at hand, we may test as follows:

After the specimens have been heat-treated and the depth of case determined, we should then proceed to test the surface for hardness, at successive depths (obtained by grinding) by either the file, scleroscope or Brinell ball tester. Having already become familiar with the requirements of the particular parts under test, we can readily find at what depth they cease to have the necessary hardness. This method does not compare with the microscope in giving complete details, but it is often sufficient for all practical purposes.

Cost of the Compound

The cost of the compound should be based upon volume and not weight, as a pot is always packed until it is filled and not with a given number of pounds. This is an essential point, and although very obvious is often overlooked. Most compounds are sold by the pound and to get a comparison of the cost we should convert this into cost per cubic foot. Having thus tested out the various compounds, we can then very readily form an opinion of their relative properties and value for the purpose in hand. We will now consider that we have chosen a suitable compound and proceed with the discussion of the actual operations in the shop.

Packing

In regard to the packing, we may divide the work broadly into two classes: first, straight packing, where the piece is carburized over its whole surface; and second, the packing of insulated work. We will discuss the former class of packing first.

In order that pieces be as evenly carburized as possible, it is essential that all portions be heated uniformly. Unfortunately, under commercial operating conditions it is impossible to realize this fully, but we may take certain precautions that will greatly aid in obtaining this object. The pot itself should be so designed that it permits the heat to have equal access to all of its sides, top and bottom. A pot

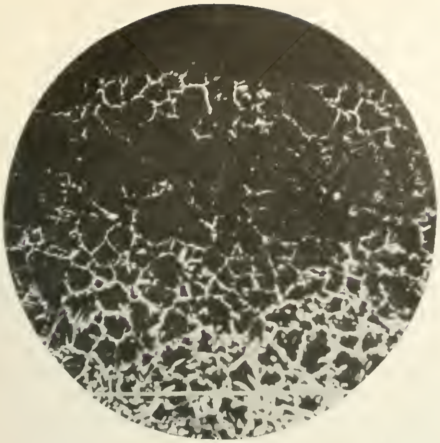


Fig. 7. Photomicrograph of Outer Portion of Caso. Magnification, 50

which takes almost the entire width of the furnace, but does not occupy so much of the length of the furnace will not heat equally. When several pots are placed in the furnace they should be spaced far enough apart to give the heat free access. If they are banked together the outside parts will be heated more rapidly than those in the center and the ware in the pots will not be carburized uniformly. In some furnaces the portion of the oven space nearest the door is considerably lower in temperature than the back of the furnace, due to the loss of heat through the door, which is not as good an insulator as the furnace walls. In this case the furnace should not be loaded so close to the door.

In packing the work in the pots care should be exercised to see that there is a tightly packed layer of carburizing compound of an inch or more in the bottom of the pot. If the parts are heavy this should be increased so that they cannot settle through the compound and come into contact with the pot walls. A layer of the parts to be carburized should be placed upon this layer of compound and more compound packed tightly above them. Alternate layers of ware and compound should be thus packed until the pot is filled to within an inch or so of the top. The uppermost layer of compound should be amply deep to allow for any settling or burning of the compound during the carburizing process. If this precaution is not observed the ware at the top of the pot may become exposed and its surface will not respond to heat-treatment. No fixed rule can be given for the location of the parts in the pot, as their size, weight and shape govern this. They should, however, be so spaced that neither jarring nor settling will cause them to come into contact with each other or the pot walls.

In packing insulated parts which are to be carburized only in certain portions, we are often confronted with problems which require considerable ingenuity to solve. Some of the simplest problems met with may be solved by the employment of sand as an insulating medium. For example, in the case of hollow cylinders or tubes which it is desired to carburize only on the inside, we may pack them one upon the other, being careful to keep them in good alignment. They may then be surrounded with sand outside and packed inside with the carburizing compound.

This will produce a case on the inside of the cylinder, while the outside will have practically no case. In this connection, it may be stated, that sand does not always entirely prevent the action of the compound upon the article, for some of the gas may penetrate the sand and produce a very slight case. Pure silica or beach sand is often less effective than sandy earth or clay, as the latter possesses finer particles and, because of the clay content, is baked into a more impervious mass, which better resists the penetration of the carburizing gases. Whatever medium is used it should first be thoroughly dried. When sand is used and it is desired to use the compound repeatedly with a certain amount of renewal by fresh compound, it is obviously necessary to have a mixture which is coarse enough to be readily separated from the sand by screening.

Instead of insulating with sand, as in the case just mentioned, caps may be placed over each end of the cylinder and held in place by a connecting bolt and nuts. This method is in quite general use and insulates more thoroughly than sand. Another method employed is to copper-plate the article at those portions which are desired to be insulated. The copper, having no affinity for carbon, prevents its passage into the steel. In this connection care should be exercised to see that the plating is done under correct conditions, as otherwise the plate chips off under the effects of the carburizing heat. Some compounds rich in cyanogen also attack the copper and render it ineffective. This is especially pronounced as the temperature of the process approaches the melting point of copperf, 1083 degrees C. (1981 degrees F.) It is also obious that the heat must be kept well below this temperature in order to avoid the danger of the copper running on the article. Still another method is to leave extra metal on the portions desired free from case. The article is then carburized all over, allowed to cool in the pot and the excess metal is then machined off, thus removing the case at the desired part. The article is then heat-treated.

In some instances it is necessary to use one or more of these methods on the same piece. It is here that the mechanical ingenuity of the metallurgist may be used to good advantage in devising new methods and combinations for doing the work efficiently.

After the parts are packed in the pot the cover should be thoroughly looted on with fireclay to which a small amount of salt may be added to prevent its cracking excessively under the heat. The pots may now be loaded into the furnace.

Temperature of the Furnace

The proper running temperature is dependent upon several factors, so that no one temperature could be recommended as ideal. The following relations hold: The higher the temperature the more rapid the penetration and the richer the case is in carbon. It is, however, obvious that too high a temperature will make a very brittle case, will also have a deleterious effect upon the steel, may fuse the compound, and will entail excessive deterioration of furnaces, pots and pyrometers. Some steels, such as the alloy steels, can withstand a higher temperature without injury, than plain carbon steels. Certain mixtures, such as the barium chloride compounds, require a high temperature to produce their best results. As carburization does not take place efficiently below 849 degrees C. (1560 degrees F.), temperatures around 871 degrees C. (1600 degrees F.) will produce a slow rate of penetration. By going up to, say, 927 degrees C. (1700 degrees F.) we gain materially in production without in any

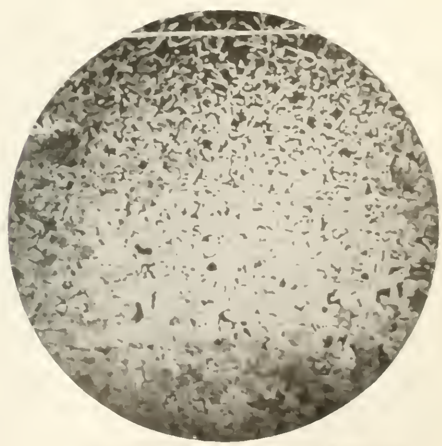


Fig. 8. Continuation of Fig. 7 showing Core. Magnification 50

way injuring a good steel. As we get much above 982 degrees C. (1800 degrees F.) there is grave danger of injuring the steel. Broadly speaking, we may say that from 927 degrees to 954 degrees C. (1700 degrees to 1750 degrees F.) is a safe temperature for good steels and gives rapid enough penetration to satisfy most conditions.

Duration of the Run

The duration of the run depends upon the depth of the case desired. We have already considered the most important factors, such as the amount to be removed in grinding, the zone desired at the surface, etc., which govern the depth of case it is necessary to obtain. It now remains to be seen how we are going to ascertain when this depth has been reached in the furnace, so that we may promptly unload it. If our steel was of absolutely uniform analysis, and all furnaces heated uniformly throughout, we could, by experiment, soon determine when to remove the charge in the furnace without actually inspecting the depth of penetration. Unfortunately these conditions cannot always be realized, so that the safest way is to remove a sample from the furnace and inspect. Our experience will soon permit us to estimate at least within a few hours when the depth of case has been obtained, and hence by withdrawing a sample or "dummy" well before the estimated time, we can tell just how much longer to leave the pots in the furnace. This dummy should be of the same steel as is in the parts being carburized, and as nearly the same in size and shape as possible—preferably one of the parts themselves. It should be conveniently located in the most accessible pot. At the time decided upon, the pot can be withdrawn from the furnace while the dummy is removed and the pot promptly reloaded again. The dummy may be quenched in water directly from the pot, reheated to a lower temperature to refine the case and quenched again. It may then be broken and the depth of case determined by the eye. From this procedure, which should not take over five minutes, we can estimate just how much longer to leave the pots in the furnace.

One precaution which is very important is the determination of how the temperature of the dummy pot compares with the other pots in the furnace, for if it should be much higher or lower the dummy would not be a safe indication of the depth of the case in the other pots. In many commercial furnaces there is considerable variation in temperature between different parts of the oven space and these should be thoroughly understood. This is particularly important in the carburization of articles of very thin cross-sections where a slight variation in penetration may result in carburizing entirely through the piece.

Heat-treatment

The heat-treatment of carburized parts is perhaps one of the most difficult thermal processes. It often prevents difficulties which baffle the most skillful and experienced workmen and are apparently in contradiction of theory itself. To obtain mere hardness or toughness alone is not so difficult a task, but to obtain them both in the highest state to which they may be developed requires the most careful manipulation. Unfortunately, there has been a somewhat common belief that any low carbon steel should carburize successfully, and this has resulted in much inferior work which cannot be laid to heat-treatment. Of this we shall speak later.

In heat-treating the articles, the procedure should be governed by the nature of the work and the requirements it is to fulfill. If it is absolutely necessary to have the highest degree of perfection in hardness and toughness, the best procedure is to give the parts two heats; a first heat and quenching at a high temperature to refine the core and a second or lower heat and quenching to refine the case. As to whether water or oil should be used depends upon the requirements to be fulfilled later by the parts. Water gives a more drastic and penetrative quenching effect and produces a better defined case and core. It is more inclined to produce distortion of the article, however, especially in the high first or core heat. For this reason its use is sometimes prohibited more from a mechanical than a metallurgical standpoint.

For the second or case heat, water is far superior to oil, as it gives a greater hardness to the case and this is, of course, the sole object of the case, the core furnishing the necessary toughness. Here again, however, distortion of the article may be the governing factor in deciding upon its use. In some cases where very large and massive articles made from ill-chosen steel are carburized, it is impossible to get them uniformly file-hard without the use of ice-cold water or brine as a quenching medium for both heats. Ice-cold brine may be employed where the highest degree of hardness is desired.

In the two-heat method the parts should be allowed to cool in the pots until they are at least below the temperature at which they might scale on being exposed to the air. The pots may then be unloaded and the parts, after being brushed and wiped clean, placed in the furnace for the first heat. The importance of having the articles perfectly clean and free from oil and grease before being placed in the furnace should not be disregarded. This is particularly true of parts which have just emerged from a high first heat and quenching in oil. If this oil and loose scale (if present) is allowed to adhere, it will bake on during the second heat and result often in soft spots. The temperature of the first heat depends mainly upon the carbon content of the steel and the alloying elements, if any are present, and on the mass of the piece.

Method of Procedure

For straight carbon steel of from 0.10 to 0.20 per cent carbon, the temperature will range from 843 degrees to 913 degrees C. (1550 degrees to 1675 degrees F.). A test specimen should be placed in the furnace, and the temperature giving the best refinement of the core determined. Where the pieces are large and massive, a higher temperature will be required to obtain the correct results. Lower heats may be used for water than for oil quenching.

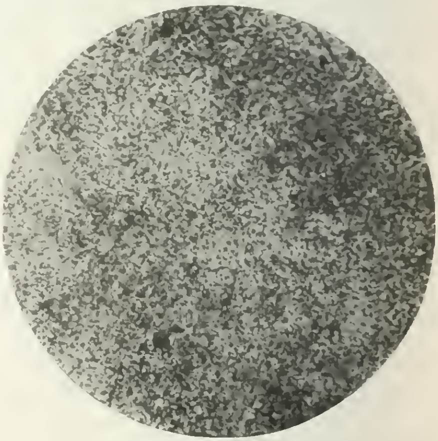


Fig. 9. Photomicrograph showing Grain Size of Core of Heat-treated Carburized Steel, containing 0.03 per cent Sulphur and Phosphorus. Magnification, 100

After the first heat the pieces should be washed in hot soda water to remove any oil, if they have been quenched in this medium. If the oil is allowed to remain on the surface it will bake on during the second heat and may cause soft spots on the case, as already mentioned. In the second heat the temperature to be used depends upon the same conditions already mentioned, namely, analysis and mass. In this case, however, the analysis is that of the case itself which, of course, is dependent upon two factors, the original analysis of the steel and the chemical content added by the carburizing compound. It is, therefore, obvious that two pieces from the same bar of steel, carburized by different methods, might require different heats for the refining of the case. A test specimen should be used to determine the heat giving the best results. A straight carbon steel of 1.00 per cent carbon content in the case will require a heat of from 760 degrees to 815 degrees C. (1400 degrees to 1500 degrees F.) depending upon its mass and the quenching medium used.

Analysis of the Steel

The idea that any low carbon steel is satisfactory for carburizing is a fallacy which modern methods are disclosing, for there is no branch of the thermal treatment of steel where the exercise of skilled judgment, based on experience, will be more amply repaid. This is particularly true of carburizing processes carried out on a large scale, for here any non-uniformity in the analysis would result in non-uniformity in the product. The writer knows of instances where much time and labor were lost in fruitless attempts to perfect some method of refining the core of carburized steels very high in impurities. An analysis would have promptly indicated the trouble as due to the steel itself, and not to its treatment.

There are in use many different analyses, some based merely upon precedent, others upon scientific investigation, with a view to radical improvement. The latter are giving very promising results and show that the field is open to still further investigation. The carbon runs generally from about 0.08 to 0.25 per cent. As to what is the best content is not a subject for argument, but dependent entirely upon the nature of the parts and the purpose for which they are designed. Parts of very thin cross-section where the space allotted to case and core is of necessity small, should, if possible, be made of the lower carbon analysis, as greater toughness can then be obtained in the core which is otherwise

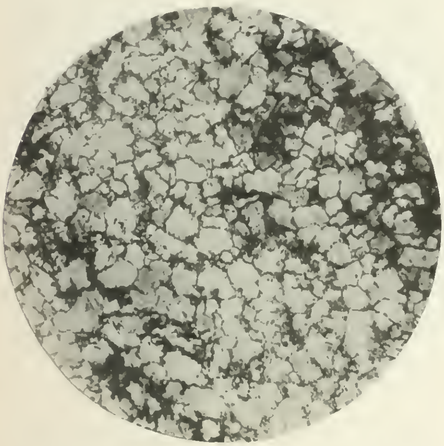


Fig. 10. Photomicrograph showing Grain Size of Core of Heat-treated Carburized Steel containing 0.06 per cent Sulphur. Magnification, 100

likely to be impaired in this respect, due to the case extending more or less into it.

If a tough core for any reason is absolutely essential in the highest degree, the lower carbon limit will obviously give the most satisfactory results. Where hardness is the most important consideration and the toughness of the core may to some extent be sacrificed, higher carbons around 0.20 per cent or more will give satisfaction. They should also be employed where it is essential that the pieces as a whole should possess considerable physical strength or where it is necessary that the case be firmly supported for excessive loads. In addition to straight carbon steels the low carbon alloy steels are employed. They add to the parts the same advantageous properties for which they are employed in other classes of steel.

Nickel is a valuable aid in producing a core which readily responds to refining and at considerably lower heats than in steel in which it is absent. In some cases results have been obtained by a single heat-treatment which compare most favorably with straight carbon steel, given two heats, one for case and one for core. The core resulting, has a fine grain and is extremely tough.

Chromium gives a very fine grain to case and core and imparts additional hardness in conjunction with the carbon. It has, however, when present much over 0.25 per cent, a tendency to render the core less tough, especially in steels around 0.20 per cent carbon, or higher.

Chrome-nickel steels containing both these elements give very fine results, with a judicious determination of their limits. They give very fine grained parts after heat-treatment and can be treated at a considerably lower temperature than straight carbon steels.

Phosphorus and sulphur are two impurities which are very detrimental to carburized steel if present in quantities in excess of 0.05 per cent. In good carburizing steels they should not exceed 0.04 per cent. This is very important, for it is quite frequently the cause of trouble experienced in refining the core and results in a very brittle article. Fig. 9 is a photomicrograph showing the grain size in the core of a carburized steel that has been given two treatments. The steel contained 0.03 per cent sulphur and phosphorus. Fig. 10 shows the grain size of a steel similarly treated, but containing 0.06 per cent sulphur. This steel possessed a very coarse and brittle core, as the photomicrograph clearly shows, while the former steel had a very fine tough core. Too much stress cannot be laid upon keeping these two impurities below 0.04 per cent. The manganese content may range from 0.30 to 0.80 per cent. The higher limits, however, tend to make a more brittle case. Silicon should be kept below 0.20 per cent.

In deciding upon the limits of analysis, care should be exercised to prevent too wide a variation in any of the constituents. Eight points in carbon is the widest variation permissible for uniform work on a large scale. Manganese should not vary over twenty points. No fixed rule can be given for the allowable variation of alloying elements, such as nickel, chrome, etc., as this depends upon the relative amounts of all the constituents present in the analysis.

Certain elements aid while others retard carburization some in a very marked degree and for this reason it is very essential that steels of different analysis be carefully kept separate. The following elements aid carburization: chromium, tungsten, molybdenum and manganese. The following retard carburization: nickel, aluminum, silicon and vanadium.

In conclusion, it may be observed that while considerable progress has of late been made in the art of carburizing, there still remains much to be done to place it upon as scientific and efficient a basis as are some of its related arts. The packing of the work by hand is crude, inefficient, and inexact and this is equally characteristic of some of the less important steps. In some of the more progressive concerns the articles are located in the pot by jigs and every mechanical convenience provided for accurate and efficient work in every particular. This practice is, however, the exception rather than the rule, but it is a step in the right direction, and shows that the opportunity for improvement has been realized.

* * *

An interesting use was made of moving pictures at the annual Graduates' Lecture delivered at the Institution of Mechanical Engineers (Great Britain). This year, Sir R. A. Hadfield delivered this lecture. Perhaps the most interesting part of it was the reference to armor plate and armor-piercing projectiles. This part of the lecture was illustrated by a moving picture display, the film being composed of a large number of drawings showing a projectile leaving the gun, striking the plate, the cap expanding and flying to pieces, and the projectile piercing the plate and exploding on the far side. The whole effect was excellent and care had been taken to produce a film built up from well-established facts. Although it was evident that the film was artificially produced, the presentation was very effective, as the series of drawings from which the film was made were carefully executed.

* * *

The quantity of iron ore mined in the United States in 1914 is estimated by Ernest F. Burchard of the United States Geological Survey to have been between 41,000,000 and 42,500,000 long tons. The average decrease in quantity mined by the fifty-two iron producing companies was 33 per cent compared with their output in 1913.

TESTING LOCKE STEEL SPROCKET CHAIN

FACILITIES PROVIDED IN THE LOCKE STEEL BELT COMPANY'S NEW FACTORY

BY EDWARD K HAMMOND*

THE manufacture of Locke steel sprocket chains was described in detail in an article entitled "Chain-making Extraordinary in a Scrapless Press-room," by Chester L. Lucas, which was published in the November, 1909, number of MACHINERY. In this article it was pointed out that the conversion of strip steel stock into chain was accomplished without wasting any of the material in the form of scrap. After going through the new factory which the Locke Steel Belt Co. has recently built in Bridgeport, Conn., the visitor will be impressed by the fact that the elimination of waste has now been carried to a further point of refinement, not only by the exceptional factory facilities and method of handling the work, but in the careful checking up of the various manufacturing operations and a thorough testing of the finished product.

Fig. 1. Marquee over Office Entrance decorated with Conventionalized Design of Chain

The following are features of the factory which help to eliminate waste. The buildings are of concrete construction, making them absolutely fire-proof, and as a result, expenditures for fire insurance premiums are unnecessary. The walls of the main building, with the exception of space occupied by the columns, are given over to windows, so that an abundance of natural light is provided. This increases efficiency in manufacturing, and is also important on account of the fact that experience has shown good lighting to be a point of cardinal importance in testing and checking a product, and in the elimination of industrial accidents.

Further provision against accidents has been made by equipping all power presses in the factory with automatic feeds or Benjamin safeguards, and it is a noteworthy fact that the provisions which have been made for the safety of workmen have proven so effective that there has not been a single accident since work was started in the new factory. Both the main building in which the manufacturing is done, and the storage warehouse in which all material is received, have platforms on a siding from the main line of the New York, New Haven & Hartford R. R., so that the unloading of material and loading of product into cars can be handled at a minimum expense. The factory has been carefully laid out so that the material moves in a continuous circuit, thus simplifying the transfer of work from department to department.

Fig. 2. Interior View in Main Building—Note Liberal Window Space which affords an Abundance of Natural Light

* Associate Editor of MACHINERY.

General Arrangement of the Plant

The plant of the Locke Steel Belt Co. is divided into four departments. It has already been mentioned that the buildings are of concrete construction. The offices of the company extend across the entire width of the main building at the front. The remainder of this building is divided into three bays which run down the entire length of the shop. The tool-room is located directly behind the office; then comes the press-room; the testing department and shipping room are located at the far end of the building. The most modern toilet facilities are provided in the basement of the main building.

The heat-treating department of the Locke Steel Belt Co. is housed in an individual concrete building which is equipped with oil-heated hardening furnaces, oil tempering baths, and the most modern form of instruments for determining and regulating temperatures. A third concrete building is provided for the storage of material, which is of ample capacity for reserve stocks. The fourth building is a small wooden structure in which the hot-rolled steel stock, from which the Locke chain is made, is "pickled" in sulphuric acid to remove the scale preparatory to sending the material to the press-room. The use of wood in the construction of this building is necessary as concrete would be rapidly damaged by the acid fumes.

Straightening the Steel

When stock comes to the press-room, the first step in this patented process of manufacture consists of straightening it edgewise ready to be fed into the dies. A special machine, shown in Fig. 4, has been built for this purpose, the design of which combines several interesting features. The principle on which it operates is the same as that of the commonly used type of flat straightener, in which the material is passed between a series of staggered rolls; but in the case of most flat straighteners, the different rolls are provided with means of making individual adjustment. In the machine which has been developed by the Locke Steel Belt Co. for straightening their steel stock, there are two sets of rolls—one for flat and the other for edge straightening—each set consisting of two rows of rolls. In each set, the position of one series or row of rolls is fixed, while the other row is

carried by an adjustable frame. In setting the machine, the position of the adjustable rolls is so regulated that the last roll just touches the stock which is to be straightened, without having any offset. The first roll is then adjusted toward the fixed rolls until the offset is sufficient for straightening the stock on which the machine is required to work. Thus, in passing through a set of straightening rolls, the bending of the stock is gradually decreased from the maximum offset to no offset whatever, and the stock comes out perfectly straight, in the plane in which a set of rolls has operated.

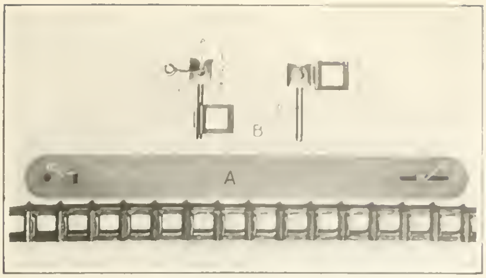


Fig. 3. Gages provided at Each Press for Use in testing Product at Frequent Intervals

The first set of rolls flattens the stock or straightens it flatwise, but has no effect sidewise. The stock then enters the second set of rolls which provides for straightening it edgewise. It has been mentioned that the machine is adaptable for straightening all sizes of stock used in making the company's product, and for the edge straightening operation it is necessary to adjust the center distance between the successive edge straightening rolls of each row to fourteen times the width of the stock which is being straightened. For this purpose, means are provided for changing the steps of both the fixed and adjustable rolls along the bed of the machine in order to give the required distance between centers. Experience has shown that with this setting the stock will come out of the machine perfectly straight, while if the center-distance between adjacent rolls were less than fourteen times the width of the stock, the strain would be so great that the edges of the stock would be upset, making it unfit for use in chain making, and a very large amount of power would be consumed.

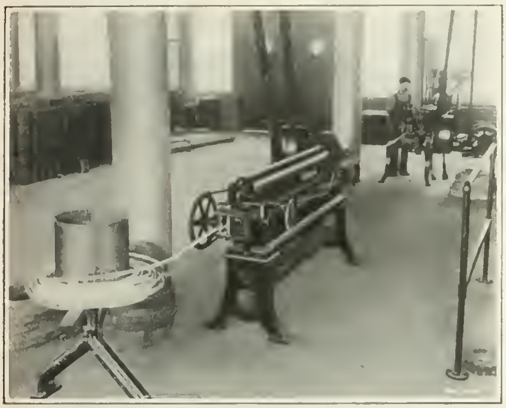


Fig. 4. Patented Straightening Machine designed for Use on Flat Stock


Fig. 5. Machines on which Every Link is tested and inspected

Testing the Finished Chain

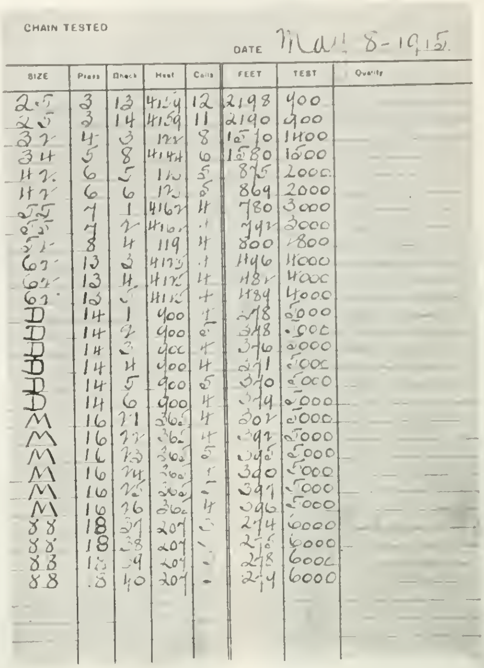
All of the chain made in the factory is subjected to a careful test which will disclose any weakness due to inherent defects in the steel or damage resulting from irregularities in the fabrication of the steel into finished chain. Gages of the form shown at *A* and *B* in Fig. 3 are provided for each press, and at frequent intervals the operator is required to use the gage *A* for testing the accuracy of the length of the chain, and gage *B* for determining the correct size of individual links. In using gage *A* the chain is slipped over the studs *a*, so that the links are held by the gaging surfaces. The distance between these is the correct length for a given number of links and by frequent use of this gage by the press hand, the pitch of the chain is checked up as it is made, thus enabling a high degree of accuracy to be maintained. Gage *B* provides for making four different measurements on the links. The pin *b* is of the correct size for the loop on the link, the width of the head of the gage is the proper width *c* for the opening in the link, the groove *d* is the proper width for the hook of the link, and the groove *e* is the proper size for the round of the link which fits through the loop in the adjacent link. The gages *A* and *B* can be used very rapidly to make the five measurements which have been referred to, and their constant use guards against the possibility of producing any appreciable amount of defective chain before the error is discovered by the power press operator.

After the chain has been heat-treated, and before it is ready for shipment, it is tested on the machine shown in Fig. 5. On this machine 10-foot lengths of chain are loaded almost to the elastic limit of the material, and if there are any weak links, they will fail under this test. The test is conducted by hooking one end of the 10-foot strand of chain over a stud on the table and then attaching the opposite end to a hook on the weight lever. The weights are then applied to the chain in order to determine its reliability.


Fig. 6. Machine on which Last Two Links from Each Coil are tested to destruction to determine Ultimate Strength

In the article previously published in MACHINERY, which described the manufacture of the chain, it was mentioned that a coil of strip steel was fed through the die from one side and that a coil of completely finished chain, made from this material, was automatically wound up on a reel at the opposite side of the press.

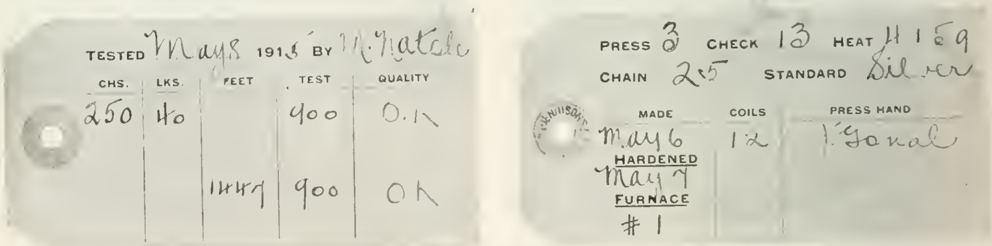
The tests of the chain described in the preceding paragraph give a fair degree of assurance that it is up to standard, but to make assurance doubly sure, two links of the chain from the ends of each coil of steel are taken to the machine shown in Fig. 6, where their ultimate strength is determined by loading the links until they break. For this purpose one link is secured to a hook held by the frame of the machine, while the other link is gripped by a hook carried on the weight beam. This beam is graduated like the beam of an ordinary weighing scale, and after the links have been set up on the machine the weight is run out on the beam until one of the links breaks. In this way the ultimate strength of the link is determined. The way in which the links break also indicates whether the strip of steel was of good quality or the heat-treatment of the chain was done in a satisfactory manner, *i. e.*, whether the steel in the finished chain has been brought to the proper condition, or if it is too hard or too soft. Experience has shown that if any variation occurs in the condition of chain made from the same coil of stock, the weakest links will be found in those sections of the chain made from the metal at either end of the coil, so that this test gives the minimum ultimate strength of the chain produced from each coil. The form shown in Fig. 7 is kept by the testing department in recording the results of the test of all chain made in the factory.


CHAIN TESTED DATE May 8-1915

SIZE	Press	Check	Heat	Coils	FEET	TEST	Quality
25	3	13	4159	12	2198	900	
25	3	14	4159	11	2190	900	
32	4	3	122	8	1510	1400	
34	5	8	4144	6	1580	1600	
42	6	5	12	5	875	2000	
42	6	6	12	5	869	2000	
55	7	1	4162	4	780	3000	
55	7	2	4162	[illegible]	742	3000	
52	8	4	119	4	800	1800	
62	13	3	4123	[illegible]	1496	4000	
62	13	4	4125	4	1482	4000	
62	13	5	4125	4	1489	4000	
D	14	1	900	4	318	5000	
D	14	2	900	5	348	5000	
D	14	3	900	4	376	5000	
D	14	4	900	4	371	5000	
D	14	5	900	5	370	5000	
D	14	6	900	4	379	5000	
M	16	21	365	4	302	5000	
M	16	22	365	4	392	5000	
M	16	23	365	5	395	5000	
M	16	24	365	[illegible]	390	5000	
M	16	25	365	[illegible]	391	5000	
M	16	26	365	4	396	5000	
88	18	37	207	[illegible]	274	6000	
88	18	38	207	[illegible]	275	6000	
88	18	39	207	[illegible]	278	6000	
88	18	40	207	[illegible]	274	6000	

Fig. 7. Form used by Inspection Department in recording Results of Tests

In keeping up the quality of the product, the expedient has been adopted of holding each workman responsible for the quality of his own product. For this purpose, a careful record is kept which shows the press on which each lot of chain was made, the workman who operated the press and the date on which the work was done. For the purpose of keeping this data, tags are employed which have the forms shown in Figs. 8 and 9, printed on opposite sides, on which the necessary information is recorded. These tags are tied onto the reels of chain as they go from department to department, and when the chain is finished, the information on the tags is copied off onto forms shown in Fig. 10, which are preserved in the office for future reference. By referring to this form, it will be seen that each coil of steel is given the steelmaker's "heat number," and when a lot of steel from a new "heat" is received at the factory, several of the coils are immediately sent to the press-room and made into chain, so that tests may be conducted to be sure that the steel is satisfactory before the shipment is accepted. In order to run this "test chain" through the factory as quickly as possible and to accumulate all necessary data, a tag of the form shown in Figs. 8 and 9 is attached to the reel, but the tag used for this purpose is red, while the ordinary tags are white. The red tag indicates that the chain on the reel is to be passed along as rapidly as possible, and observed closely for proper temperatures of heat-treatment, etc.


TESTED May 8 1915 BY M. Natale

CHS.	LKS.	FEET	TEST	QUALITY
250	40		900	O.K.
		1447	900	OK

PRESS 3 CHECK 13 HEAT 4159
CHAIN 25 STANDARD Silver

MADE	COILS	PRESS HAND
May 6	12	Gonal

HARDENED May 7
FURNACE #1

Figs. 8 and 9. Forms printed on Tags used for recording Each Step in Process of Manufacture

Determining the Power Capacity of Different Sizes of Chain

Fig. 11 shows a special form of dynamometer built by the Locke Steel Belt Co. for use in determining the wearing qualities and power transmitting capacities of different sizes of chain of its manufacture, when running at various speeds. It will be seen that this equipment consists of a pair of sprockets over which the chain is run. Instead of a prony brake to apply the load, the shaft which carries the driven sprocket is belted to an electric generator. The current developed is delivered to a series of arc lamps, the required number of which may be connected to the circuit; and incandescent lights are provided for making finer adjustments for the power consumption. An ammeter and a voltmeter are connected into the circuit, and from the readings of these instruments the number of kilowatt of power developed by the generator can be readily calculated. As 1 horsepower is equivalent to 0.746 kilowatt, the power developed by the generator—and hence the

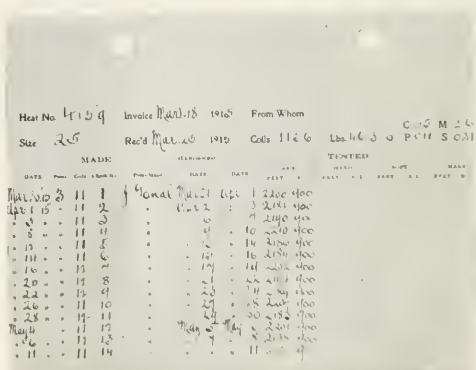

Heat No. 4159 Invoice Mar-18 1915 From Whom
Size 25 Rec'd Mar-20 1915 Coils 11 & 6
MADE
TESTED

Fig. 10. Form used by Office in keeping a Record of Every Chain made in the Locke Factory

power transmitted by the chain—may be easily converted into horsepower. This test also affords a means of determining the pull on the chain in transmitting power at various speeds. We know that 1 horsepower is equivalent to 33,000 foot-pounds per minute. Hence, by multiplying the number of horsepower transmitted by 33,000, and then dividing the speed of the chain in feet per minute, we obtain the pull in pounds.

There is a commonly quoted proverb that a chain is no stronger than its weakest link. The rigid tests to which all of the chain made by the Locke Steel Belt Co. is subjected, both during the process of manufacture and after completion, is the means of producing a chain of great uniformity with any chance weak link eliminated. As a result, advantage is taken of the full strength of the steel and there is practically no danger of a chain giving trouble when it is used for service of the character for which it is intended.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Grant of Patent Equivalent to Sale

(Federal.) A grant, for a fixed royalty paid in advance, of the right to use a patented machine during the full term of the patent, when it is to become the property of the licensee if he has observed the terms of the license, is equivalent to a "sale," and the owner of the patent, having received full payment of the price, fixed by himself, cannot by a provision of the license, restrict the right of the licensee to transfer the same for whatever consideration he may see fit. This is so, even though the patentee still has the right under its form of license to require the transferee to purchase from itself certain things adapted for use with the patented machine. *(National Malleable Castings Co. v. T. H. Symington Co., 222 Fed. 523.)*

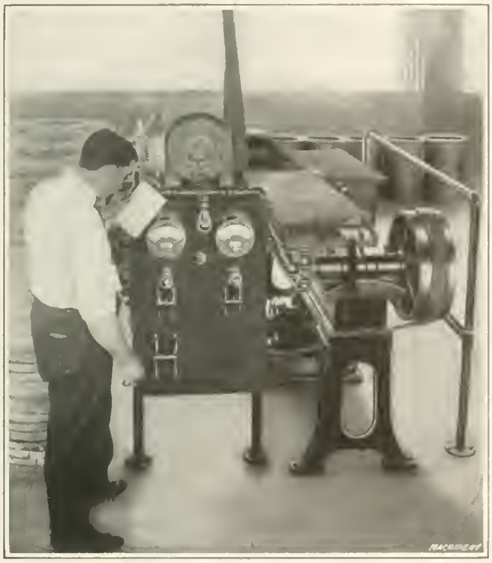


Fig. 11. Special Dynamometer used to determine Comparative Work and Wear under Actual Running Tests

Notice to Cancel Purchase Contract May be Oral

(New York.) Where a contract of sale provided that, if the defendant could purchase elsewhere a similar machine better suited to his requirements, its contract with plaintiff "should expire thirty days after notice of such possibility shall be served," the provision requiring notice could be satisfied either by an oral or written notice; the use of the word "served" not necessarily implying a writing. *(Lang v. Lux Mfg. Co., 153 N. Y. S. 292.)*

Waiver of Breach of Warranty

(New York.) Where, in an action for machinery sold and delivered, a reasonable time has elapsed after delivery to enable the buyer to examine the machinery, and to reject it if not conforming to sample, a failure to return or offer to return the machinery within such time, constituted a waiver of breach of warranty as a defense. *(Silberstein v. Blum, 153 N. Y. S. 34.)*

Liability of Manufacturer for Sale of Dangerous Machinery

(New York.) A manufacturer of automobiles, who constructs a hand brake on an automobile of inferior materials and who improperly assembles the parts of the car, is liable to a purchaser of the car from the manufacturer's agent, who had purchased it from the manufacturer, for injuries to the car, caused by the defective equipment and negligent assembling. *(Quackenbush v. Ford Motor Co., 153 N. Y. S. 131*

Verbal Warranty of Machine not Admissible as Evidence

(Michigan.) In the trial of an action for the price of a machine sold to defendant, wherein defendant gave notice that it would show that plaintiff, to induce the purchase of the machine, fraudulently represented that its installation would save over $3,000 a year, such representation did not amount to a false representation, but only to a verbal warranty, inadmissible as evidence to vary the terms of the written contract of sale. A buyer who kept a machine and continued to use it down to the trial of the seller's action for the price was estopped to claim a rescission of the contract as a defense. *(Linderman Mach. Co. v. Shaw-Walker Co., 153 N. W. 34.)*

Not Entitled to Allowance

(Kentucky.) In an action for the balance due on the purchase price of certain machinery which the buyer had used for two years, during which time he had made payments and had renewed his notes for the balance, though complaining of defects, he is not entitled to an allowance for such defects. He should not have made payments until the defects were remedied. *(Oman-Bowling Green Stone Co v. Sullivan Machinery Co., 176 S. W. 973.)*

Not Entitled to Warning that Machinery Was Dangerous

(Missouri.) Plaintiff, who had worked about a baling machine, and was familiar with it, and to whom the danger of putting his hand into it while it was moving was obvious, although the machine moved slowly, and could be readily and quickly stopped by a lever, was not entitled to any warning of such danger which was merely incidental to the service; although, where the danger is an extraordinary one, that is, not ordinarily incident to the service, and the master has knowledge thereof, failure to warn the servant of such danger would be negligence.

In such case the foreman's direction to plaintiff to operate the machine with the lid raised was not actionable negligence, where the lid was not designed to protect the servant from the danger of injury by putting his hands into the machine when in operation, and where the defendant could not have reasonably anticipated that to operate the machine with the lid raised would occasion the injury, which could not have occurred otherwise than by unnecessary exposure to danger, since the master is not an insurer of the servant's safety, and if the method adopted, though not the safest, is a reasonably safe one, is not liable for having adopted such method. *(Piorkowski v. A. Leschen & Sons Rope Co., 176 S. W. 259.)*

County Liable for Value of Machinery

(Texas.) A manufacturer of machinery selling one of its machines to a county agent not knowing him to be such agent, and discovering the fact may call upon the county for payment of the machine especially where the county has benefitted by the use of the machine. *(Dallam County v. S. H. Supply Co., 176 S. W. 799.)*

* * *

As a quenching medium for hardening, mineral oils are generally more effective than fish and cotton-seed oils, which latter for a long time have been looked upon as the best oil for quenching purposes. A mineral oil having a specific gravity of 0.86, a flash point of 420 degrees F., a viscosity of 170 seconds at 100 degrees F., as shown by the Saybold viscosimeter, gives good results and can be bought cheaply

THE HEAT-TREATMENT AND TESTING OF SHRAPNEL SHELLS*

RECORD OF THOROUGH SHOP TESTS TO SECURE DATA FOR HEAT-TREATMENT

BY J M WILSON†

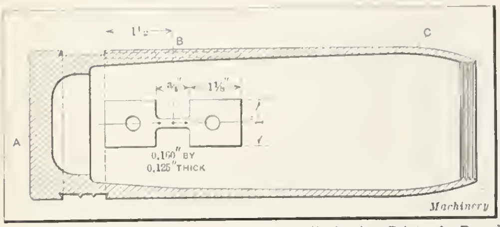


Fig. 1. Cross-sectional View of Shrapnel Shell showing Points A, B and C where Tests are made, and one of the Tensile Test Samples

While most Canadian manufacturers have overcome the difficulties which are now more or less to be expected in taking up the manufacture of such a special and unusual article as shrapnel shells, many of the firms are still ex-experiencing some trouble in heat-treating the shells to enable them to fulfill the requirements of government specifications. The object in heat-treating shells is to give the forgings a minimum strength which will enable them to resist firing strains at certain points. The manner in which these strains arise and the condition of the steel necessary to meet them should be clearly understood by all those who have any responsibility in the heat-treatment of shells, as it is possible to have good and bad shells and still meet government specifications. The writer of this article has been actively engaged in treating shells since the beginning of the war, and had to rely entirely upon his own resources in meeting and overcoming the troubles which seemed to arise on all sides, causing manufacturers serious, and by no means unfounded, alarm as to the ultimate success of their efforts.

The government shell specifications call for a yield point or elastic limit, after heat-treating, of not less than 36 tons per square inch, a breaking point or ultimate strength of not less than 56 tons per square inch, and an elongation of not less than 8 per cent in ⅝ inch. Officially there is no maximum specified for either of those three physical characteristics; but as a matter of fact any unusual condition which is not in conformity with recognized metallurgical practice may cause the chief government inspector for the district in which the manufacturer is located to reject a shipment. Reference has been made to certain points in the shell which must resist the strains due to firing. The nature of these strains and condition of the steel best suited to meet them will be understood from Fig. 1, which shows a cross-section of the British 18-pound shrapnel shell. When a shell is fired from a gun, the base *A* is subjected to a blow, *i. e.*, a sudden increase of pressure which almost instantly attains a maximum of 12 to 14 tons per square inch, and imparts the initial velocity to the shell. The shell, being a body at rest, opposes this velocity with its own inertia, the result being that both compressive and tensile strains are set up in the shell body. The shell body assumes the conditions of a column which has a compressive load varying from nothing at the nose, to a maximum at the base. The tensile load is due to the inertia of the bullets inside the shell. These bullets are subject to an increasing compressive load from the top down, the resultant strain being a bursting effort which attains a maximum in the region of the point *B* known as the "set-up point."

When the time required for the fuse to act has elapsed, the powder charge is exploded, and the contents of the shell are blown forward in the usual manner. The contents are released either by the stripping of the thread of the brass socket, or else the walls of the shell yield at the point *C*, opening the threads sufficiently to free the socket. At *A*, (the base) the shell must be perfectly sound and free from flaws such as minute cracks, etc., which may allow the flame from the firing charge to strike through with disastrous results to the shell and gun. The metal in the base must not be too hard or it may fracture under the pressure of the explosion, and it must not be too soft or it may flatten out and spoil the rifling in the bore. At the point *B* there is no maximum requirement so far as tensile strength is concerned, but any abnormal strength is viewed with suspicion unless it is accompanied by a generous elongation. At *B* the metal is particularly liable to distension while the shell is acquiring velocity, and unless the shell is strong enough to resist the sudden bursting strain, and the amount of elongation is sufficient to cushion or absorb this strain at the instant of firing, the shell is liable to take a permanent set in the region of point *B*, with results mentioned above. The shell must not be too hard at the point *C* as it may burst, thus neutralizing the real object of a shrapnel shell which is to project the bullets forward with increased velocity at the predetermined instant, being in fact an aerial gun arranged to discharge its contents at any desired point of its flight. The favorite expression of newspaper correspondents, "a fragment of shrapnel," would therefore indicate a prevalence of defective shells so far as the enemy is concerned.

TABLE I. RESULTS OF TESTS TO DETERMINE THE BEST QUENCHING MEDIUM FOR SHRAPNEL SHELLS

Quenching temperature, degrees F.	Quenching medium	Temperature of quenching medium, degrees F.	Scleroscope hardness No.
1475	Fish oil......	90	50 to 55
1475	Coal oil......	90	65 to 70
1475	Cottonseed oil	90	70 to 75
1475	Engine oil...	90	75 to 80
1475	Oil of degras.	90	77 to 85
1475	Water	90	82 to 87

Machinery

TABLE II. RESULTS OF TESTS CONDUCTED TO SECURE GENERAL DATA ON HEAT-TREATMENT

Heat No.	1	2	3
Carbon, per cent......	0.45	0.52	0.50
Manganese, per cent..	0.68	0.62	0.47
Decalescent point, degrees F.............	1400	1425	1390
Quenching temperature, degrees F.....	1450	1475	1450
Temperature of oil, degrees F...........	160	160	120
Resultant hardness, scleroscope No.......	65 to 75	65 to 75	*39
Temperature of water, degrees F...........	....	....	75
Resultant hardness, scleroscope No.......	....	....	55 to 60
Tempered until showing a scleroscope hardness of..........	48	48	52
Yield point, tons......	47.8	48.6	46.5
Breaking point, tons..	67.9	65.4	66.2
Elongation, per cent..	14.6	16.9	17.4

Machinery

* Note: This shell was then reheated and quenched in water with results shown

* For other articles on the manufacture of shrapnel published in MACHINERY, see "Shrapnel and Shrapnel Manufacture" by Douglas T. Hamilton, April, 1915; "Machining Shrapnel Shells, March, 1915; and other articles there referred to.

† Address: Metallurgist, Chapman Double Ball Bearing Co. of Canada, Ltd., 339-351 Sorauren Ave., Toronto, Canada.

Having gotten these requirements firmly established in his mind, the heat-treating expert is now confronted with a double problem: How is it possible to give steel the suitable strength; and having done so, how is it possible to know that the desired result has been obtained, without actually making test pieces from each shell. The principal condition upon which successful heat-treating depends is uniformity of material. Carbon and manganese are the principal substances which influence the results. The exact composition of steel specified by the government is not given to any manufacturers other than steelmakers. It is, however, generally understood to be a 0.50 per cent carbon, 0.60 per cent manganese steel. Allowing five points variation in carbon and 10 points variation in manganese, the requirements would be approximately 0.45 to 0.55 per cent carbon and 0.50 to 0.70 per cent manganese. In one carload of forgings, the author's firm received shells from 23 different heats or melts, with carbon varying from 0.60 to 0.47 per cent, and manganese varying from 0.63 to 0.49 per cent, with all possible combinations and proportions between these limits. The number of forgings supplied from each heat varied from one up to 1200 so that the question of determining the best temperature for each carbon content was indeed quite impracticable. Many manufacturers at the present moment may be in a similar position, and the gravity of the situation, both from a financial and a military point of view, may justify a somewhat detailed description of the method which was followed in treating shells of such varying composition.

It is generally known to manufacturers that the highest tensile strength of steel is obtained by cooling it rapidly from a temperature slightly higher than the decalescent point or critical temperature. The degree of hardness resulting from this operation can be ascertained quickly, accurately, and repeatedly by means of the scleroscope. The degree of hardness thus shown is a reliable indication of the probable strength of the material; that is to say, after making due allowance for different makes of steel and varying proportions of the principal constituents, the scleroscope readings are a reliable indication of the results which may be expected when a tensile test is made of any given shell. In the opening months of the shell business, considerable reliance was placed on the accurate determination of the decalescent point. Forgings of varying analysis were received; the carbon being from 0.48 to 0.53 per cent, and the manganese from 0.54 to 0.69 per cent. All steels whose composition was within those limits showed a decalescent point of between 1390 and 1425 degrees F., and when quenched in

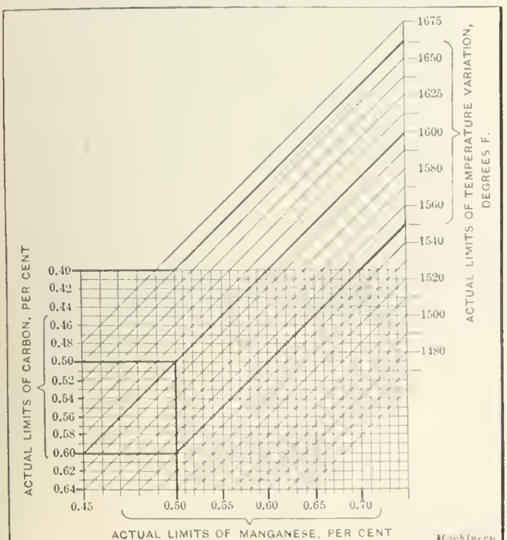


Fig. 2. Chart showing Hardening Temperatures for Various Percentages of Carbon and Manganese in Steel used for Shrapnel Shells

TABLE III RESULTS OF TESTS ON SAMPLES TAKEN FROM A SHELL WITH A SCLEROSCOPE HARDNESS NO OF 48 TO 52

Heat No.	Scleroscope reading on test piece after machining	Yield point, tons	Breaking point, tons	Elongation, per cent
1	Outside 52—53—50 Inside 55—55—55	55.8	73.3	14.3
2	Outside 52—54—50 Inside 55—57—53	53.8	72.4	17.4
8	Outside 57—57—49 Inside 60—62—51	52.8	77.3	12.7

Machinery

water at 50 degrees F. above the decalescent point, such steels would have a scleroscope hardness number as high as 85; but when quenched in ordinary fish oil the hardness was only slightly over 50, the sample being 1 inch square and 1/4 inch thick. A complete shell quenched in fish oil would show a scleroscope hardness number at the set-up point of 38 to 40. Test pieces from such a shell failed to reach the minimum breaking strength of 56 tons by the narrow margin of 0.6 tons, and this failure brought up the question of which was the best quenching medium. A series of experiments gave the results presented in Table I; all conditions were equal in each test, and the test pieces were all made from the same forging.

From the results of the tests presented in Table I, oil of degras, commercially known as "No. 2 soluble quenching oil," was selected as the quenching medium and operations were commenced on forgings supplied from two separate heats. The results were all that could be desired until forgings were received from a certain heat, which would not respond to treatment based upon the results of preliminary experiments. Investigation yielded the results presented in Table II. While water-treatment of the forgings from Heat No. 3 gave satisfactory strengths under test, the liability of shells to crack, owing to their thin walls contracting more rapidly than the base, was a fatal objection to this method. Attention should be called to the fact that while the temperature at which quenching should be done is specified by the government at 1560 degrees F., manufacturers are not tied down to this particular temperature. What is required is that the manufacturers shall so treat the material that it will fulfill the requirements already stated. If while fulfilling the requirements, should the treatment prove detrimental to the shell in other respects, then it is time for the manufacturer to worry.

Referring to results presented in Table II, Heat No. 3, it will be observed that the manganese is only 0.47 per cent with carbon 0.50 per cent. Comparing Heat No. 3 with Heat No. 1, it is evident that an increase of 5 points carbon is more than offset by a reduction of 21 points in the manganese. Increase of temperature seemed to offer the greatest possibilities and sample shells were drawn every 12½ degrees up to 1675 degrees F. The greatest hardness was obtained at 1637½ scleroscope readings of 50 to 55 being the average. This was not considered satisfactory, and the oil-circulating pump was speeded up. Scleroscope readings as high as 65 were frequently obtained at a quenching temperature of approximately 1635 degrees, and when the shell was tempered to read 48 to 52 on the scleroscope, three test pieces from one shell gave the results presented in Table III. A careful study of this data revealed the fact that, while a low carbon, low manganese steel hardens satisfactorily within a very limited range of temperature, a medium steel has a wider range, and a high steel a still wider range of hardening temperature.

When the shipment of mixed heats previously referred to was treated, the method pursued was to take 0.50 per cent carbon and 0.50 per cent manganese as a base composition which hardened at 1600 degrees F. to show 55 to 65 hardness on the scleroscope. Then: (a) If, for every point of carbon below 50 there be present 1 or more points of manganese above 50, the steel should harden satisfactorily at 1600 degrees F. (b) If, for every point of manganese below 50 there

be present 2 or more points of carbon above 50, the steel should harden satisfactorily at 1600 degrees F. (c) If both carbon and manganese be below 0.50 per cent, increase the hardening temperature 12½ degrees F. for each point of manganese short of 50, and 6¼ degrees F. for each point of carbon short of 50. (d) If both carbon and manganese are above 0.50 per cent, a hardness number above 55 will probably be obtained at a quenching temperature of 1600 degrees F., but the maximum hardness, *i. e.*, 75 to 80 will be obtained at a somewhat lower temperature, the exact temperature being most easily found by starting at 1500 degrees F. and trying a couple of sample shells every 25 degrees F. until a maximum hardness is obtained. Forgings containing 0.50 to 0.55 per cent carbon and 0.54 to 0.62 per cent manganese in any varying proportions may be hardened at 1600 degrees F. to show a hardness number of 55 to 75; and when tempered to give a hardness number of from 48 to 52 they will yield the following results: yield point, 45 to 50 tons; breaking point, 65 to 70 tons; and elongation, 14 to 20 per cent.

Looking back, (c) offers a basis for charting the hardening points in a fairly approximate manner, to form a guide as to where the best hardness may be obtained. Such a chart is shown in Fig. 2. By following the horizontal and vertical lines from the carbon and manganese content until they intersect, a diagonal line will be found which will indicate the temperature at or about which the maximum hardness will be obtained. This does not prevent the use of 1600 degrees F. as the average temperature for the majority of shells, provided they are strong enough when hardened at that temperature; but where shells do not harden satisfactorily at 1600 degrees F., the chart offers an alternative method subject to such variation as may arise due to the use of steel from different makers, etc. The author's practice is to make careful scleroscope readings of each piece before pulling. Care must be taken to have a uniform surface on both sides, all tool marks being removed with fine emery cloth. The points tested are shown at *A*, *B* and *C* in Fig. 1. After the test piece is made, the value of the hardness number increases as a result of the piece being solidly supported in the scleroscope, whereas when the reading is made on the shell, the arched form of the wall acts as a spring, and absorbs the shock to some extent. Readings thus increase from 2 to 10 points after the test piece is finished.

A careful study of the data presented in Table IV reveals the fact that results are not always consistent. With an increase of carbon, one occasionally finds an increase in elongation and *vice versa;* and the results due to variations in manganese content are similarly unreliable. In order to secure a degree of uniformity in hardness, which will be sufficient to insure test pieces standing up successfully, it is necessary to have the shell hard inside as well as outside, and a method of doing this is referred to later. Assuming now that the shell has been tempered, it is rough-polished on a canvas buffing wheel around the outside of *B*, Fig. 1 for a width of at least 1 inch. Readings by the scleroscope are made on a zone ¾ inch wide and if they are between 46 and 52 the shell may be relied upon to show good results in the tensile test. In making test pieces, it is desirable to cut the piece from a spot which reads 48 to 50; and in machining the test piece, care should be taken to remove an equal quantity of metal from either side of the wall so that the test piece is a true specimen of the average wall structure. Where a shell is carelessly quenched, and the test piece so machined that the surface on one side is practically the same as the inner side of the wall, the results would not be a true indication of the real average strength, and a lot of shells might possibly be rejected on account of a slight oversight in this respect. Reference has been made to the base *A*, Fig. 1. Forging defects show up here occasionally and in such cases the shell is at once condemned. These flaws take the form of small cracks, from the width of a hair up to 1/16 inch. They seldom can be detected until after heat-treating, and are most easily observed by polishing the base on a disk grinder. Losses in this respect vary, but might average about 0.20 per cent. The hardness of the base itself may vary from 38 to 50, which insures an ample degree of toughness and avoids all possibility of the shell cracking under fire.

Many methods of heating, quenching, annealing and cleaning are in

TABLE IV DATA ON THE HEAT-TREATMENT AND STRENGTH TESTS OF SHRAPNEL SHELLS

Carbon, per cent	Manganese, per cent	Quenching temperature, degrees F.	Tempered, scleroscope hardness No.	Readings of scleroscope	Yield point, tons	Breaking point, tons	Elongation, per cent
0.50	0.47	1635	51	60—57—57 47—48—48	48.3	69.9	16.9
Three pieces from one shell				60—56—53 48—52—58	45 2	70 6	19 1
				63—56—57 51—55—54	51 6	74 6	16 9
0.48	0.65	1565	49	51—54—52 48—53—50	47.3	67 4	15.9
Three pieces from one shell				51—52—49 53—51—51	48 2	67.9	15 3
				52—55—50 50—55—47	49.2	70.7	15 4
0.50	0.57	1600	50	50—52—50 49—50—49	46.0	64.8	19 0
0.50	0.57	1600	50	56—60—57 54—56—54	55.8	77.8	14 3
0.50	0.57	1600	50	59—60—56 55—59+56	60.7	82.2	12.7
0.60	0.57	1600	50	60—61—55 60—62—57	57 8	80 0	12.6
0.60	0.57	1600	52	57—57—56 54—56—53	48.2	69.7	17.5
0.50	0.57	1600	50	48—52—50 49—52—49	44.2	64.3	17.4
0.50	0.57	1600	50	52—55—55 50—51—52	44.7	65.2	14.7

Machinery

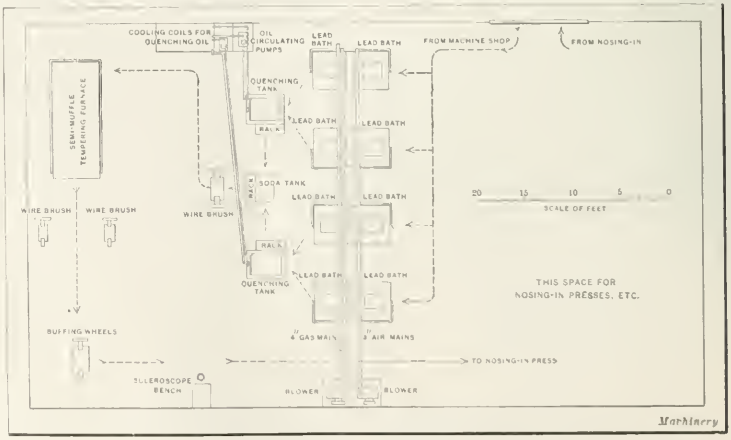


Fig. 3. Layout of Heat-treating Department for Factory producing 12,000 to 15,000 Shrapnel Shells a Week

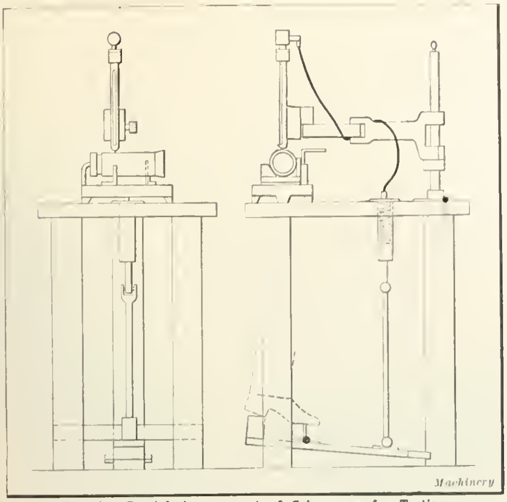


Fig. 4. Special Arrangement of Scleroscope for Testing Shrapnel Shells

use by the different firms engaged in shell making. For rapidity of output, cleanliness of the resulting product, ease and economy of operation, and uniformity and control of results, the author is in favor of the lead bath for hardening, and semi-muffle furnace for annealing. In one case the use of a lead bath by a skilled operator yielded excellent results both as to economy and uniformity, but when the output exceeds 500 shells per 12 hours, a semi-continuous furnace meets the requirements to better advantage. The layout of a hardening room for an output of 12,000 shells per week is given in Fig. 3. The lead baths consist of a rectangular pot of suitable capacity, resting on a 4½-inch hearth built of common firebrick and heated by either oil or gas burners below the hearth. They are built in pairs with a common wall between, which is thick enough to provide a flue to carry off products of combustion. The quenching tanks are rectangular, water-jacketed, and provided with two quenching cradles each. These cradles are arranged to swing lengthwise in the tank and when the carrier holding the shell is lowered into the oil, a pipe is automatically extended downward into the shell and introduces cold oil in the inside of the shell, while the operator swings the cradle back and forth in the tank, thus cooling the outside of the shell at the same time. This method of quenching has enabled the writer to harden shells which, by reason of low carbon and manganese, defied all conventional methods of dipping and swinging back and forth with tongs. The output per man with this apparatus is largely in excess of any hand method, while the uniformity and degree of hardness is all that could be desired.

The oil pump draws the oil from a depth of 6 inches below the surface and pumps it through 100 feet of 1-inch copper pipe arranged in two 50-foot coils in parallel. The cooled oil is delivered into an overhead reservoir, the overflow being connected to both tanks equally. After quenching, the shells are set on draining racks, and then washed in boiling-water and sal-soda, placed on another draining rack and then roughly brushed on wire brushes ready for tempering. The tempering furnace is of rectangular form, and consists of a long flat hearth with rails laid lengthwise on it. At each end a space is partitioned off from the body of the furnace, by means of vertical sliding doors; and a rack holding a number of shells is deposited on the rails at the front end of the hearth, the door is elevated and the rack is slid into the main chamber. After a suitable lapse of time another rack is introduced, and so on until the first rack is ejected at the rear end of the furnace. The shells are now hot enough to loosen all foreign matter on the surface, and a few seconds brushing with a wire brush cleans out the driving band groove, and leaves the shell with a delicate brown oxidized finish. The shell is now spotted on three places with a canvas buff and tested for hardness on the scleroscope. Fig. 4 shows the arrangement of the scleroscope as used by the writer. The shell is supported on a single narrow V-block with hardened edges, situated immediately under the set-up point. A narrow strip supports the open end of the shell, thus giving a three-point support, while a vertical stop at the back of the shell maintains it in a position tangential to the radius of the swinging arm. The usual rubber bulb was soon dispensed with as being quite unsuited for such hard service, and a small pump cylinder substituted. The piston in the cylinder is operated by a downward pressure of the heel on the pedal to give compression, and a spring inside the cylinder gives the necessary pull when the scleroscope hammer is to be raised by suction. After being tested the shells are ready for "nosing in."

* * *

STANDARD JIG FASTENING

BY CHARLES C ANTHONY*

In shops where a great many jigs are used, confusion is bound to occur if some uniform system is not adopted for securing the jigs to the machines on which they are to be used. In some cases the jig is put on the faceplate of a lathe or other machine for which it is intended, the correct position determined, and the jig is then bolted in place. Obviously where such a course is followed, the setting up of a machine takes a lot of unnecessary time. To overcome this difficulty, some shops resort to the practice of drilling dowel-pin holes, but where this is done for a number of different jigs, the operator is frequently in doubt as to which holes belong to the particular jig which he is setting up.

In order to enable any jig to be used on any lathe, the writer adopted the following method. A narrow circular groove 4 inches in diameter by about ¼ inch in depth was turned in the faceplate of each lathe, as shown at *A*, and all jigs were made with a ring of the proper dimensions to enter this groove. In this way all jigs are interchangeable between different machines and there is no loss of time in setting up. For use on milling machines, shapers, planers and other machine tools on which jigs and fixtures are employed, a similar method has been adopted, except that a graduated base *B* is made; the circular groove is cut in this base and the base is clamped to the table of the machine in the usual way. A feature of this method is that any jig can be set up on any machine which is idle, so that loss of time which would otherwise result through waiting for a given machine is avoided. Old jigs and fixtures can be adapted to this system by turning a groove in the base of the fixture, and then fitting a ring into this groove, which is of the proper size to enter the circular groove in the faceplate or graduated base which supports the fixture. The method has proved a valuable one, and may interest other mechanics who have met with the same difficulties as the writer. It increases the efficiency of the shop.

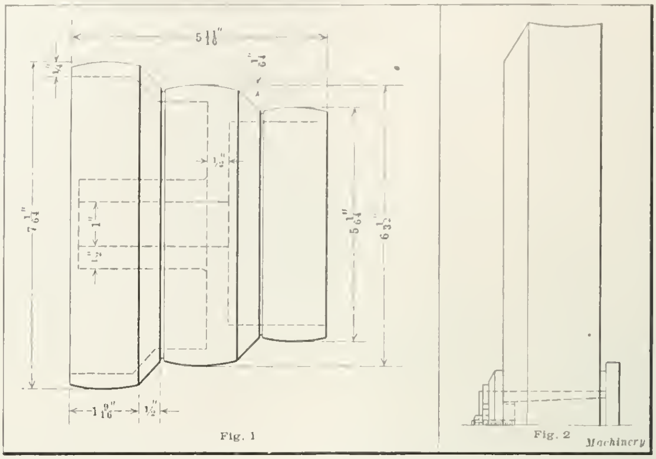
Interchangeable Method of fastening Jigs and Fixtures to Machines

* Address: 312 Franklin St., Reading, Pa.

GRINDING CONE PULLEYS AT THE NORTON PLANT*

BY HARRY W. AULT†

It is the purpose of this article to describe the grinding of three-step cast-iron cone pulleys of the form shown in Fig. 1, and also to explain the use of the attachment employed for truing the grinding wheels to the shape illustrated in Fig. 2. Probably the best way to give the reader an idea of the condition in which the work comes to the grinding machine will be to briefly describe the roughing operations performed on the crown and bevel of the pulleys. The pulley castings come to the factory in lots of 200 and are drilled and reamed, have the inside turned and the hub turned and faced; in addition, the pulleys are faced on each end.



Figs. 1 and 2. One of the Cone Pulleys to be ground; and Wheel for grinding Crown and Beveled Face simultaneously

After these operations have been performed, the work is taken to a 16-inch Reed engine lathe, which is equipped with a forming attachment for roughing-out the crown on the pulleys. A gang tool is used for this operation so that cuts may be taken over each of the three steps. The rate of production is 100 pulleys in a ten-hour day. The next operation consists of turning the bevel between the steps on the pulleys. A gang tool is also employed for this work, which is done on the same lathe that was employed for forming the crowns. On the bevel turning operation, the rate of production is 150 pulleys per day. After completing this operation the pulleys are ready for grinding.

For the grinding operation, a 10-inch Norton plain grinding machine is employed, the machine being equipped with a 20K alundum wheel. The truing device, which is shown in place on the machine in Fig. 3, is provided with a templet *A* which is formed to the desired shape. The diamond *B* is traversed across the face of the grinding wheel by means of the handwheel *C*, and the roll *D* which controls the movement of the diamond, is held in contact with the templet *A* by means of a spring located under the arm *E*. The pulleys are subjected to rough- and finish-grinding operations and are handled in lots of four, as experience has shown that four pulleys is all that a wheel will grind before it requires re-truing. The rough-grinding is the most important operation as the results obtained at this time are responsible for the accuracy of the finished pulleys.

In truing the grinding wheel for the roughing operation, the diamond is traversed very rapidly across the face of the wheel and leaves it quite rough. This condition is desirable as the pulleys are out of round as much as 1/32 inch in some cases, and as a result it is necessary for the grinding wheel to cut both freely and rapidly. The wheel is fed straight into the work, grinding one crown and one beveled face at each traverse. After four pulleys have been rough-ground in this way, the grinding wheel is dressed preparatory to the performance of the finishing operation. In truing the wheels ready for the finishing cut, the diamond is traversed across the face of the wheel at a much slower speed and leaves the face of the wheel very smooth. After truing the grinding wheel, the four pulleys are finish-ground by feeding in the wheel as in the case of the roughing operation, and merely cleaning out the marks left by the roughing cut. The grinding machine table is located for each step of the pulley by means of a spacing bar which brings it up to a positive stop for each successive step on the pulley. The rate of production is eight pulleys an hour, which includes the performance of both roughing and finishing operations. This means that from 75 to 80 pulleys are ground per day.

When one stops to consider the very satisfactory results which are obtained by this method, and the condition of the pulleys as they come to the grinding machine, it will be granted that the rate at which the work is turned out is exceptionally high. In order to give an idea of the degree of accuracy which is obtained, it may be mentioned that the wheels will not pass inspection if a step runs 0.005 inch out of true, and on most wheels the error does not exceed 0.003 inch. The finish is perfect. To those who have had experience in using a lathe to machine frail pulleys of the kind referred to in this article, trying to keep them as nearly round as possible and still maintain a satisfactory rate of production, these results will be as much of a surprise as they were to the writer, the first time he saw the work done. The method described will, therefore, no doubt be of interest to mechanics in general, and is of considerable value.

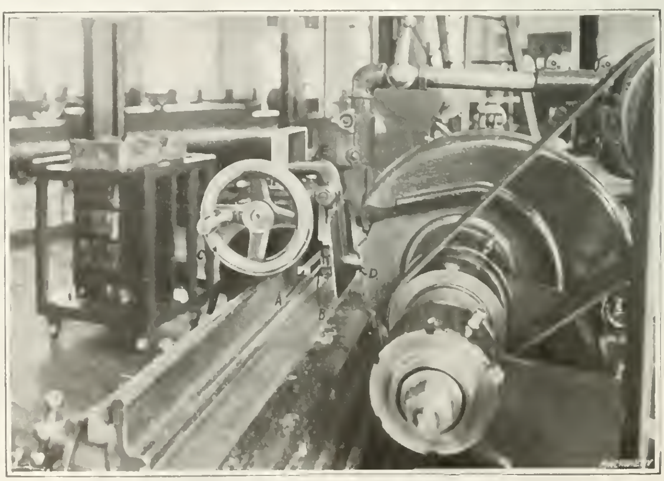
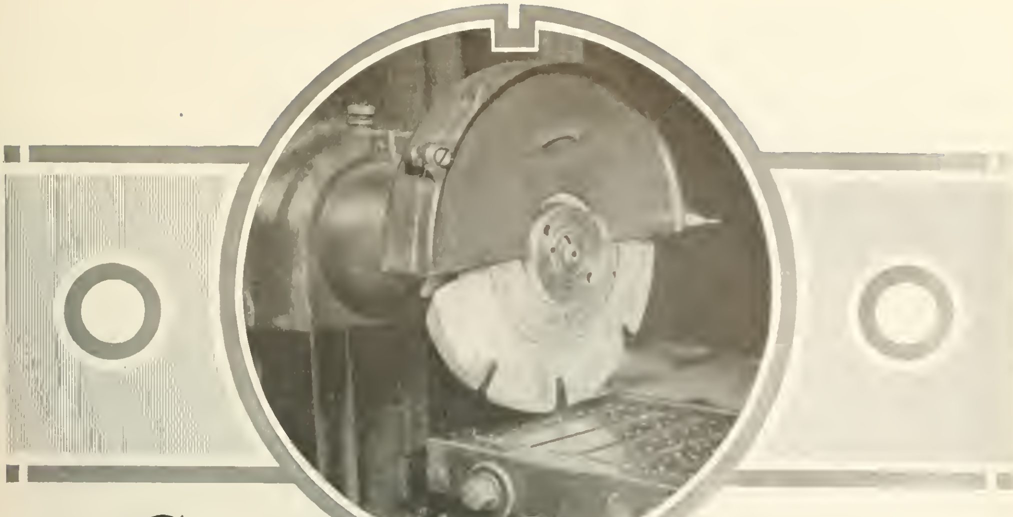


Fig. 3. The Wheel Truing Device set up on Grinding Machine ready for use

* For other articles on the grinding of pulleys published in MACHINERY, see "Grinding Crowned Pulleys" by Howard W. Dunbar, July, 1916, and other articles there referred to.

† Address: 19 Rockdale St., Worcester, Mass.



Surface Grinding

Methods of Grinding Plane Surfaces on Reciprocating and Rotary Surface Grinding Machines*

by Douglas T. Hamilton†

THE grinding of plane surfaces is called surface grinding and differs from cylindrical grinding in many respects. In the first place, the wheel makes greater contact with the work, especially when cup or cylinder wheels are used; consequently, more trouble is experienced with heating and warping. Surface grinding in connection with tool-room work is generally done dry, and is used chiefly as a means for correcting hardened parts or in cases where exceptional accuracy is desired. It is also used for sharpening tools such as punches and dies, etc. When surface grinding is done wet, little trouble is experienced in heating and warping, but it is not always feasible to use water or other cooling lubricants, owing to the nature of the work, and other requirements, and dry grinding must sometimes be resorted to. In the following will be given several interesting methods for preventing undue heat and warping in grinding dry, as well as examples of work with complete data.

Methods of Presenting Wheel to Work for Surface Grinding

Surface grinding is done on several different types of machines, some of which are adapted principally to tool-room work and others to general manufacturing. The most common method of grinding a flat surface and one that is generally used on tool-room work is shown at *A* in Fig 1 The work *a* is traversed back and forth beneath the grinding wheel *b*, as indicated by the dotted line, and either the wheel or work is fed laterally at each end of the stroke, so that the wheel gradually grinds the entire surface.

With this method of grinding, especially on thin work, considerable trouble is experienced with local heating and warping. In order to reduce this trouble to a minimum, light cuts with coarse traverse feeds—almost equal to the width of the face of the wheel per each stroke—are advisable. The chief cause of warping is due to the fact that the heat generated by grinding cannot be absorbed quickly enough by the body of the metal to allow it to expand uniformly and the expansion of the heated surfaces causes it to assume a convex shape. When the wheel is removed and the heat has been absorbed by the work, the surface which has been ground will be concave, and to grind it perfectly flat, light cuts with fast side feeds of the wheel are necessary in order to insure a more even distribution of heat.

Another method of producing flat surfaces is shown at *B* in Fig. 1. In this case, it will be noticed that the wheel *b* is slightly greater in width than the work, and covers the entire surface to be ground. When using this type of wheel, the grinding must be done wet as the surface contact of the wheel on the work is greatly increased. When the grinding is done wet, very accurate work can be secured.

The diagram at *C* shows still another method of producing flat surfaces. The wheel *b* in this case is of the cylinder or ring type, and the vertical surface *c* is ground by being traversed past the face of the wheel; hence this is often called face grinding This method is used quite extensively in the grinding of comparatively large castings such as crank-case covers, gear housings, crank-cases, and similar work.

The diagram shown at *D* illustrates the operation of what is known as the vertical surface grinder. The grinding is done by either a cup or cylinder wheel *b* which revolves

* For additional information on grinding, grinding wheels, and allied subjects see "Internal Grinding," in the August, 1915, number and other articles there referred to.

† Associate Editor of MACHINERY.

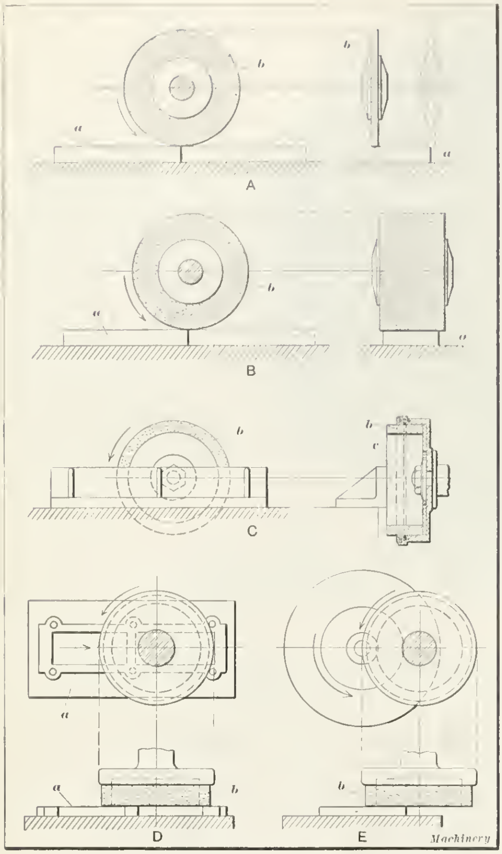


Fig. 1. Diagram illustrating Various Ways of applying Grinding Wheel to Work

about a vertical axis. The work a is held on a reciprocating table by means of a magnetic chuck or other device, and is traversed back and forth beneath the grinding wheel. The wheel-head remains stationary as far as lateral motion is concerned, and is fed down gradually at the end of each stroke until the desired amount of material has been removed. The grinding is done wet.

The diagram shown at E illustrates the operation of another type of vertical surface grinding machine. In this case the work-table has a rotary instead of a reciprocating movement, and the head carrying the cylinder wheel b is fed down a certain amount for each revolution of the work-table. This type of machine is suitable for grinding a large variety of work, such as piston rings, facing sides of ball bearing race rings, and many other machine and engine parts. It can also be used for the grinding of the sides of saws, the required clearance being obtained by setting the axis of the wheel-spindle to an angle less than 90 degrees with the top surface of the work-table.

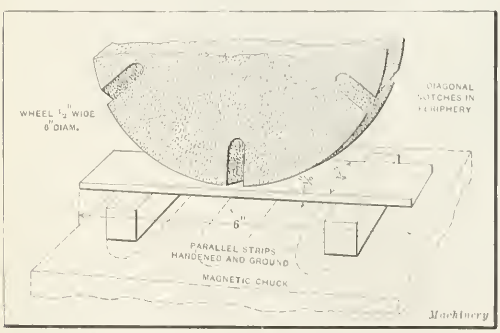


Fig. 2. Method of holding a Thin Piece to prevent warping when grinding Dry

Cooling Water for Surface Grinding

When it is possible to use water, the trouble generally experienced from heating and warping of the work can be overcome. For the grinding of cast iron and hardened steel, sufficient sal-soda should be added to the water to prevent rusting. For grinding soft steel, it is advisable to add some cutting oil to the soda water, as this will improve the finish on the work. The amount of oil used in the soda water is generally in the proportion of 1 gallon of mineral lard oil to 32 or 35 gallons of soda water. On machines of the type illustrated by the diagrams D and E, Fig. 1, plenty of cutting lubricant should be used inside the rim of the wheel, as over-heating of the wheel-face is likely to cause cracking. In most cases, no additional lubricant would be required except for broad surfaces where it may be necessary to use an outside nozzle to assist in cooling the work.

Preventing Thin Work from Warping When Grinding Dry

When it is necessary to grind thin pieces accurately, many different methods to prevent warping are resorted to. One method that has been used with success is illustrated diagramatically in Fig. 2. The piece to be ground is 1/4 inch thick, 3/4 inch wide, by 6 inches long, and is made from steel casehardened. In grinding this piece by holding it in direct contact with the face of the magnetic chuck, it is practically impossible to bring it to a uniform thickness. The method adopted in grinding this particular piece was to rough it out by holding it in direct contact with the magnetic chuck, leaving about 0.002 inch to remove in finishing. Two

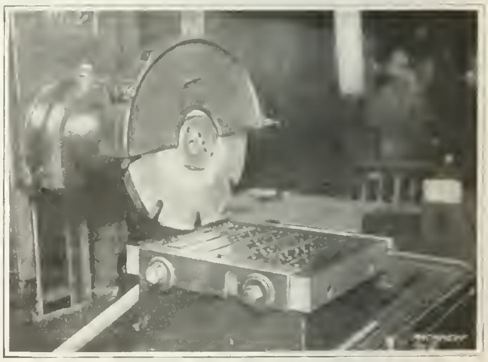


Fig. 3. Method used in holding a Number of Very Thin Pieces on a Heald Magnetic Chuck

accurately ground parallel strips were then placed on the magnetic chuck with the work located on them in about the position shown. The current was then turned on for the operation of finish-grinding. The first step was to true the face of the wheel, which it will be noticed, is provided with eight diagonal notches cut in its periphery at an angle of 45 degrees with the axis of the wheel-spindle. The work was then ground by taking very light cuts with coarse side feeds and rapid table traverses, the work being inverted after taking a cut from each side.

By holding the work in this manner, warping was practically eliminated because of the reduced chances for overheating. A current of air is allowed to pass through freely under the work at all points, except where it contacts with the parallel strips. In addition, the diagonal notches in the wheel-face convert the wheel into a fan, assisting in cooling the work. Even with this method of holding and grinding, it would be impossible to get the piece absolutely flat without inverting it after every cut. This method, of course, is not recommended for manufacturing purposes as the expense would be prohibitive and this illustration is given simply to show how a thin piece of work can be ground accurately when it is impossible to use water.

Figs. 3 and 4 show another method of holding thin work to prevent warping when grinding. In this case the work being ground is a steel plate 0.050 inch thick by ⅜ inch wide by 1 1/16 inch long, which must be ground to a limit of 0.0005 inch in thickness from end to end and parallel. The method of grinding these pieces was to arrange 48 of them on a Heald 6 by 8 inch rectangular magnetic chuck in the manner shown in Fig. 4. Instead of placing the chuck on the grinding machine table in the usual manner, that is with the magnetic poles parallel with the axis of the wheel-spindle, the position was reversed so that the poles were at right angles to the axis of the wheel-spindle. The pieces were then arranged in double rows, butted together, and overlapping the non-magnetic surfaces in the manner illustrated. While this arrangement reduced to a certain extent the strength of the magnetic flux, it made possible the holding down of the pieces with an equal pressure for their entire length. In order to prevent undue heating, a wheel of the shape shown in Fig. 3 was adopted. The efficiency of this method of holding is proved by the fact that 1320 pieces were ground to the limits required in 30.6 hours.

Holding Warped or Sprung Work

If a thin or light piece is warped when it comes to the surface grinding machine, considerable care must be exercised in holding it in order to prevent distortion. For instance, if it is held on a magnetic chuck, the pull of the chuck may so distort it as to make it out of true when released. Turning such a piece over several times during the grinding will, to a certain extent, eliminate much of the variation. When grinding large thin parts with a vertical-spindle rotary type of machine, warping can be minimized by placing the work central on the chuck, using suitable stops, and grinding the first side without using any magnetic current.

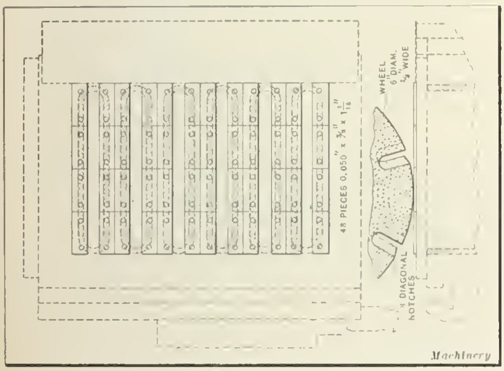


Fig. 4. Diagram showing Arrangement of Pieces held on Chuck shown in Fig. 3.

This operation need only be carried far enough to clean up the surface on one side to a fair bearing and present a flat surface to the chuck so that it can be held magnetically. Large thin plates such as circular saws are often best ground without using the magnetism at all. A good general rule to follow in practically all work that is warped or sprung out of shape, is not to hold it magnetically for grinding the first side, but to support it in some other way.

Holding Non-magnetic Work

When grinding brass, aluminum and other non-magnetic materials, the work must be clamped or secured in some other way than by direct magnetism. The method generally used is to employ a vise, clamping fingers, or other work-holding fixture for retaining the part to be ground where the use of such a device is possible. If the work is quite heavy, it can be held on a chuck by simply using a backing-up strip to prevent it from shifting. When the piece is in the shape of a ring or plate, and a vertical spindle rotary type of machine is used, it can be ground by being placed centrally on the table, as it will be held down by the wheel itself and need only be centered by stops, or by a plug in the center of the hole, if there is one in the piece.

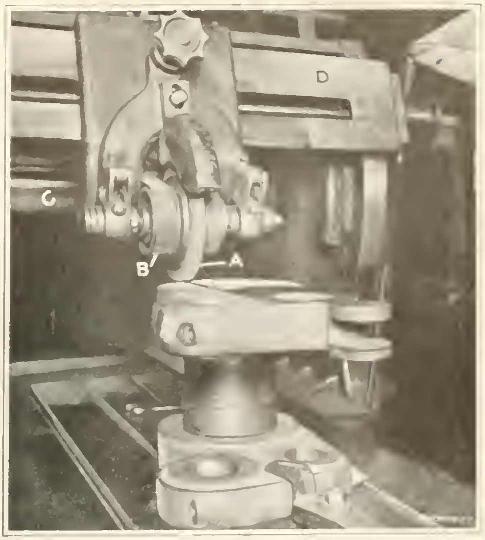


Fig. 5. Grinding a Milling Machine Wrist on a No. 4 Brown & Sharpe Surface Grinding Machine

The magnetic chuck can sometimes be used to advantage for holding non-magnetic work by using strips or stops as shown in Fig. 7. In diagram *A*, four small steel blocks are placed and held on the magnetic chuck as illustrated, and prevent the casting *b* from shifting, enabling it to be ground. Still another method is shown at *B*, where a chuck ring c and four pieces *d* are used for supporting the work and preventing it from shifting on the magnetic chuck. Still another method is shown at *C* where the pieces for supporting the work are clamped by bolts to the chuck. This method can also be used with a non-magnetic chuck.

Non-magnetic work of box form can be held magnetically by using blocks of cast iron or steel which are placed inside the parts to be ground. The magnetic attraction of these blocks to the chuck will be strong enough to hold the work, provided the thickness of the latter does not exceed 1 16 inch. The same method has been very successful for holding thin pressed steel boxes, the sides of which were so high that the boxes could not be held rigidly enough for grinding the upper edges, without placing the magnetic blocks inside.

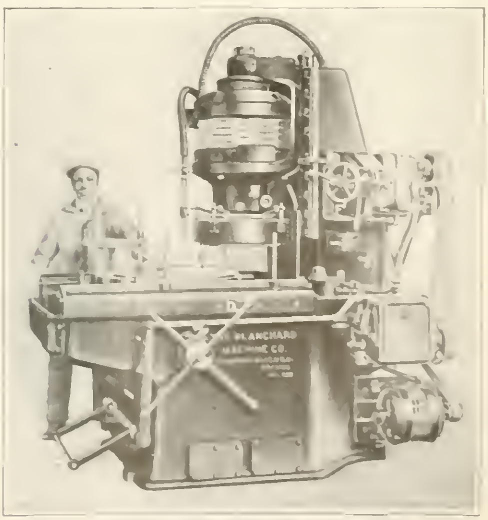


Fig. 6. Blanchard High-power Vertical Surface Grinder—Motor-driven Type

Grinding Large Castings on Planer Types of Surface Grinding Machines

For grinding large machine parts such as milling machine tables, wrists, etc., the Brown & Sharpe No. 4 surface grinding machine, as shown in Fig. 5, is sometimes used. This particular machine carries a disk wheel *A* which is driven from the overhead works by means of the pulley *B* from a drum pulley *C*. The grinding wheel-head is held on the rail *D* and can be moved back and forth by means of power or hand feed, power feed being effected in practically the same manner as on a planer. It will be noticed that the rail swings on an arc; the reason for this is that because of the method of driving, the belt would be tightened and loosened if the rail were adjusted up and down in a vertical position. The point from which the rail swings is the axis

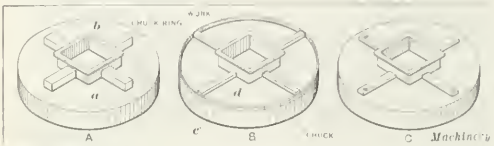


Fig. 7. Methods of holding Non-magnetic Work on Vertical Surface Grinder

of the drum pulley *C*. When grinding parts on a surface grinding machine of the planer type, the work is generally clamped direct to the table by means of bolts, as illustrated, or is held up against angle plates, the method depending entirely on the character and shape of the work.

Wheel Speeds for Surface Grinding

The grinding wheel speeds for surface grinding are generally less than those for external cylindrical grinding, and vary between 3000 and 5000 feet per minute. The speeds are generally higher for a disk wheel than for a cylinder or ring wheel, the latter grinding on the edge instead of on the circumference. On surface grinding machines of the type shown in Fig. 3, which carry disk wheels, the wheel speed is kept as close as possible to 5000 feet, whereas on the Blanchard machine, the wheel speed is about 4000 feet per minute. On the Heald rotary surface grinder where a disk wheel is used, the speed is about 5000 feet per minute.

Work Speeds and Feeds for Surface Grinding

The feeds and speeds to use for surface grinding depend largely upon the method of applying the wheel to the work. On the type of surface grinding machine that operates on the principle shown at *A* in Fig 1, the traverse speed of the table varies from 25 to 50 linear feet per minute, depending upon material, the width of face of the wheel used, and the depth of cut taken. Usually the cross-feed is equal to ½ or ¾ the width of the grinding wheel face, but this lateral

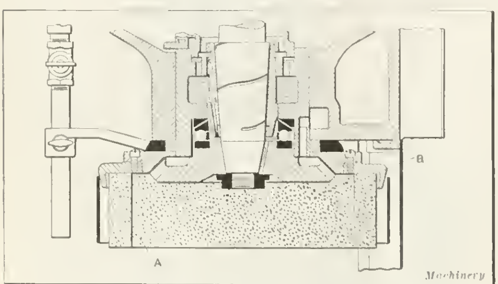


Fig. 8. Section showing how Cylinder Wheel of Blanchard Vertical Surface Grinder is held and mounted

feed is varied, according to the finish required. When the piece is to be finished in one cut and a fairly smooth surface is required, a wheel ¾ inch wide, and a feed of from 1/16 inch to ⅛ inch per traverse is generally used. The depth of cut varies from 0.0005 to 0.003 inch.

When grinding on machines working on the principle shown at *B* in Fig. 1, if the work is less than 10 inches in width, the wheel is not fed across the work, but the work is traversed back and forth under the wheel, the complete surface being finished in one cut. On this machine, the table traverse varies from 25 to 50 linear feet per minute, and the depth of cut from 0.0005 to 0.003 inch per traverse.

On surface grinding machines that work on the principle shown at *C*, Fig 1, the table is traversed at the rate of from 25 to 50 linear feet per minute, and the cut varies in depth from 0.001 to 0.005 inch per traverse. When this type of machine is used for large castings, a heavier cut is taken than where the work is smaller or more accurate.

Where the grinding is done on a machine of the type illustrated at *D* in Fig. 1, the table is traversed back and forth and usually the ring or cylinder wheel used covers the entire width of the surface being ground. When this is the case, the only two points to consider are the table traverse and the down feed of the wheel per traverse. The table traverse varies from 15 to 50 linear feet per minute, and the down feed from 0.0005 to 0.002 inch per traverse.

On surface grinding machines working on the principle shown at *E*, Fig. 1, where the work and wheel both rotate but are not traversed, the two conditions to consider other than the wheel speed, are the speed of the work-table and down feed of the wheel per revolution of the work-table. Generally the down feed of the wheel-head varies from 0.001 to 0.002 inch per revolution of the work-table and the table speeds vary greatly depending upon the type of machine and the character of the work. The type of grinding wheel

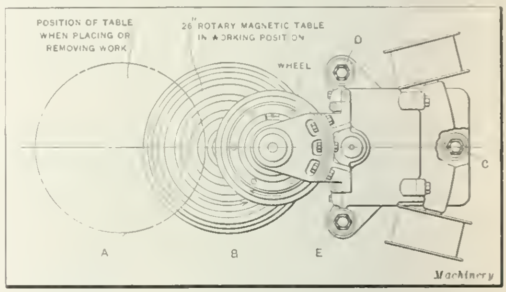


Fig. 9. Diagram showing Working Position of Table on Blanchard Machine and Method of adjusting Vertical Column

to use on machines of this design is not adapted to deep cuts and more stock can be removed with less wheel wear by means of light cuts and comparatively fast speeds than by heavy cuts and slow speeds. The cut, however, should be deep enough to keep the wheel cutting freely, and feeds as fine as 0.0002 to 0.0004 inch should be avoided, as on most work they tend to make the wheel glaze.

In determining the correct table speeds and depth of cut to use on the Blanchard high-power vertical surface grinder, a down feed of about 0.001 inch should be used to start with. If the wheel glazes, rough the face with a carborundum block held in the hand, and try the wheel again, using the next lower table speed with slightly increased down feed. If the wheel appears to be too soft and wears away too rapidly, increase the table speed and decrease the down feed. Obviously a down feed of 0.002 inch with a table speed of 6½ revolutions per minute removes the same amount of stock per minute as a down feed of 0.001 inch with a table speed of 13 R. P. M. Varying the speed and feed to improve the cutting action of the wheel need not, therefore, change the rate of cutting. It should be clearly understood, however, that in order to obtain satisfactory results, the wheel must be suited to the work. The variations of speeds and feeds will not adapt an unsuitable wheel to the work and they are simply used as an aid to secure the highest possible economy of operation with a wheel that has been found suitable for the work in hand.

The Blanchard High-power Vertical Surface Grinder

A surface grinding machine that works on the principle shown by the diagram at *E* in Fig. 1, is shown in Fig. 6. This is the latest type of Blanchard high-power vertical sur-

face grinder, and is motor-driven. The base is made of one casting and is of box form heavily ribbed inside, forming a rigid support for the various parts of the machine. The column is of box form with internal stiffening webs, and carries the wheel-head. The slide upon which the wheel-head fits is 36 inches long and has three accurately fitted tapered gibs extending the entire length to provide against wear. The slides on the wheel-head are 30 inches long, accurately scraped to master plates and carrying a separate housing which contains the bearings for the upper end of the spindle. The spindle is made from a forging of 0.40 to 0.50 per cent carbon steel, and is finished all over by grinding; it is fitted with ball-thrust bearings and an automatic spring take-up; the side pull is taken by a bronze bushing at the lower end of the spindle and by a radial ball bearing at the upper end.

The motor used on the wheel-head is 20 horsepower and of the alternating-current type. The field frame is centered in a bored recess in the wheel-head and is bolted to it only at the lower end. The upper end of the field frame has a cover which keeps out dirt and fills the space between the field and the upper spindle bearing. The cover carries an oil catcher which traps any oil escaping from the upper bearing, and conducts it away from the motor. A screened opening extending around the cover admits air into the interior of the motor to which it is circulated by fans on the spindle and discharged through holes in the lower part of the motor frame. These fans force a large quantity of air to the motor, cooling it effectively even when severely overloaded.

The gear-box shown at *A*, Fig. 6, through which table *B* is rotated, provides for eight changes of speeds varying in revolutions per minute as follows: 5, 6.5, 8.5, 13, 17.5, 22, 29 and 44. The chuck is usually started and stopped by means of a hand lever on the gear-box. The foot treadle *C* is used for moving the chuck through part of a revolution when placing the work in position for grinding. The table is brought into position under the wheel, after the work has been located in the chuck, by operating turnstile *D*. The correct working position for table is shown in Fig. 9.

The vertical feed for the wheel-head can be effected either by hand or power, and is varied by adjusting the feed variator *E* (Fig. 6). Feed wheel *F* is graduated in such a manner that a movement of ½ inch on the circumference of the wheel means a down feed of 0.001 inch. Down feeds of the wheel-head can be varied from 0.0002 inch to 0.005 inch per revolution of the work-table by steps of 0.0002 inch. The down feed is also provided with an automatic stop which can be set to disconnect the feeding movment when the desired thickness on the work is obtained. The water tank has a capacity of 64 gallons, and is supplied with a submerged centrifugal pump having an 8-inch fan and a 1½-inch discharge pipe.

Mounting and Truing Wheels

The grinding wheels used on the Blanchard, motor-driven, vertical surface grinders are 18 inches in diameter, 5 inches deep and with rims varying from 1- to 1½-inch thick, depending upon the work to be ground; whereas those used on the belt-driven are 16 inches. Of the 5 inches total depth, 3 15/16 inches can be used. As shown in Fig. 8, the grinding wheel *A* is cemented into a cast-iron retaining ring *B*, which, in turn, is held to a flange retained on the lower end of the vertical spindle.

There are several methods of mounting wheels of this type. One is to mix equal parts of Portland cement and sand with water, to the consistency of a thin paste; then wet the wheel thoroughly all over and spread a thin layer of the cement paste on the end that is to go next to the retaining chuck. The next step is to remove all dirt and grease from the inner surfaces of the retaining ring, and place the wheel centrally in the ring with the cemented end down; next fill the space between the wheel and the iron ring with the cement paste, using a thin piece of metal to ram it in. All surplus cement should be removed from the outside of the ring, and then the wheel should be covered with clothes and placed in a covered box or barrel. The wetting of the wheel before cementing and keeping it damp while the cement sets, are very important. Wheels should be allowed to set two days, or more, varying with the brand of cement used. If the inside of the ring wheel has not already been "waxed" it should be covered with parafine wax painted on hot to prevent any trouble from the water spraying.

Another method of cementing in cylinder or ring wheels, which is much quicker than that previously described, is to use melted sulphur. The wheel and ring are cleaned as before, then the sulphur is melted and poured into the intervening space between the wheel and ring. The sulphur hardens as it cools, and the wheel may be used within a short time after the sulphur has been poured in.

For truing the wheel used on the Blanchard vertical surface grinder, a stick of special carborundum mounted in a cast-iron holder is used. This is applied to the wheel by holding the carborundum stick-holder on the magnetic table and sliding the table in and out to pass the carborundum stick across the face of the wheel. Care should be taken, of course, to see that the truing device is held magnetically before being passed under the wheel. A new wheel should be trued before using, but after this first truing has been done the wheel should not be touched until it glazes. As soon as glazing occurs, the wheel-face should be roughed

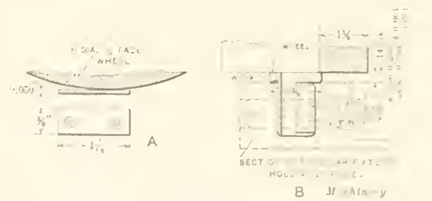


Fig. 11. Examples of Thin Work ground without Distortion and Data on grinding Flange of a Bushing

A

Work:—Pivot plate made from 0.20 per cent carbon cold-rolled strip steel, casehardened 0.012 inch deep.

Operation:—Grinding both sides with Norton vitrified alundum wheel, grain 38-46, grade G; 6 inches in diameter, ½-inch face, wheel speed, 3183 R. P. M.—5000 feet surface speed; provided with eight diagonal notches around its periphery, amount removed from each side, 0.0015 to 0.002 inch.

Remarks:—Table is traversed back and forth by [illegible] and also in and out by hand, 48 pieces held at one time on a Heald 6- by 8-inch flat magnetic chuck, pieces arranged along or parallel with magnetic poles instead of spanning them; four traverses to complete each side, [illegible] pieces turned out per each truing of wheel, production, 1320 in 30 6 hours; machine used, No. 2 Brown & Sharpe surface grinding machine.

B

Work:—Bushing for steering spindle 0.15 per cent carbon [illegible] steel, carbonized and hardened.

Operation:—Surface grinding large end with a Norton vitrified alundum wheel; grain 24, grade L; 14 inches in diameter, 1¼-inch face speed 1400 R. P. M.—5120 feet surface speed; table speed, 100 R. P. M.; head travel or traverse speed, 42.5 linear inches per minute, amount removed, 0.007 to 0.010 inch.

Remarks:—Wheel is traversed back and forth across work, which is held in a special ring fixture carrying 28 bushings; production, 4000 in nine hours; machine used, Heald rotary surface grinding machine.

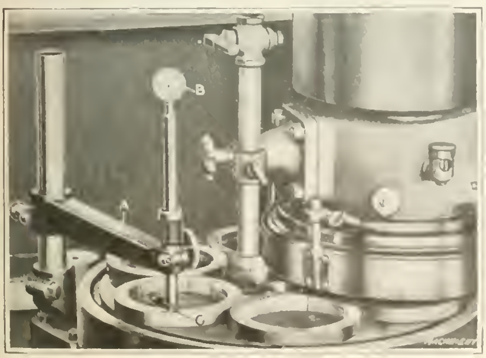


Fig. 10. Continuous Reading Caliper for Use on Blanchard Vertical Surface Grinder

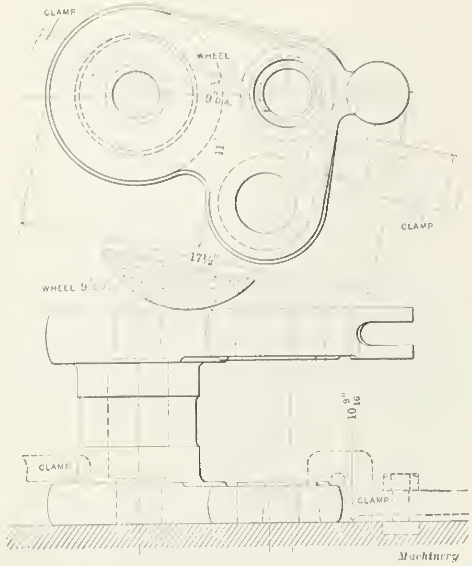


Fig. 12. Method of grinding a Wrist for a Plain Milling Machine

Work:—Wrist for a plain milling machine made from iron casting.

Operation:—Surface grinding one face for finish with a Carborundum Co.'s (vitrified) carborundum wheel, grain 36, grade P or M; 9 inches diameter, ¾ inch face; speed, 2122 R. P. M.—5000 feet surface speed; work speed—or table travel—35 linear feet per minute; traverse feed, 1/16 inch per traverse of wheel; amount removed from surface, 0.005 to 0.007 inch.

Remarks:—Narrow face wheel is fed once across work; work is held down on table of grinding machine by clamps (see illustration); 8 pieces turned out to each truing of wheel; production, 9 to 10 per hour; machine used, No. 4 Brown & Sharpe surface grinding machine.

up with a piece of carborundum held in the hand. A wheel that requires this treatment frequently is too hard or too fine for the work and should be changed. The right wheel for the job will run until worn out without dressing. It should also be remembered that in a vertical surface grinder of this type, the wheel-face does not need to be kept flat in order to secure flat work.

Working Relation of Table to Wheel on Vertical Surface Grinder—Setting Wheel-head to Grind Work Concave

For loading the magnetic table or chuck on a Blanchard vertical surface grinder, the table is moved out as previously described, bringing it out of contact with the grinding wheel, as shown by the dotted line *A* in Fig. 9. The work is then placed on the magnetic chuck, after which the table is moved in until the outer rim of the wheel coincides with the central axis of the work-table, as shown at *B*. The table and work are then rotated.

A word here about keeping the chuck clean may be of interest. It is the practice of the Blanchard Machine Co. to use a loose ring of sheet steel laid around the group of pieces to be ground (as will be seen in the illustrations further on) and sometimes another ring is laid inside the piece. This is very clearly shown in Fig. 19, which illustrates a number of rifle hammers in place for grinding. When one side of the pieces has been ground, the chuck is moved to the end of the machine, the magnetism turned off, and both work and the chuck rings removed, leaving the chuck face clear of everything except the water and chips. Cleaning is then done with a rubber edged scraper or squeegee—the same device that is used for cleaning plate glass windows. By depressing the treadle at the front of the machine, the operator can set the chuck in motion without leaving his position at the end of the machine and with the squeegee can clean off the chuck face as it revolves, in a few seconds. This is sufficient for all but the most particular work, for which further cleaning is usually given with a cloth.

For straight plain surface grinding, the spindle should be set absolutely square or at right angles with the chuck-face, so that the wheel touches the work on both sides; when the wheel is properly set, limits of 0.0003 inch total variation, can easily be worked to. There are some classes of

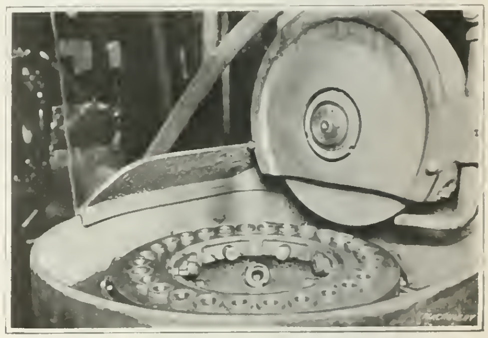


Fig. 14. Method of holding and surface grinding Top Flanges of Bushings

work, however, for which it is necessary to set the wheel-spindle at an angle to the face of the work-table, as when grinding the concave sides of circular saws, etc. To make this adjustment, the rear column support *C*, Fig. 9 is provided with a graduated washer. To set the head for concave work, the three-column support bolts, *C*, *D*, and *E* should be loosened, but the two front washers should not be disturbed. A note should be made of the setting of the rear washer before changing; then turn this washer to the right until the spindle is inclined the desired amount and tighten all the bolts firmly before starting the machine. A slight adjustment of the rear or two side supports may be made by simply loosening the bolt which is to be adjusted.

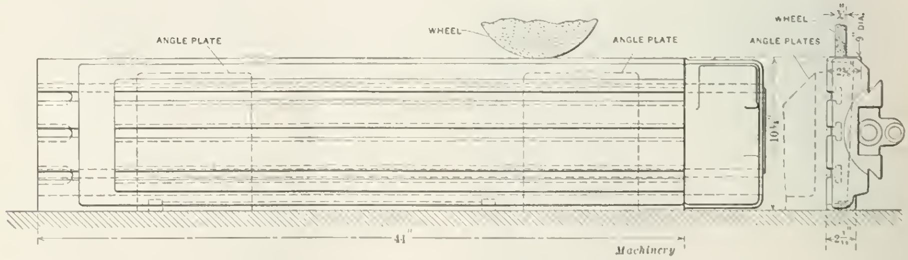


Fig. 13. Method of grinding Both Edges of a Milling Machine Table

Work:—Milling machine table made from iron casting.

Operation:—Grinding both edges for finish with a Carborundum Co.'s (vitrified) carborundum wheel, grain 36, grade P; 9 inches in diameter, ¾ inch face; speed, 2122 R. P. M.—5000 feet surface speed; table traverse, 35 linear feet per minute; cross feed, 1/16 inch per traverse; amount removed, 0.005 to 0.007 inch.

Remarks:—Narrow face wheel is fed once across work; work is held down on table by clamps and up against two angle plates (see illustration); 2 pieces turned out per each truing of wheel; production, 5 per hour, both edges ground, machine used, No. 4 Brown & Sharpe surface grinding machine.

Measuring Work on Surface Grinding Machines

The method of measuring work on surface grinding machines depends entirely on the type of machine. On machines of the type where the wheel-head is lowered or elevated by means of an adjusting screw, the graduated index on the wheel is generally used as a guide for grinding the work down to approximately the required thickness. The work is then removed from the chuck and measured from time to time until the desired thickness has been obtained. After several pieces have been ground it is possible to grind very close by means of the index wheel, as the only variation is due to the wear of the wheel.

On the Blanchard vertical surface grinder a device known as a "continuous reading caliper" is applied directly to the work and readings are taken continuously as the work-table rotates. This attachment consists of an arm *A*, as shown in Fig. 10, which is clamped to a vertical post and carries in its front end a spindle and other members that operate the needle of a dial *B*; this dial indicates the exact amount, in thousandths of an inch, by which the work thickness varies from the finished size. The reading is secured through a hardened steel button *C* that rests on the work and is connected to the gage. To set the caliper the button is brought down on a sizing block or finished piece, placed on the table, and the dial of the gage-head revolved to bring the zero line into agreement with the needle.

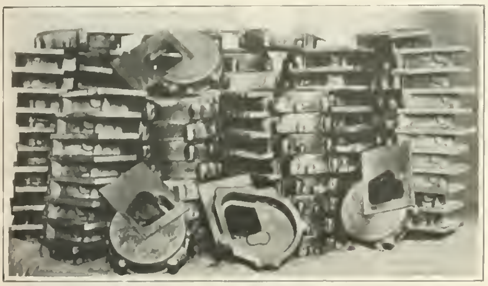


Fig. 15. Gear Housings ground on Both Sides on a Blanchard Vertical Surface Grinder at the Rate of 60 Pieces per Hour

Examples of Surface Grinding

In the following will be given examples of work that have been accomplished on the various types of surface grinding machines shown by the diagrams in Fig. 1. Surface grinding has always been considered a difficult proposition because of the over-heating and warping of the work; therefore, the examples given in the following should be of interest to those doing this class of work.

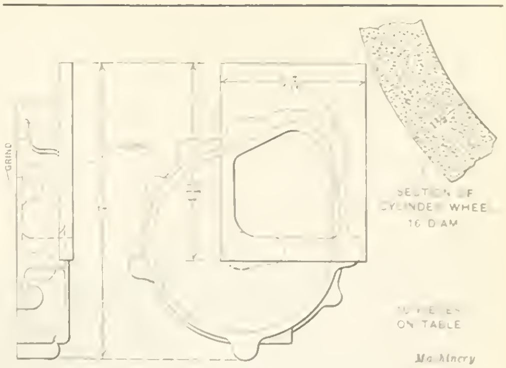


Fig. 17. Data on grinding of Gear Housings shown in Fig. 15

Work:—Gear housing, cast ...

Operation:—Surface grinding two sides from the rough with a American (vitrified) carbolite wheel; grain 20, grade H, 16 inches diameter, 1½-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, roughing and finishing, 13 R. P. M.,—down feed of wheel, 0.0012 inch per revolution of table; amount removed from each side 0.032 inch.

Remarks:—10 of these pieces are held at one time on Blanchard magnetic chuck; grinding time, 7 minutes; handling time, 3 minutes; limits plus or minus 0.001 inch; production, 60 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

Grinding Small Thin Plates

Diagram *A*, Fig. 11, shows an example of surface grinding to which reference has previously been made. This is a small pivot plate made from 0.20 per cent carbon, cold-rolled strip steel, case-hardened 0.012 inch deep. It was satisfactorily ground by using a Norton alundum wheel, grain 38-46, grade G, by cutting diagonal notches in the periphery and then using a Heald magnetic chuck to which the pieces were held as previously described.

Examples of Work done on Planer Type of Surface Grinding Machines

Fig. 12 shows a milling machine wrist which is ground on a surface grinder of the planer type illustrated in Fig. 5. A carborundum wheel, grain 36, grade P or M, 9 inches in

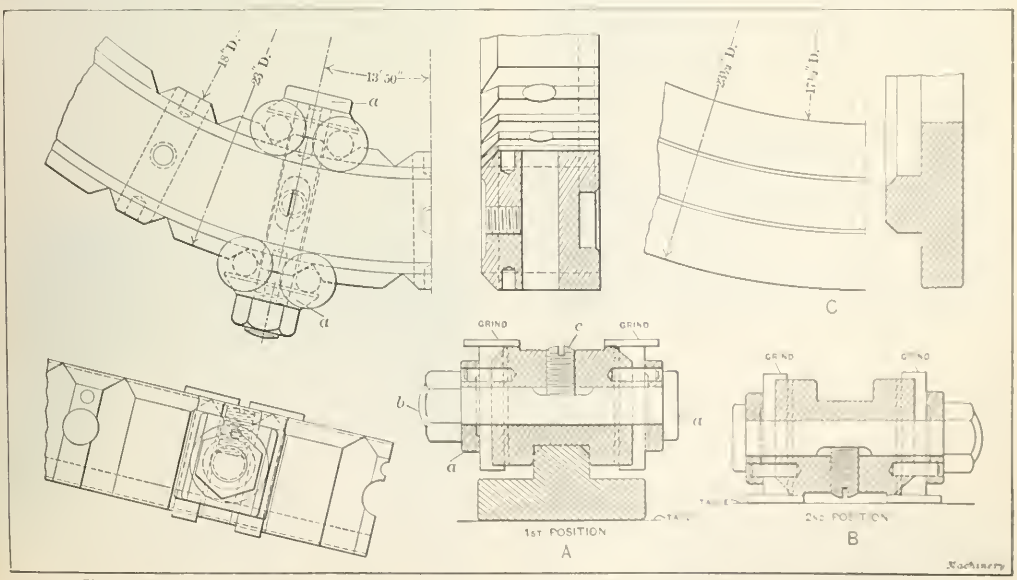


Fig. 16. Method of holding and grinding Valve Push Rods on a Blanchard Vertical Surface Grinder at the Rate of 720 per Hour

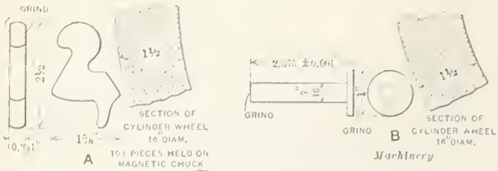


Fig. 18. Examples of Surface Grinding on Rifle Hammers and Valve Push Rods

A

Work:—Rifle hammer, soft steel forging, not hardened.

Operation:—Grinding both sides from the rough with an American (silicate) corundum wheel; grain 58-24, grade ¾; 16 inches diameter, 1½-inch rim; speed 1000 R. P. M.—4190 feet surface speed; table speed, roughing, 17 R. P. M.—finishing 5 R. P. M.; down feed of wheel, 0.001 inch per revolution of table; amount removed from each side, 0.025 inch.

Remarks:—103 of these parts are held at one time on Blanchard magnetic chuck between two retaining rings; grinding time, 8 minutes; handling time, 12 minutes; limits, plus or minus 0.0005 inch; production, 300 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

B

Work:—Gas engine valve push-rod, vanadium steel drop-forging, heat-treated.

Operation:—Surface grinding both ends from the rough with an American (silicate) corundum wheel; grain 30; grade 1-W; 16 inches diameter, 1½-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, 17 R. P. M.; down feed of wheel, 0.0015 inch per revolution of work-table; amount removed from each end, 0.010 inch.

Remarks:—104 of these parts are held at one time on a Blanchard magnetic chuck by means of a special clamping fixture; handling time is greatly reduced by providing three fixtures; production, 720 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

diameter, is fed across the work at the rate of 1/16 inch per traverse of the wheel with the work-table operating at a speed of 35 linear feet per minute, and removing from 0.005 to 0.007 inch.

Still another example of a somewhat similar nature is shown in Fig. 13. This is a milling machine table, and the grinding is done on both edges of the table. For this work a carborundum wheel of the same grain and grade as that used in Fig. 12 is used and the other facts concerning the job are also similar. The top of the platen has been accurately finished so that this face is used as a locating point for grinding the edge, the platen being clamped against two accurately finished angle plates. Probably a more satisfactory way of handling this work would be to locate the

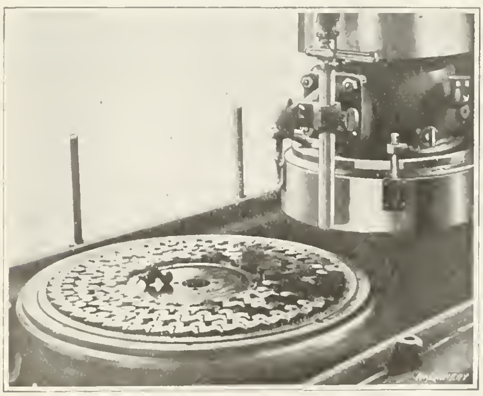


Fig. 19. Method of holding and grinding Rifle Hammer shown at A in Fig. 18, on a Blanchard Vertical Surface Grinder

platen from the V-slide, having several hardened rollers fitting in the lower angle of the slide and resting on hardened blocks, then clamping the work in the position as illustrated, and using the ways simply as a means of getting the sides of the table straight and parallel with the V-ways.

Grinding Top Face of Flanges of Bushings

An interesting method of handling and grinding the flanges of bushings is shown in Fig. 14. The machine used is a Heald rotary surface grinder carrying a disk wheel 14 inches in diameter, 1¼-inch face. This wheel is traversed back and forth across the top faces of the bushings to grind them to the required thickness. The bushings are held in a special fixture carrying twenty-eight at a time; the fixture, in turn, is clamped to the magnetic chuck. The data for this particular operation are given at *B* in Fig. 11.

The gear housings shown in Fig. 15 represent a good example of surface grinding as handled on the Blanchard vertical surface grinder. These are made from cast iron and 0.032 inch of metal is removed from each side from the rough. Ten of these pieces are held on the magnetic chuck at one time, and the production is at the rate of sixty pieces per hour, as will be seen by referring to Fig. 17 where data regarding the wheel, and the work speeds are given.

Grinding Valve Push Rods

The valve push rods shown clamped in the fixtures at *A*, see Fig. 16, are examples of work that can be handled on the vertical surface grinder. The grinding is done on both the small and large ends, the push rods being ground to the correct length within limits of plus or minus 0.001 inch. Two operations are necessary. The first operation, which is shown at *A* in Fig 16, consists of grinding the top or largest diameter of the push rod, removing about 0.010 inch. For this operation, a blocking ring of inverted T-section, as shown at *A*, is placed under the fixture. This raises the fixture from the magnetic chuck and prevents the push rods from touching the chuck. For grinding the small ends of the rods, the blocking ring is removed and the fixture is located on the table, as indicated at *B*, the

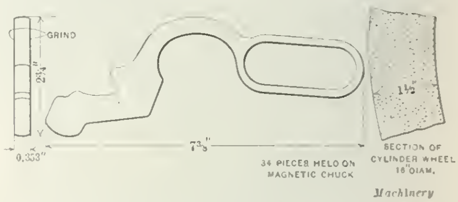


Fig. 20. Data on Levers for Repeating Rifle ground as shown in Fig. 21

Work:—Lever for repeating rifle, soft steel forging, not hardened.

Operation:—Surface grinding both sides from the rough with an American (silicate) corundum wheel; grain 58-24, grade 1; 16 inches diameter, 1½-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, roughing, 17 R. P. M., finishing 5 R. P. M.; down feed of wheel, 0.0012 inch per revolution of table; amount removed from each side, 0.032 inch.

Remarks:—34 of these parts are held at one time on Blanchard magnetic chuck located inside one retaining ring; the pieces are flattened after trimming, and before grinding; grinding time, 8 minutes; handling time, 4 minutes; limits, plus or minus 0.001 inch; production, 204 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

previously ground faces of the rods resting on the magnetic chuck. This feature insures greater accuracy.

The method of clamping the push rods is simple, but effective. The clamping device consists of two blocks *a* through which a shoulder binding stud *b* passes. This stud, in connection with the two clamps, holds four push rods in place. The studs are prevented from turning by

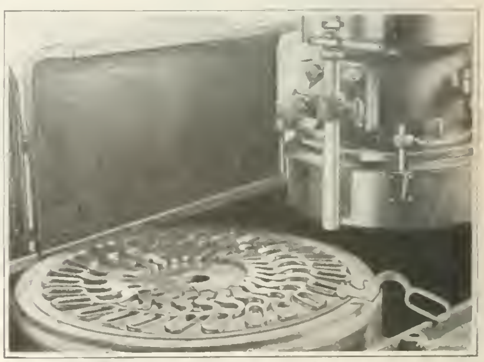


Fig. 21. Method of holding and grinding Lever for Repeating Rifles shown in Fig. 20, on a Blanchard Vertical Surface Grinder

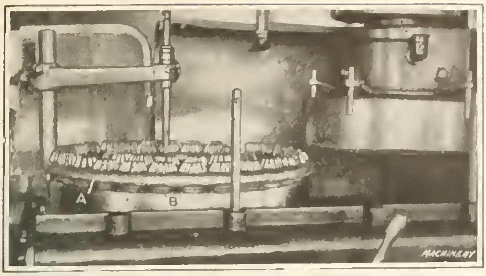


Fig. 22. Method of holding and grinding Front Ends of Bevel Pinions on a Blanchard Vertical Surface Grinder

headless screws *c* resting on flats provided on the studs. The rods are held in V-grooves in the body of the fixture and are located when being placed in the fixture, by the under surface of the head, which rests on the finished top face of the fixture. Three fixtures of this type are provided so that the handling time is reduced to a minimum. Section *B* in Fig. 18 gives all the facts on the grinding of these push rods.

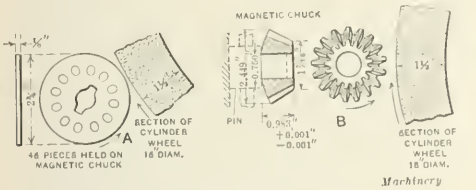


Fig. 23. Examples of Meat Chopper Disk and Bevel Pinion Surface Grinding

A

Work:—Meat chopper disk, soft steel punching, not hardened.

Operation:—Surface grinding both sides from the rough with an American (silicate) corundum wheel; grain 24, grade ¾; 16 inches diameter, 1½-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, roughing, 13 R. P. M., finishing, 5 R. P. M.; down feed of wheel, 0.0014 inch per revolution of work-table; amount removed from each side, about 0.008 inch.

Remarks:—46 of these parts are held at one time on Blanchard magnetic chuck located between two retaining rings; grinding time, 4 minutes, handling time, 4 minutes; limits, just clean up; production, 345 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

B

Work:—Bevel pinion, 0.020 to 0.030 per cent carbon, open-hearth steel, carbonized and hardened.

Operation:—Surface grinding one end from the rough with an American (silicate) corundum wheel; grain 30, grade 1¾-W; 16 inches diameter, 1½-inch rim; speed, 950 R. P. M.—3971 feet surface speed; table speed, 6 R. P. M.; down feed of wheel, 0.0005 inch per revolution of work-table; amount removed from end, 0.010 inch.

Remarks:—44 of these parts are held at one time on a Blanchard magnetic chuck, being retained magnetically on pins held in a special fixture; handling time, 6 minutes; production, 200 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

Grinding Rifle Parts

The grinding of certain rifle parts can be done satisfactorily on the vertical surface grinder, because such a large number of pieces can be held at one time, and the method of holding does not require the need of special fixtures for many of the parts. This is clearly seen in Fig. 19, where 103 rifle hammers are shown held on a Blanchard magnetic chuck by simply using two retaining rings, one inside the group of pieces and one outside. This brings up a point regarding the vertical surface grinder that is worthy of attention. For a large number of parts, the surface grinder requires almost no fixtures; simple rings of sheet steel may be laid around the groups of pieces to be ground, and even if the parts are of irregular shape, it is usually possible to make a very simple magnetic fixture.

Referring to *A* in Fig. 18, it will be seen that the rifle hammer is made from a soft steel forging and is not hardened. The speed of the table is changed twice for finishing the surface. For roughing, a speed of 17 R. P. M. is used, whereas for finishing, the rotative speed of the table is reduced to 5 R. P. M. This enables the same wheel to be used for both roughing and finishing operations, and gives the desired finish.

The lever for a repeating rifle shown in Fig. 20 is another rifle part that is ground in a similar manner on the Blanchard vertical surface grinder. Fig. 21 shows how thirty-four of these parts are held on the magnetic chuck at one time. No special fixtures are required, the pieces being simply located inside a retaining ring and held magnetically to the chuck. Referring to the data shown in Fig. 20, it will be noticed that roughing and finishing cuts are taken from each side of the forgings, the roughing being done at a table speed of 17 R. P. M., and the finishing at a table speed of 5 R. P. M.; the same wheel, which is an American

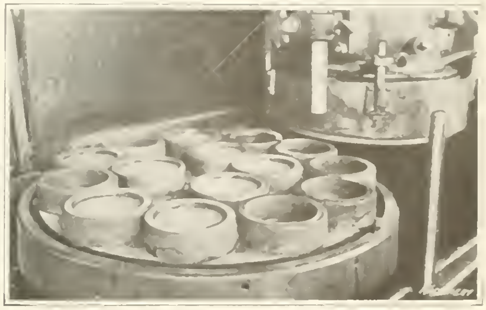


Fig. 24. Method of holding and grinding Roller Bearing Race Rings on a Blanchard Vertical Surface Grinder

(silicate) corundum wheel, grain 58-24, grade 1, being used for both operations.

Grinding Ends of Bevel Pinions

An interesting application of the vertical surface grinder to the grinding of bevel pinions is shown in Fig. 22. The portion ground as shown at *B* in Fig. 23, is the front face which measures about 1 7/16 inch diameter. The fixture used is of interesting construction, as shown in Fig. 22, and comprises a ring *A* in which 44 steel pins *B* are inserted. The upper ends of these steel pins are turned to fit the holes in the pinions, and the latter rest on top of ring *A*. The magnetic force holds the pinions down against the top surface of ring *A*, and, at the same time, prevents them from turning on the pins *B*. In this way the pieces are held very effectively and the grinding can be done rapidly. In this case it will be noticed that the wheel is rotated at 950 R. P. M., giving a surface speed of 3971 feet, whereas the work-table is rotated at 6 R. P. M., the gear blanks being finished at one speed. The production is 200 pieces per hour.

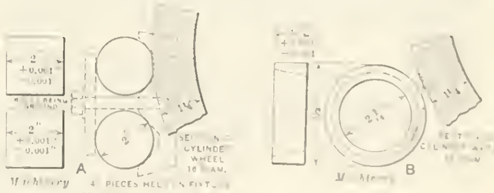


Fig. 25. Examples of Roller Bearing Rolls and Race Ring Grinding

A

Work:—Roller bearing rolls, high carbon steel, hardened.

Operation:—Surface grinding both ends from the rough with a Norton (silicate) alundum wheel; grain [illegible]-24, grade H; 16 inches diameter, 1¼-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, 17 R. P. M.; down feed of wheel, 0.0002 inch per revolution of table; amount removed from each end, 0.[illegible] inch.

Remarks:—40 of these parts are held at one time on a Blanchard magnetic chuck by means of a special fixture; limits, plus or minus 0.001 inch; production, 800 pieces per day; machine used, Blanchard high-power vertical surface grinder.

B

Work:—Roller bearing race ring, high carbon steel, hardened.

Operation:—Grinding both sides from the rough with an American (silicate) corundum wheel; grain 30, grade ¾; 16 inches diameter, 1¼-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed 17 R. P. M.; down feed of wheel, 0.0012 inch per revolution of table; amount removed from each side from 0.010 to 0.015 inch.

Remarks:—30 of these parts are held at one time on a Blanchard magnetic chuck; no retaining ring used; limits, plus or minus 0.001 inch; production, 1[illegible] pieces per day; machine used, Blanchard high-power vertical surface grinder.

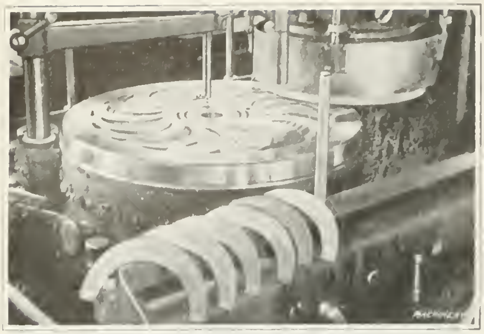


Fig. 26. Method of holding and grinding Micrometer Frames on Blanchard Vertical Surface Grinder

Grinding Meat Chopper Disks

The meat chopper disk shown at *A* in Fig. 23 is another good example of vertical surface grinding. This disk is made from a ⅛-inch soft steel punching, not hardened; forty-six disks are held on a Blanchard magnetic chuck at one time, and are located between two retaining rings. The wheel used is an American (silicate) corundum wheel, grain 24, grade ¾; it is operated at a surface speed of 4190 feet per minute. The table speed is 13 R. P. M. for roughing and 5 R. P. M. for finishing.

Methods of Holding and Grinding Roller Bearing Race Rings and Rolls

The roller bearing race rings shown in Fig. 24 illustrate another example of work that is satisfactorily handled on the vertical surface grinder. For the holding of these race rings, no special fixture is required. The race ring blanks are simply placed on the magnetic chuck without any retaining ring, the magnetism holding them rigidly in position. The data is given at *B* in Fig. 25.

The roller bearing roll shown at *A* in Fig. 25 is another part that is ground on both ends in a Blanchard vertical surface grinder. Forty of these parts are held at one time on a special fixture, provided with V-slots in which the rolls

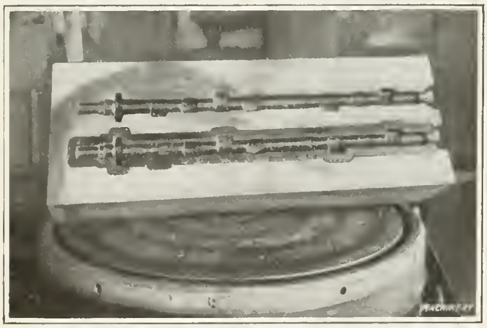


Fig. 27. Cam-shaft Drop-forging Die ground on a Blanchard Vertical Surface Grinder

are clamped by means of straps. The fixture is held on the magnetic chuck.

Grinding Micrometer Frames

Still another example of work that can be handled efficiently on the vertical surface grinder is the micrometer frames which are punched out from soft steel. Fig. 26 shows the manner in which these are held on the magnetic chuck. By referring to this illustration, it will be noticed that they are placed inside of a comparatively broad retaining ring, but otherwise are not held, except magnetically. The wheel found to be the most satisfactory for grinding these stampings from the rough is a Norton (silicate) alundum wheel, grain 38-30, grade J, 1½-inch rim, operated at a surface speed of 4190 feet. The table speed was at the rate of 9 R. P. M., and the down feed of the wheel 0.0016 inch per revolution of the work-table. These parts were ground to a limit of 0.0005 inch, and 0.025 inch of metal was removed from each side. The production was 30 per hour.

Grinding Face of Drop-forge Dies

The drop-forge die shown on the Blanchard magnetic chuck in Fig. 27 is a good example of tool-room work. Previous to the use of the vertical surface grinder, considerable trouble was experienced in getting the top face of these drop-forge dies perfectly flat, as they were warped considerably in hardening. This particular block is 28 inches long, 9 inches wide, by 9 inches deep, and 0.012 inch of material was removed from the top surface. Formerly the time required to grind this size of drop-forge die block was three hours, and the time was reduced to 5 minutes on the Blanchard vertical surface grinder.

Grinding Flat and Concave Portions of Cutting-off Saws

The group of cutting-off saws shown in Fig. 29, is an example of work for which the vertical surface grinder of the

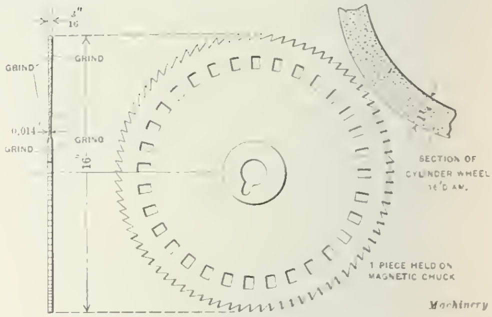


Fig. 28. Higley Type of Metal Cutting Saws ground Flat and Concave on a Blanchard Vertical Surface Grinder

Work:—16-inch (Higley type) metal-cutting saw, high-speed steel, hardened.

Operation:—Surface grinding both sides from the rough with a Norton (silicate) alundum wheel; grain 38-24, grade H; 16 inches diameter. 1¼-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, roughing, 8½ R. P. M., finishing, 5½ R. P. M.; down feed of wheel, 0.0016 inch per revolution of table; amount removed from each side, 0.015 inch; four operations—two for flat and two for concave grinding.

Remarks:—One of these parts held at one time on Blanchard magnetic chuck; grinding time, 8 minutes; handling time, 3 minutes; limits, plus or minus 0.002 inch; production, 6 per hour; machine used, Blanchard high-power vertical surface grinder.

rotary type is particularly adapted. As shown in Fig. 28, the saw is ground all over and in addition is made concave, nearly to the center hole to provide clearance. The flat surface of the saw is ground first on both sides; then the three-point column support of the machine is adjusted so as to set the spindle off to the desired angle to give the required concavity. The saw is again placed on the machine and both sides reground to give the amount of clearance desired. On grinding the flat portion, one saw is held at one time on the magnetic chuck. See Fig. 28 for data for the saw shown in the center of Fig. 29.

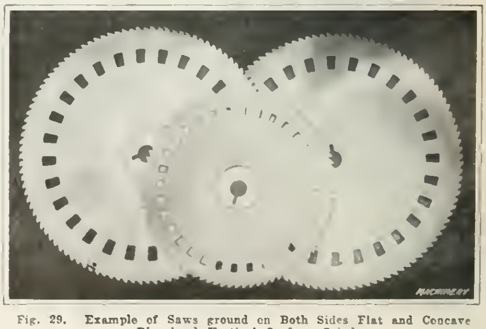


Fig. 29. Example of Saws ground on Both Sides Flat and Concave on Blanchard Vertical Surface Grinders

DON'TS FOR TOOL DESIGNERS*

BY EDWARD J. UTZ†

Don't design without a system.

Don't draw a tool to any other scale than full size.

Don't use screw drill bushings.

Don't forget that two operations may be cheaper than one.

Don't forget it is harder to actually make the tool than to design it.

Don't use dowel pins where cast-iron backing is available.

Don't forget that all wearing parts should be easily duplicated.

Don't put cast-iron bosses on wearing surfaces which are of importance.

Don't use too many screws and levers on your design.

Don't forget that certain parts of the tool must be cleaned after each operation.

Don't put springs and levers or any moving part on the tool where the chips will fall on them, unless they are properly covered.

Don't forget that many drill press tables and surface plates in actual practice are not true.

Don't design point bearings on jigs and fixtures which have to lie on drill press tables, etc. A two-line contact is better.

Don't design a tool until you have studied the conditions under which it has to work. By so doing, you will save time and money.

Don't design an elaborate tool when something plain and inexpensive will do the work.

Don't forget that nine out of every ten tools are never duplicated; therefore take pains to design as efficient a tool as possible.

Don't design a tool that cannot be cleaned effectively in the least possible time.

Don't forget that many operators are unskilled men and very cheap labor.

Don't give a toolmaker a drawing full of decimals; remember, he can gage 2 inches more effectively by standard gages than 1.985 inch.

Don't design parts to be countersunk; they cost money.

Don't forget to use patternmakers' dimensions very sparingly, as they are of no use to the toolmaker.

Don't design sharp corners on any part of the tool.

Don't forget that cores on jigs and fixtures are expensive, and by careful design they may be eliminated. Show all drafts on your design, and show which way you wish to have it cast.

Don't dimension a flat on a round piece from the center; always give the size from the outside diameter to the flat.

Don't forget that drill bushings below 3/8 inch in diameter cannot be ground; they must be lapped.

Don't design drill bushings that are too thin and too short.

Don't forget that the ends of all screws must be round for rough work and flat for finished work, and that they must also be casehardened.

Don't forget that in accurate drilling all holes must be reamed.

Don't allow more than 0.002 to 0.010 inch for reaming. Always drill and ream in the same jig by the use of slip bushings.

Don't hold a slip bushing in any way; let it slide freely in the master bushing.

Don't design collars on drill bushings; they are of no use to any one and cost money.

Don't forget that all bushings over 1 inch outside diameter can be made of machine steel, pack-hardened and ground.

Don't design a tool in such a way that you must drill against a screw; such a construction is not reliable. Always use a clamp.

Don't use a thumb-screw where a set-screw is needed.

Don't design loose parts on jigs and fixtures; they are apt to be lost and it will cost a lot of money and time to replace them.

Don't design gaging points where they will affect the efficiency of the operator.

Don't design heavy jigs and fixtures; a little figuring will convince you as to the strength of materials.

Don't forget that each motion that is required on your tool has to be duplicated on each piece, costing time and money. In designing gaging points always have them in even figures such as 1/4, 1/2, 3/4 inch from the part to be machined. Always use machine steel for gaging parts, and have it casehardened and ground to size.

Don't depend upon springs to operate parts of a mechanism.

Don't design cams on jigs and fixtures; they cost money and are not reliable.

Don't forget that standardization of screws, bushings, thickness of walls, size of clamps and studs will prove a great time saver not only to you but to all the factory. Adopt standards which are far-reaching and easily understood; and always look for improvements on your standards. Do not be satisfied with something simply because it works.

Don't forget that two ideas are better than one; therefore, if there is something that you don't like, call it to the attention of the chief and talk things over with him.

Don't forget that it is easier to erase a screw or change its position on a design than it is after the casting is made. Always design the tool as if you were going to make the pattern and the casting, and had to do the machining and finally the operating. Always remember that the tool designer is responsible for the profit of the manufacture. Efficiency of the tool means manufacturing profit.

Don't forget that your requirements are large; therefore keep up with all the latest technical journals; not only read them but study them.

Don't forget that in your design many parts such as screws, clamps, etc., should only be shown on two views.

Don't forget that it is easier to make a free-hand sketch to get an idea if your plan will work than to start on the drawing board, and finally have to throw the whole design away.

* * *

* For additional "Don'ts" published in MACHINERY see also "Don'ts for Ball Bearing Users," July, 1914; "Don'ts for Drilling Machine Operators," November, 1913; "Don'ts for Draftsmen," September, 1913. "Don'ts for Drill Grinders," July, 1913; "Don'ts for the Manager," November, 1912; and "Don'ts for Toolmakers," December, 1911.

† Address: 106 Blackstone St., Woonsocket, R. I.

SETTING TIMER GEARS ON THE FRANKLIN CAR

At the H. H. Franklin Mfg. Co.'s factory in Syracuse, N. Y., where the Franklin car is manufactured, the operation of setting timer gears either in the factory or outside is greatly facilitated by broaching the timer gears with irregularly spaced multiple keyways at the time of manufacture. The illustration shows the positions of the four keyways that are broached at varying distances in the timer gears, both the gear on the magneto and that on the camshaft being similarly treated. It will be readily appreciated that with the option of setting the timer gear at any of four designated positions on the shaft, each of which gives slightly different timing, the proper adjustment is easily made.

Four Irregularly Spaced Keyways in Timer Gears to facilitate Setting

Especially does this feature prove valuable to the car owner who has broken a timer gear and orders a new one from the factory. He has no trouble in locating the gear on the shaft, nor is it necessary to mark the gear for any particular position and have a keyway specially cut, for out of four possible positions, one is sure to give correct timing. Moreover, this advantage does not add appreciably to the manufacturing cost of the car. C. L. L.

RECTANGULAR DRAWING AND TRIMMING*

LAYING OUT RECTANGULAR DRAWING DIES—DETERMINING NUMBER OF OPERATIONS—TRIMMING DRAWN PARTS

BY JOSEPH M STABEL†

THE drawing of rectangular shapes does not seem to be understood by many tool- and die-makers as well as cylindrical drawing, which is doubtless due to the fact that rectangular dies are not as common as those used for drawing cylindrical parts. Consequently when a rectangular die is to be made some experimental work is usually required, although much of this could be eliminated if certain fundamental points in regard to rectangular drawing were understood. The writer will endeavor to explain some of the points which experience has shown are essential to success.

Shape of Drawn Part and Points to Consider when Selecting Material

The first thing to consider is the design or shape of the part to be drawn. This is often overlooked by the designer, as all he may have in mind is to produce a box of a certain size. Therefore he may specify a radius of 1/8 inch at the corner of this box when the radius could just as well be 1/2 inch, and perhaps the radius at the lower corner could also be larger than is specified. This matter of corner and edge radius is important and may greatly affect the drawing operation. The kind of metal to be used should also be considered. It is often more profitable to make small parts of brass than of steel because there is less wear on the dies and fewer spoiled parts. When steel is to be used and the depth of the draw exceeds one-half the width of the box, a "deep drawing" steel should be used. A deep drawing steel which has proved satisfactory contains from 0.08 to 0.18 per cent carbon (preferably about 0.10 to 0.12 per cent); about 0.35 per cent manganese with less than 0.03 per cent phosphorus and sulphur. It is advisable to be on the safe side when deciding what thickness of metal to use; that is, it is preferable to use a little extra metal and have ample strength at the lower edge of the box where the greatest strain from drawing occurs, than to use a metal that is barely strong enough to withstand the drawing operation. This is especially true if the part must be drawn to considerable depth. When using brass and aluminum, the cost of the material is an important factor and it is common practice to begin with stock, say, 1/32 inch thick; the original thickness is retained in the first draw, but is reduced in each succeeding draw so that when the box is finished the sides will be considerably thinner than the bottom. With this method, less metal may be used or, in other words, a smaller blank than if the box were made of uniform thickness. The reduction of thickness at each draw should not exceed 0.0025 inch on a side. Thinning the sides in this way is not considered practicable when using steel, owing to the comparative cheapness of steel and the increase in wear on the dies which would result.

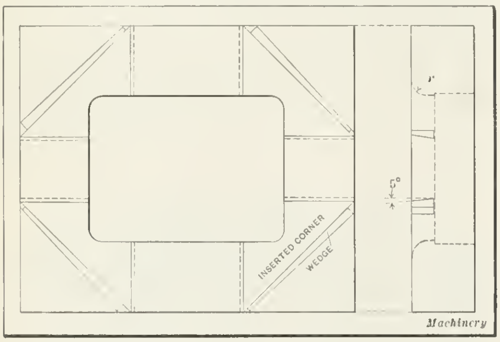


Fig. 1. Rectangular Die with Inserted Corner Pieces

Laying Out Rectangular Dies

After having carefully considered the design of the part to be drawn and the material from which it is to be made, the next step is that of laying out the die or dies. as the case may be. There are several fundamental points that should be considered before proceeding with the laying-out operation. For instance, there may be some doubt as to the practicability of drawing a box in one operation, and one might naturally suppose that by employing two operations many difficulties would be avoided, because the work is divided between two dies. There may be more trouble, however, when using two dies, especially if steel is to be drawn, because the drawing operation is confined to the corners, and forming the sides of the box is nothing more than a folding or bending operation; consequently the wear of the dies is in the corners, and as the result of this wear and increase of clearance space the metal thickens at the corners. In some cases the metal will thicken to such an extent as to make it impossible to push the work through the second die when two are employed, without rupturing the box at the corners. Moreover, when there are two operations, annealing may be required between the draws, and if this is done in an open fire, oxidation takes place which would require a pickling operation to free the part from scale. Even though a closed furnace is used, the parts should be washed to free them from grit, as otherwise the die would be lapped out very quickly. If there is no doubt as to whether a box should be made in one die or two, it is advisable to first make the finishing die and attempt to produce the part in one operation. If this trial draw shows that one die is not practicable, then the first-operation die can be made.

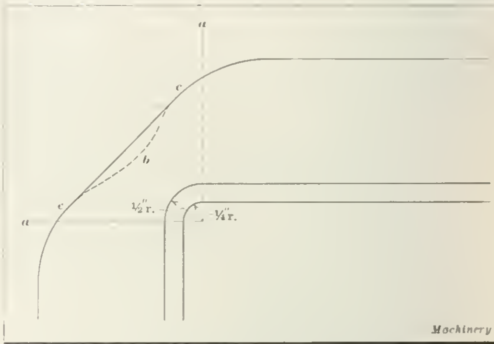


Fig. 2. Outline of Blank, and Drawn Boxes of Different Sizes and Corner Radii

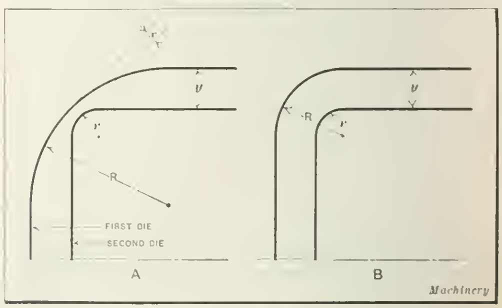


Fig. 3. Correct and Incorrect Methods of laying out First-operation Die

* For additional information on dies, see the following articles previously published in MACHINERY: "Automatic Indexing Multiple Drawing Die," July, 1915; "Deep Drawing in Combination Dies," April, 1915; "Dies for Drawing Flanged Shells," March, 1915; "Press Tools for Making a Roller Bearing Cage," March, 1915; "Formulas for Blank Diameters of Drawn Shells," January, 1915; "Edge Radius of Drawing Dies," October, 1914; "Sub-press Dies for Armature Manufacture," July, 1914; "One-piece Armature Disk Tools," March and January, 1914.

† Address: 1653 Main St., Rochester, N. Y.

The amount of clearance at the corners is another important point. By allowing a little more than the thickness of the metal between the punch and die at the corners, the pressure required for drawing is considerably reduced. For instance, if stock 0.0625 inch thick were being used, a space of about 0.067 inch should be left at the corners; this clearance is advisable for a one-operation die and also for the final die of a series. The top surface of a first-operation die should

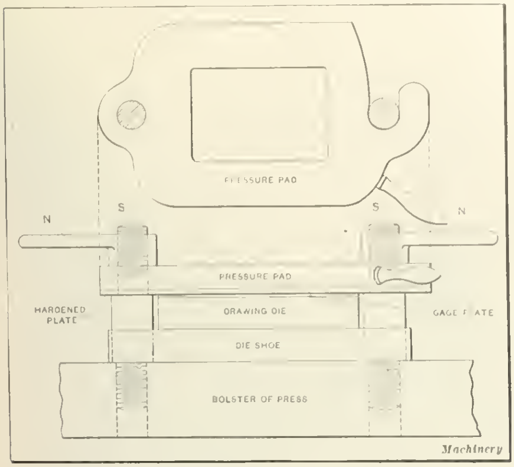


Fig. 4. Simple Design of Rectangular Drawing Die

be perfectly flat and smooth. If this surface is ground, the grinding marks should be polished out, as otherwise the pressure of the blank-holder will tend to hold certain parts of the blank more than others, causing an uneven draw.

The corners of the die, as well as the punch, should be made very hard. The writer has used a die equipped with inserted corner pieces, as shown in Fig. 1. This form of die was designed for drawing a large number of steel parts, 6 by 8 inches in size, and up to the present time the sides have outworn at least six sets of corner pieces, not counting the number of times these pieces have been reworked. This construction allows the corners to be made much harder than if

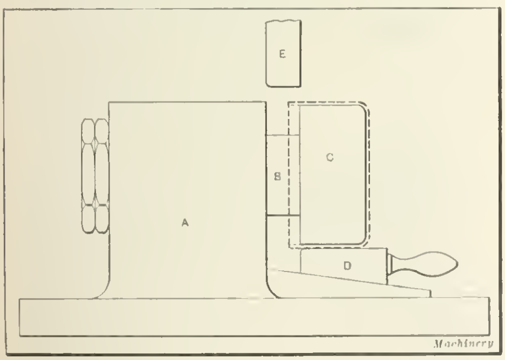


Fig. 5. Fixture for trimming Square Boxes

they were part of a solid plate. It also permits the use of expensive steel, such as high-speed steel, for these corner pieces, as they are small in comparison with the rest of the die. This form of die is not recommended for small work.

Drawing Edge Radius of Rectangular Dies

The radius *r* (Fig. 1) of the drawing edge is another point which often does not receive the attention that its importance merits. In the first place, this rounded surface should be uniform and smooth. The edge radius of the first drawing die (assuming that more than one operation is required) is the most important. Theoretically, this radius should be as large as possible, but it is restricted for the reason that the larger the drawing radius the sooner the blank is released from under the blank-holder or pressure pad, and if this release occurs too soon, the metal will wrinkle; wrinkling of the metal will cause a fractured corner.

It is also important to make the corner radius as large as possible. Fig. 2 shows, in part, the outline of a blank and also corners of 1/4 and 1/2 inch radius, respectively. The dotted lines *a–a* indicate the metal in the blank which must be folded up and compressed into a corner. When the corner radius does not exceed 3/4 inch, the radius of the drawing edge of the first die should be about the same as the corner radius, whereas for a corner radius exceeding 3/4 inch, the drawing edge radius of 3/4 inch should be retained.

Determining Number of Drawing Operations Corner Radius

In laying out rectangular dies, naturally one of the first things to consider is the number of operations required to complete the box or whatever part is to be drawn. The number of operations is governed by several factors, such, for instance, as the quality of material, its thickness, the corner radius and also the radius at the bottom edge of the drawn part. In some cases, this lower edge can be rounded considerably, whereas in others it must be nearly square. Obviously, when the corner is sharp a fracture at this point is more likely to occur, owing to the pull of the drawing punch. Because of these variable conditions no definite rule can be given for determining the number of operations, although the following information will serve as a general guide.

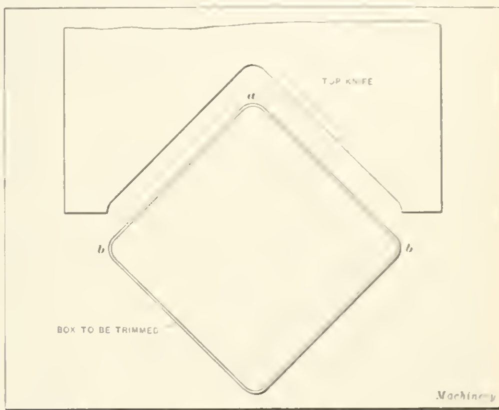


Fig. 6. Trimming Knife for cutting Two Sides in One Stroke

When drawing brass, it is safe to assume that the part can be drawn to a depth equal to six times the corner radius. This rule has been applied to all radii not over 3/4 inch. For rectangular parts having larger corner radii, the depth would be somewhat less than six times the corner radius. Suppose a box is to be drawn that is 5 inches wide, 6 inches long and 3 inches deep, and that the corner radius is 1/2 inch, and the lower edge rounded to about 1/4 inch radius. By applying the foregoing rule we find that this can be done in one operation; thus, the depth equals six times the corner radius, or $6 \times 1/2 = 3$ inches. If the corners were of 1/4 inch radius, then two operations would be required.

When two dies are required the first die should have a corner radius equal to about five times the radius of the finished part. The relation between the corners of the first and second dies is indicated by the diagram *A*, Fig. 3. As will be seen, they are not laid off from the same center but so that there will be enough surface *x* between the two corners to provide a drawing edge. The reason for selecting such a large corner radius for the first die is that when these large corners are reduced to the smaller radius in the second die a large part of this compressed metal is forced out into the sides of the box. Now if the first die were laid out as indicated at *B* or from the same center as the second die, there would be a comparatively large reduction at the corner and, consequently, the metal would be more compressed and the drawing operation made much more difficult, because, as previously mentioned, the drawing action is confined to the corners when drawing rectangular work. Sometimes dies are

made as indicated at B, but the reduction necessary in the second operation is likely to result in fracturing the metal. The radius of the first die should be laid out from a center that will leave a surface x (see sketch A) about $\frac{1}{8}$ inch wide, although this width should be varied somewhat, depending upon the size of the die.

The amount y that a rectangular part can be reduced between draws depends upon the corner radius and diminishes as the corner radius becomes smaller. For instance, a box with corners of $\frac{1}{8}$ inch radius could not be reduced as much as one with corners of $\frac{3}{8}$ inch radius. To obtain the total amount of reduction, or $2y$ (see Fig. 3), multiply the corner radius required for the drawn box by 3 and add the product to the width and length, thus obtaining the width and length of the preceding die. This rule should only be applied when the corner radius is less than $\frac{1}{2}$ inch. For all radii above $\frac{1}{2}$ inch, simply multiply the constant 0.5 by 3 in order to obtain the reduction. Suppose a box is to be drawn that is 5 inches wide, 6 inches long, $\frac{1}{8}$ radius at the corner, and we desire to establish the size of the first-operation die. By applying the rule just given, we have $\frac{1}{8} \times 3 + 5 = 5\frac{3}{8}$ inches, and $\frac{1}{8} \times 3 + 6 = 6\frac{3}{8}$ inches. Therefore, the die should be made $5\frac{3}{8}$ inches by $6\frac{3}{8}$ inches. As previously mentioned, the corner radius for the first-operation die should be about four times the corner radius of the finished part; hence the radius in this case would equal $\frac{1}{8} \times 4 = \frac{1}{2}$ inch. In this way, the number of operations required to draw a rectangular part is determined.

Shape of the Blank

After the drawing dies are completed, the shape of the blank must be determined. While a blank can be laid out which would be of approximately the required shape, the exact form must be determined by trial before the blanking die can be made. (A good method of laying out blanks for rectangular parts was described in the April number of MACHINERY, page 687.) The proper way is to first lay out the blank and then cut out two blanks so that after one has been drawn the other can be changed as may be found necessary. When laying out the blank, it is often advisable not to attempt to secure a shape that will form corners that are level with the sides of the drawn part, but rather a form of blank that will produce corners that are a little higher than the sides. This is desirable for two reasons: In the first place, as previously mentioned, the wear on the die is at the corners, and when wear occurs the metal will thicken and then the drawn part will be low at the corners, provided no allowance is made on the blank. Second, the shape of the blank for drawing an even level corner would often correspond somewhat to that indicated by the dotted line b in Fig. 2, and the tendency of the high projections c would be to carry the metal toward the corner and cause a seam, due to the low part b. Incidentally, a burr along part of the blank edge often causes trouble, because it tends to hold that part of the blank tighter under the blankholder than the remainder, thus causing an irregular shape.

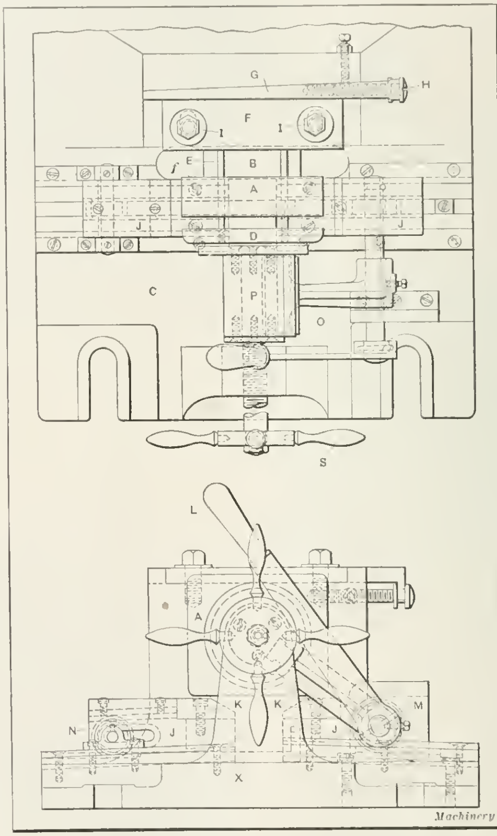


Fig. 7. Trimming Fixture for drawing Steel Parts

Type of Die for Use in Single-action Press

Many are of the opinion that a double-acting press is necessary for this kind of work unless the drawn part is shallow and a combination die is used, but this is not the case. A single-acting press which is geared for reduced speed will serve the purpose, and a simple type of die may be employed. The speed, however, should not exceed 60 revolutions per minute. The greatest difficulty connected with the use of a single-acting press is the arrangement of the blank-holder or pressure pad. This can be made in several ways. One method is to attach the drawing die to the ram of the press and the punch below in the die-shoe with the pressure ring extending around the punch and resting on pins that pass through the shoe and bear against a plate which is backed up by a rubber buffer or spring pressure attachment that can be adjusted to give the pressure required. This arrangement is satisfactory for many classes of work, but when drawing comparatively deep parts it is objectionable in that the blank-holder pressure increases as the die descends; consequently, if this pressure is sufficient for the beginning of the drawing operation, it will be excessive at the end of the downward stroke. This defect is sometimes remedied by using extra long springs or buffers, or a special "compensating attachment." For deep drawing, when a single-acting press is to be used, the writer prefers a die equipped with a pressure pad of the type shown in Fig. 4. The die and die-shoe rest upon the bolster of the press and into the latter are screwed two shoulder studs S having coarse threads onto which are fitted the handled nuts N. These nuts serve to hold down the pressure pad which is pivoted on one of the studs and slotted to receive the other so that it can be swung out of the way. (See plan view.) The under side of the pad is faced with a hardened tool-steel plate $\frac{1}{4}$ inch thick. When using the die, the pressure pad is swung out, the blank placed in position, and then the pad is swung back and tightened by nuts N. After a few parts have been drawn, the operator will be able to determine how much these nuts should be tightened to prevent wrinkling. The heavier and more rigid the studs and pad are, the less tightening is necessary, because the object is simply to confine the metal before it goes into the die so that wrinkling will be impossible. This form of die has proved satisfactory and it is similar in effect to the action of the double-acting press. A vent hole should never be omitted in the drawing punch, as this facilitates stripping the drawn part.

Trimming Drawn Rectangular Parts

After a square or rectangular part is drawn, it is necessary to trim the edges unless the depth of the draw is comparatively small, as in the case of can or box covers, etc. There are several ways of trimming the edges in a punch press. If the box is square it can be placed on a fixture of the type shown in Fig. 5 and be trimmed by cutting the four sides successively, the work being indexed by turning spindle B. Each cut should overlap the other by a small margin to in-

sure a smooth even edge. The spindle B is a running fit in the main casting A and holds the hardened tool-steel knife C. The dotted lines show the position of the box to be trimmed. As shown, a tapered wedge D which slides in under the lower side of the box serves to locate the box and also to take the downward thrust of the cut. The blade or knife E, which is attached to the ram of the press, may be ground square across the end or at a slight angle on the cutting face; a slight amount of angle or rake is desirable when trimming thick stock. If the part to be trimmed is rectangular, the length of the knife should be equal to the length of the longest side of the box minus the radius of one of the corners. For instance, a box 5 by 6 inches having a ½-inch corner radius should be trimmed with a knife 5½ inches long. The two long sides should be cut first because if the short sides were cut first, there would be a tendency to distort the corners. When the sides are unequal, the wedge D should either be double-ended or have enough taper to compensate for the difference in the box dimensions.

Another method of trimming is shown in Fig. 6. In this case, two sides are cut simultaneously so that only one indexing is required. This method is satisfactory for soft metal such as brass or aluminum, but is likely to cause trouble when trimming steel, because the corners are so hard as the result of drawing that the top corner a might split from the strain of the cut, unless the box were annealed for trimming.

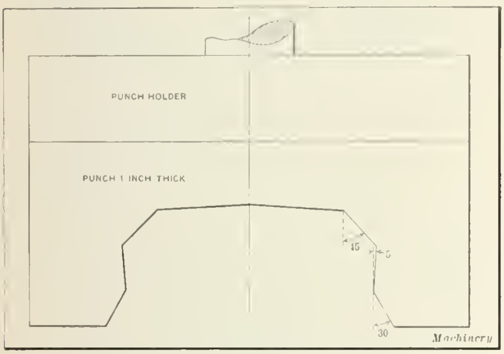


Fig. 8. Trimming Punch used in conjunction with Fixture shown in Fig. 7

The fixture for indexing and supporting the work is similar to that illustrated in Fig. 5.

To avoid making four cuts when trimming steel parts, and also to obviate annealing, the special trimming die shown in Fig. 7 was designed. This die has been in use for the past seven years and has trimmed thousands of boxes each year. It has a lower knife A, held by spindle B, which is a running fit in a bearing at the rear of the main body casting C. The box to be trimmed is placed over knife A. Spindle B is held in position by nuts (not shown) and has a ¾-inch knockout rod extending through it which acts upon a knockout pad D. This pad also serves as a stop-gage for regulating the depth to which the box is trimmed. A fixed length is retained irrespective of how much knife A is ground. Four pins E are screwed into the pad and pass through holes in knife A, resting against the face of a hardened bushing in the casting. This allows the face f of the knife to be ground repeatedly because knife A rests against the shoulder on spindle B and pins E hold pad D stationary. The knockout rod (not shown) is actuated by a series of levers connecting with a handle at the left of the operator. The hardened plate F is for taking the thrust of the top knife which is held in the punch-holder. This plate is secured by cap-screws I, and it can be adjusted by screw H and wedge G to compensate for sharpening the top knife. The two slides J which have hardened faces K slide underneath the box and serve to locate it in position, and also support it rigidly against the thrust of the cut. These slides are operated by lever L through pinions M and N. Pinion M has its bearing in the right-hand slide and engages a stationary rack beneath it. Attached to the right-hand slide K is an extension X having rack teeth which mesh with the pinion N mounted in a stationary bearing. This pinion, in turn, meshes with a rack above it attached to slide K. Thus it will be seen that a movement of lever L from right to left causes both slides K to move in under the box to be trimmed. This same movement of the lever also moves arm O and slide P into position for clamping the bottom of the box, the clamping being effected by pilot wheel S, which is attached to the screw shown. With this arrangement only a small movement of the screw is required, and when lever L is thrown to the right and the distance block P is removed there is plenty of space for taking out the trimmed box and inserting another. A detailed view of the trimming knife or punch is shown in Fig. 8. Considerable experimenting was necessary before securing a trimming punch that was perfectly satisfactory. The edge having a 30-degree angle on each side shears the side of the box down a little beyond the center; the 5-degree edge provides the necessary clearance; whereas the 45-degree section cuts out the round corners of the box, after which there is a slight shearing cut to the center.

* * *

TRAINING OF SHOP TEACHERS FOR INDUSTRIAL SCHOOLS*

In dealing with the subject of the training of teachers for industrial and trade schools, there are two general classes that must be recognized, depending upon, or resulting from, the two general sources from which such teachers come. These sources are the trained academic teacher and the trained mechanic. There is a division of opinion as to which source furnishes the better type of teacher. There are those who believe that the primary requisite of such a teacher is the ability to grasp the educational value of a subject, and to deal with and give instruction to the learner. These hold that pedagogical training is the basis upon which must be placed enough knowledge of the subject to enable the teacher to meet the problems of the school shop. There are others that believe that, since it is industrial training that is wanted, the essential things are the industrial atmosphere, methods, and standards of efficiency. These hold that any mechanic of a degree of intelligence to become a candidate for a teacher's position can be trained sufficiently in methods of instruction to make him the better type of shop teacher. Of course the ideal shop teacher is the one who is thoroughly trained in both phases; but since a thorough training in either involves several years of time and study, we are likely, at the present salary schedule, to have to choose between the two types.

To discuss the ability of the mechanic teacher it is necessary to establish the rank in the industry from which the average candidate comes. Shop instructors are generally recruited from the ranks of journeymen. Some of these have only a common school education, a few have high-school education, but none of them are college men. This statement would hold in general for all apprenticeship schools established by railroads and factories. In the public schools the situation is slightly different, with probably a little more inducement for the man of higher rank to enter. Yet, just as the railroad shops or factories cannot take their foremen to teach the apprentices, so society cannot take trained foremen as teachers in public industrial schools. In other words, industry outbids the public schools for such men. Dr Snedden, probably the one most influential in the demand for the mechanic teacher, says that the rank of foreman is preferable, but recognizes that he can only demand that of journeyman.

To those of us who know the present method of commercial production and the lack of apprenticeship in the industries, the requirement of journeyman standing does not insure ability. The journeyman is usually the victim of the factory system or the contractor's policy of keeping him at the one special job which he can do best. He might be highly skilled in laying floors, shingling, lathing, framing,

* Abstract of article by Harold F. Speece in the "Manual Training Magazine."

stair building, or some other specialty, but not have a general training in carpentry. He might be a specialist in some phase of machine work, but we have heard lately, from Mr. Ford, that it takes only two weeks to train a specialist.

Observation seems to show that the candidate is usually a young handy man of a high degree of intelligence, who has been earning his living at some form of the work he intends to teach, and who is dissatisfied with the social position of a worker in his trade, and desires to make more money per year and have a summer vacation.

Strong Points of the Mechanic Teacher

1. He can do good work himself. This gives him a confidence in demonstration, and gives the boys a confidence in him that is invaluable. There seems to be to us all, and especially to the boy, a strong appeal in the ability to do things with the hands.

2. He can apply commercial standards. Most of our school shop work falls below commercial standards for two reasons: First, the workers are only of apprenticeship rank; and second, the teacher does not know the commercial construction which they would be able to use. Also, the element of time does not enter into school shopwork, and only a trained mechanic knows how to appreciate this.

3. He can create a shop atmosphere. An atmosphere is the most intangible, elusive thing in the world, and yet it is the most influential. A school boy changes from a careless, indifferent piddler to an earnest, zealous workman with a change of atmosphere, and yet one could see no concrete thing that he could say, "That is it." Perhaps the air of quiet confidence in the ability to turn out work that is worth while gives the boys the same confidence.

4. He is in sympathy with the labor element of society. One of the large features in the training of the worker of today should be the giving of an outlook on life and social problems that would rescue him from the agitator. This would mean constructive leadership by the teacher in the affairs of citizenship and social conscience. This could best be done by the mechanic, because the problems of labor today must be solved by the friends of labor, otherwise there will be no solution. The trained academic teacher is usually not wholly in sympathy with the labor element, because he is a product of a selective institution, deals largely with abstractions, and is more interested in teaching the traditional past than the progressive present.

5. He can give the student correct guidance as to desirability, opportunity, and dangers of the trade in question; in other words he is a better authority on that vocation, having followed it, than the trained pedagogue who has read about it. This vocational guidance is also one of the large functions of the industrial school teacher of the future. Statistics show that only a small percentage of the pupils really follow the vocation for which they train in trade schools. So we must make the schools more than ever a trying-out place, and save some of the misfits if we can.

Weak Points of the Mechanic Teacher

1. He does not understand teaching principles. In the learning process there are certain fundamental laws and principles. These laws and their operation are the subject of years of study and training for the teacher, and it would be too much to assume that a worker who had spent no thought upon the subject would not suffer in comparison in this field. We are all familiar with the mechanic teacher who makes the jigs, sets the machine, gives the finishing polish, and makes a splendid exhibit. On the other hand, these laws are not so occult that the intelligent person desiring to impart knowledge or training to a pupil cannot by good sense accomplish largely what he intends, without having heard of one of them. Also, he is dealing with pupils who will not recognize if they are the victims of poor pedagogy, while ofttimes they would recognize quickly if the teacher did not use correct shop methods.

The laws and principles of teaching should be one field of training for the mechanic candidate. The teacher must be able to recognize the stage of progress of the learner and be able to carry him forward in sequence. He must recognize that while the learner consciously controls the stroke of the hammer, he is quite as likely to hit his thumb as the nail; that it is the subconscious control that brings skill in operations; that it is one thing to do a thing well, and quite another to tell just what coordinations are necessary to bring the result. He must recognize that training in trade processes is not necessarily education, but may be made the basis and motive for education. He must recognize the value of initiative and resultant satisfaction on the formation of habits, and a few other things like these, before he is prepared to stand before a class to teach.

2. He does not understand scientific management. The urgent demand for better organization and more scientific management everywhere concedes that the standards of efficiency are not so generally recognized as we are sometimes led to believe. Why are not the skilled trades more highly organized and systematized than the unskilled? When organization and system are introduced into an industrial plant today, it is not the trained mechanic who is called in to establish the system; it is usually the specialist, a college man. This means merely that the college man is of a more highly selected group, with greater capacity for organization.

3. He cannot grasp new problems or problems outside his own specialty like the teacher. In one case a machinist of many years' experience and a technically trained teacher came upon the problem of a change-gear box, where by shifting three levers it was possible to get sixteen changes of speed. After a glance at the instructions the teacher could make any desired change instantly, while the mechanic had to go over and over the operation until it became a part of his experience. This is only one "robin," and does not make it spring, but according to observation, the more highly selected and trained group of teachers will be able to duplicate these results in most new situations.

4. In administrative capacity he is likely to over-emphasize his own trade. In a prominent high school there is what seems a decidedly one-sided equipment and over-emphasis of machine work. There, in an equipment costing one hundred twenty-five thousand dollars, one-half of it went to the machine work alone. The pattern shop, foundry, and mechanical drawing rooms were simply auxiliary departments to the machine shop. All other trades commonly taught in school were ignored.

Training the Teacher

The strengths and weaknesses of the academic teacher candidate have been given by inference in contrast to the weaknesses and strengths of the mechanic candidate. All things considered it seems that the weaknesses just about balance the strength of each. Why then is the weight of sympathy of the organizer today toward the mechanic candidate? Is it not because of the methods of training the teacher candidate? The mechanic frankly accepts the fact that he must study, and spend good time and money, before he can accept a position, and then he usually goes in as assistant, while the teacher candidate heretofore has been accepting positions without further preparation than the study of classroom methods of a slightly different kind. The trouble has been that we have been giving both classes of candidates exactly the same type of training, while their previous experience demands opposite kinds of training. The mechanic candidate needs the theory and practice of teaching and classroom management. The academic candidate needs the actual participation in the production in the line he proposes to teach. Let him count the difference in wages in shop and his school salary as the price he pays for training for a new and better paying position. What he should do is frankly to accept the fact that this is a new field of knowledge to him, and that he must study in this field by actual participation. With the addition of this experience he will become, because of more rigid selection, the better type of teacher.

The conclusion then is that if the demands of an organizer of a school system were such as to bring two classes of candidates, one class with five years experience as mechanics and one year as teachers, and another class with five years experience as teachers and one year as mechanics, the better type of teacher would be found in the second class.

VALVE PART MANUFACTURING ON A BENCH LATHE

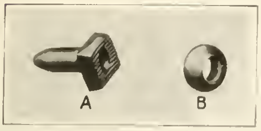


Fig. 1. Valve Parts made on a Bench Lathe

The two small parts shown in Fig. 1, and in detail in Fig. 2, are used in a newly designed pneumatic valve. These pieces are shown greatly enlarged in Fig. 2, the actual size being less than ½ inch long for the larger part, and ¼ inch diameter for the smaller hemispherical part. Both pieces are made of steel. The production required was not sufficient to warrant tooling up a screw machine and milling machine, and yet the output was large enough so that it would not be economical to make them up without special tools or fixtures of any kind. The Rivett Lathe & Grinder Co. of Brighton, Boston, Mass., recently completed the tooling up of one of its lathes for producing the parts, using its regular turning, milling and grinding fixtures. No special attachments of any kind were used; and this shows what can be done with standard equipment when properly used.

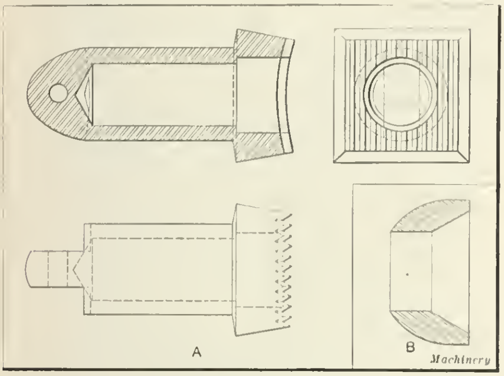


Fig. 2. Details of Valve Parts

Taking first the piece designated as *A*: this is made of cold-rolled steel, and the first operation consists in gripping the 11/32-inch round bar stock in the collet chuck while it is formed with a circular forming tool held on the forming tool-slide, as shown in Fig. 3. At the rear side of the slide a set-screw may be seen that limits the cross travel of the slide to the point, which leaves the finished diameter 0.150 inch. After this piece has been formed, the cutting-off tool mounted at the rear side of the slide is brought in, the part severed from the bar and the stock fed forward to a stop ready for forming the shank of another piece. This operation forms the entire shank of this piece. The next operations are on the head.

Fig. 3. Using Forming Attachment

Next the partly formed piece is held shank inward in a collet chuck, and spotted with a drill in the tailstock turret. Then the hole 0.120 inch diameter is drilled to a depth of 0.360 inch. After this the 0.143-inch section at the end of the hole is counterbored for a depth of 0.110 inch.

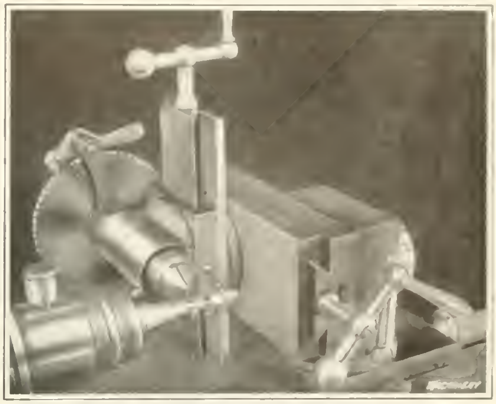


Fig. 4. Milling Attachment in Use

The third phase of the work is performed in the manner shown in Fig. 4. This illustrates the shaping of the sides and the forming of the face with the aid of the regular milling attachment for the bench lathe, the part being held by the shank in a draw-in collet. At this setting the milling of four tapered sides is done with a pair of angular mills that are held on an arbor in the spindle of the lathe. These two cutters are spaced exactly the right distance apart, and by feeding the work vertically between the cutters, two sides are straddle-milled. The part is then indexed 90 degrees, and the two opposite sides are similarly finished. The end face of this part is also concaved and grooved at this setting. The only change in the tools for doing this operation is the substitution of a hob of the correct diameter, ¾ inch, and the cross-slide is fed toward the hob until the desired finish of the face is secured.

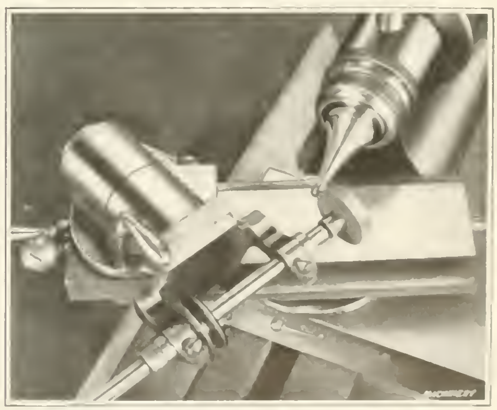


Fig. 5. Grinding Ball on Bench Lathe

The last series of operations on this part is performed upon the rear end by milling with straddle-mills so as to leave the central "fin" only, as shown in Fig. 2. After this, the part is slipped into a simple jig and a No. 60 hole is drilled crosswise through the web. This completes the part, leaving it as shown.

In the manufacture of the half-ball-shaped piece shown at *B*, the first operation is to drill and countersink the end of the bar, and then to form it with the attachment that has

been shown in Fig. 3. The part is then hardened and is ground in the manner shown in Fig. 5, using the regular Rivett grinding attachment for the bench lathe. The work is held on a stud arbor, with expanding jaws that are opened under pressure of a small screw that operates in the end of the arbor.

These two examples of work serve well to show what can be done with standard bench lathe equipment plus a little ingenuity. C. L. L.

* * *

HOLDING WORK ON THE MAGNETIC CHUCK FOR MILLING

The magnetic chuck has for years been a familiar shop fixture for holding work for surface and cylindrical grinding, but its operation has been largely restricted to use on grinding machines because of the low gripping power usually developed. The Heald magnetic chuck made by the Heald Machine Co., Worcester, Mass., has gripping power sufficient to hold work for other machining operations such as shaping and milling. Figs. 1 and 2 illustrate vertical and horizontal milling operations, as performed on work held

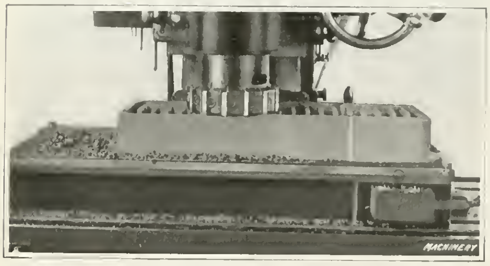


Fig. 1. Magnetic Chuck used for holding Work for End-milling

with Heald chucks. Fig. 1 shows an end milling operation on the body of a magnetic chuck casting; the material in this chuck casting is cast iron, and the depth of the cut is 3/16 inch. These castings are 8 inches wide and 24 inches long, and the time required to mill one of them is five minutes. A steel plate is bolted to the end of the chuck to act as a stop against which the thrust of the cut is taken. No gripping device of any kind other than the magnetic chuck is employed for holding the work.

An even more severe milling operation is the one illustrated in Fig. 2 that shows the milling of a bar of cold-rolled steel, 32 inches long, 2 inches wide, and 3/4 inch thick. The operation being performed is the tapering of the piece to the shape of a wedge, measuring 1/4 inch at the thin end and 5/8 inch at the thick end. The depth of the cut is 3/16 inch and the feed is five inches per minute. A feed of seven inches per minute was attempted, but the machine

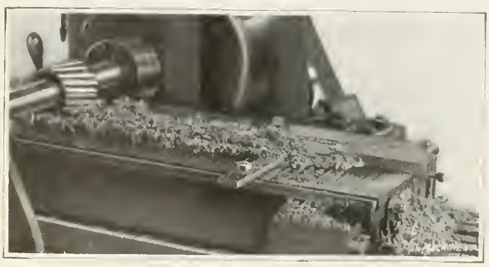


Fig. 2. Horizontal Milling Operation performed with Aid of Magnetic Chuck

would not pull the cut. No holding-down clamps of any kind are employed, but guide blocks at the sides and one end are used to support the work; these do not exert any downward pressure on the work. The chucks furnish the holding-down power, and show absolutely no tendency to allow the work to lift or move. C. L. L.

FLASHBACK IN THE WELDING TORCH

ITS RESULTS, CAUSES AND METHODS OF PREVENTION

BY M KEITH DUNHAM*

Flashback in the welding torch is the skeleton in the closet of the oxy-acetylene industry. We who have sold apparatus, especially in the early days, know the care we have taken in demonstrating the equipment not to bring the welding tip too close to the molten metal, how we avoided unduly heating the head, and with what inward fear and trepidation but outward nonchalance, we turned over the torch to the green workman and awaited the almost inevitable scream of the flashback, as the trembling hand plunged the tip into the molten mass of metal. You who use apparatus or are around where it is being used know the unpleasant noise when the torch flashes. If you are a nervous man you are invariably startled, yet there is no danger; but the user must figure the results of flashback on a dollars and cents basis, for persistent flashback will waste gases and labor to an enormous extent.

Catalogues are very reticent when it comes to the question of flashback. Instruction books say that it is caused by lack of acetylene pressure, by the sparks igniting the mixture (this explanation seems wholly mysterious, as the mixture is already ignited), by forcing the flame back into the mixing chamber when it is brought too close to the metal, by excess heating of the chamber or nozzle containing the mixed gases, by a burr or obstruction in the tip, etc. The manufacture of oxy-acetylene apparatus apparently being a profitable one, and the industry still being in its swaddling clothes, it presents an inviting field for the brass specialty factories to enter. In many cases their product has shown real Yankee ingenuity, but unfortunately with unmistakable evidence of a lack of knowledge of the requirements of the gases used. One of these tell-tale features is the persistent flashback of the torch when any tips but the smallest are used or when the weld is being made on a hot casting where the heat rising to the torch from the metal is considerable.

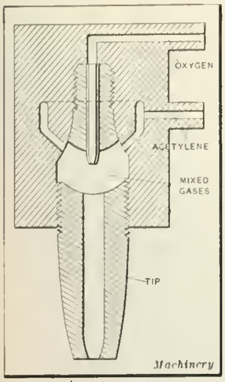
The user of such a torch generally will swear at oxy-acetylene welding rather than by it, so for the good of the industry let us open the closet and look at the skeleton. Flashback is costly; the gases burn just the same, but they burn inside the torch, and in the meantime the weld begins to grow cold. This means lost labor, lost gases and the likelihood of producing blow-holes or unfused metal, while the torch is being cooled, relighted and readjusted. I have in mind the welding of two gears, each identical in weight, shape and character of weld. The welds were preheated and kept at a red heat by gas torches during the time that the weld was being made; this is a rather difficult test for a torch, but one which is frequently necessary where heavy castings are welded. Two different welding torches were used, the work being started on both gears at the same time. I remember that the workman using the correctly designed torch finished the weld in a little less than forty minutes without a flashback. We gave up timing the other man when the hour limit was reached and he had had eleven flashbacks. Each torch had the same size of tip, the hourly consumption of oxygen being about 50 cubic feet. One can readily appreciate, then, that on heavy hot work, a torch which has the "flashback habit" may easily cost from 25 to 100 per cent more to operate than the torch which is free or relatively free from flashbacks.

The results of a flashback are a considerable source of annoyance; they introduce the possibility of poor welding and are responsible for a serious loss of efficiency. The cause is a little more difficult to understand. Acetylene will not burn unmixed with air or oxygen; but it must be remembered that the welding torch does mix the oxygen with the acetylene in the tip, the head or sometimes just beyond the handle. A mixing chamber and tip are shown in the accompanying illustration which does not represent any particular torch, but is a general type. It has already been

* Address: Room 1375, 50 Church St., New York City.

found that acetylene and oxygen will burn backward, *i. e.*, against the flow, unless the mixed gases have a speed of 330 feet per second. Note carefully that it is not one gas or the other which must attain this flow, but both together.

One of the first causes of a flashback may be lack of velocity; and in securing the necessary speed, the manufacturer unfamiliar with the proportions of gases, and using the general type of mixing chamber illustrated, is very likely to secure an oxidizing flame by using a high oxygen pressure to attain the proper velocity. This is the reason why, when all other explanations of flashback seem futile, the instruction book tells you to increase the pressures. But suppose that the pressure has been increased until the flame will stand no more and is ready to blow away from the tip; that the velocity is even in excess of that required and the torch continues to flash. We unscrew the tip and may find a shoulder caused by careless drilling, perhaps a chamber or recess (common with copper-end tips) or maybe some chips or filings. Did any one of these cause the flash? Perhaps so, since an obstruction or depression would have the tendency to retard the flow of gas temporarily, and therefore cause the speed of the gases to be momentarily checked and the flame to back up to that point.



General Type of Mixing Chamber and Tip used in Oxy-acetylene Torches

We secure a perfect tip, thread it into the chamber and begin welding again. This time the torch works much better, but when we start welding in a depression, where there is no escape for the heat waves except directly against the flame, the torch again flashes, and this time we must look for trouble elsewhere than in the tip. We note that there is soot or carbon in the chamber of the mixed gases, so we must conclude that this chamber has in some manner acted as a retarding agent and checked the proper speed of the gases. This mixing chamber or expansion point is necessary in some types of apparatus, especially where the acetylene is under little or no pressure and the force of the oxygen must be used to inject or suck the proper proportion of acetylene into the nozzle. The velocity of the gas in this case might be too great to hold the flame at the end of the tip, so the expansion chamber is necessary to retard the speed. But if these mixed gases are not everywhere moving at the required speed to prevent the backward propagation of the flame, the flame will burn back if sufficiently tempted to that point where the speed of the gases is not sufficient.

Perhaps the construction of the torch is such that it permits unscrewing the mixing chamber from the head. In such a torch we may find soot or carbon in the acetylene chamber, perhaps as far back as the entrance of the acetylene tube to the head. Then the gases must have been burning back to this point. Since acetylene alone will not burn without the air or oxygen mixture the oxygen must have "backed up" to this spot, and the speed of the gases at this point being very low (the acetylene under a comparatively low pressure and only a small amount of oxygen backing up) the flashback continued here until the gases were shut off. Here is the cure for all flashbacks preventing the oxygen from entering the chamber or tube of acetylene will absolutely prevent flashbacks, providing the speed of the mixed gases is up to the required point.

Obstructions, depressions or rough spots in the tip will cause a momentary backfire but will not cause a flashback. The backfire is simply a snapping, *i. e.*, a tendency to burn backward; the flashback is the actual burning back of the flame which continues till one or both of the gases are shut off. A torch may show this tendency to burn back, but will not do so if the rule outlined above can be followed in construction details. Curiously enough, it may be impossible to so construct the torch as to prevent the mixture of the oxygen with the acetylene at the wrong point; it depends entirely upon the pressure of the acetylene. If the low pressure type of generator is used, delivering the gas to the torch under a few ounces pressure, the high velocity of the oxygen necessary to inject the acetylene must result in a considerable opportunity for this high pressure to back up or partially back up, and mix with the acetylene to cause a flashback. This high velocity also makes necessary an expansion chamber as previously noted, which is another temptation to retard the speed of gases too much. Nevertheless, in torches of this type, it is possible by very careful construction and with a full knowledge of the difficulties, to get good working results; but the torch cannot be absolutely free from flashbacks since it is mechanically impossible to prevent the oxygen getting into the acetylene chamber.

There is, however, another type of generator known as the medium pressure type, which delivers the gas to the welding torch at a pressure somewhere under 15 pounds per square inch—the limit allowed at the generator. With the acetylene under some pressure, it is entirely possible to so reduce the velocity of the oxygen that its tendency to back up into the acetylene chamber is considerably reduced, although it is not eliminated, since the pressure of the oxygen is still considerably in excess of that of the acetylene. An expansion chamber is sometimes employed in this type of torch, but it is not necessary and if it is not used another invitation to flashbacks is obviated, so that generally speaking it is possible to construct a torch using acetylene under some pressure but the oxygen under a considerably higher pressure, so that flashbacks are intermittent only.

Besides the low- and medium-pressure types of generators, acetylene may also be used from storage tanks in which it is dissolved in acetone, and the acetylene in this instance may be delivered to the welding torch under a sufficient pressure to so lower the velocity of the oxygen that the entrance of the oxygen into the acetylene chamber becomes impossible, because the pressure of the acetylene is as great as or greater than that of the oxygen. If from this point to the burning point of the two gases the speed of both gases is correct, flashback becomes impossible under any conditions. Naturally, there are other things to take into consideration in the construction of a welding torch, such as rigidity of the flame, the proper proportion of the gases, and the possible danger of too high an acetylene pressure; and the prevention of flashback may at times be considered secondary in importance to one or all of these items.

The point to be clearly understood, however, is the desirability of using the welding torch designed for the acetylene supply. An injector torch should not be used on dissolved acetylene, for the simple reason that it does not take advantage of the pressure in the dissolved acetylene cylinder to avoid flashbacks, and while it is exactly what is required for a low-pressure generator, from the standpoint of the elimination of flashbacks (as well as for another reason not a part of this subject) it is not an economical torch to use where the acetylene is already under a sufficient pressure so that a high velocity of the oxygen is unnecessary. For the same reasons the medium-pressure torch should not be used on dissolved acetylene, but to secure the greatest efficiency the torch must be constructed in all cases with a view to taking advantage of acetylene pressure. Unfortunately, some manufacturers, either through lack of knowledge or in a spirit of "anything-is-good-enough" make and sell apparatus wholly unsuitable from the standpoint of efficiency or economy. The use of such apparatus is a serious detriment to the oxy-acetylene industry. It is well to understand that a flashback should be a rare occurrence in any type of apparatus, but that in apparatus using dissolved acetylene it can be wholly eliminated.

* * *

Chinese white silver, which is simply a variety of German or nickel silver, contains about 40 per cent copper, 32 per cent nickel, 25 per cent zinc, and 3 per cent iron.

STANDARDIZATION OF SCLEROSCOPE OBSERVATIONS*

BY J. J. RALPH†

Criticisms are often heard concerning the scleroscope as an instrument for determining the condition of metals; and the following account of an experience with this instrument may help in extending its field of usefulness. Journals somewhat similar to that shown in Fig. 1 are used in large quantities in a shop making universal joints for automobiles. They are made from a very tough steel, drop-forged, annealed, machined, casehardened and ground. The soft tough core carries the load and takes the shock, while the case serves to prevent undue wear. Seven sizes are used, the largest being about 1½ inch in diameter at the bearing points. Inspection is very rigorous and the standards are high. A change of men brought together a new heat-treating foreman and a new foreman of inspectors, which led to a difference of opinion on the question of the proper hardness for these journals. The inspector reported that the pieces were coming too soft, while the heat-treating foreman claimed that it was impossible to satisfy the demand that they be casehardened so that they could not be touched with a file. It was proved that a new fine file of the best grade would touch even the test block used for standardizing a scleroscope, which had a hardness of 103; but the tester's files were found to be of all degrees of sharpness. No trouble had been previously experienced, and so little attention had been paid to the matter.

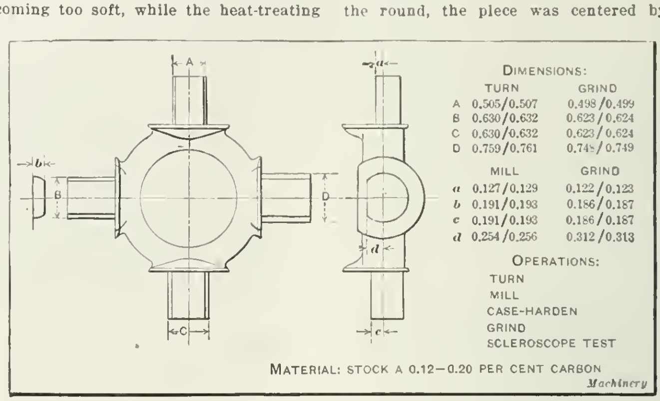


Fig. 1. Part of Universal Joint on which Determination of Hardness gave Trouble

It was decided to employ a more exact method, and finally a scleroscope was purchased for the use of the inspection department. As a standard, the minimum limit was set to the readings taken from a journal that had seen over 60,000 miles of service in a heavy car, and that still showed grinding marks over almost all of the bearing area. But the troubles became worse; and lot after lot of the journals were returned as unsatisfactorily casehardened. The entire gamut of casehardening possibilities was tried, but without success; and the handling of the scleroscope was criticised and investigated, but no fault could be found. Finally it was proved to the satisfaction of all that a small journal giving low readings, as compared with a large journal giving much higher readings, was really harder as shown when tested with a new fine file in the hands of the same man. For the same size journal the scleroscope gave readings which could be compared, and the instrument was standardized on this basis.

The six larger journals were made from an open-hearth basic stock with a carbon content of 0.12 to 0.20 per cent, which is designated as stock A. For machine shop reasons, the smallest journal was made from stock B, which contains 0.08 per cent carbon, with a narrow allowable variation range. From a medium sized forging, four pieces were made as shown in Fig. 1; and the journals proper on these were made of different sizes to allow of comparison. Four pieces, as shown in Fig. 2, were machined directly from a bar of stock B; and flats were milled on each to find the effect of curvature and to afford a basis of comparison between the different sizes, with the unknown eliminated. Handling was made as close to regular practice as possible, and the machining and grinding limits were standard, the diameters being the same as in general use. After machining, the journals were casehardened with a regular run of work. The time was about eight hours, and the temperature was kept below 1650 degrees F. They were quenched in water direct from the hardening heat.

The Test

In conducting the tests, care was taken to see that the scleroscope tube was vertical; and in taking readings on the round, the piece was centered by means of the small notch at the bottom of the guide. The flats were lined up by means of the milled surface on the bottom of the hammer guide. Two sets of readings were taken on the pieces shown in Fig. 2, one with the piece laid loose in the supporting V-block, and another with the piece held firmly. A number of readings were taken on each diameter; the maximum and minimum are given in Table I for the journals and in Table II for the test pieces. Two of the diameters of the journals were made the same to find the effect on the uniformity of the case due to difference in position. In hardening, two pieces of each kind were put in one pot and one of each kind in two other pots. The pots were then put in different parts of the furnace. Sections made at several points showed a practically uniform depth of casehardening on all, but on the small diameters and at the corners there was a slightly greater depth. The file could detect no differences in hardness. The assumption was therefore made that the case was equally hard throughout.

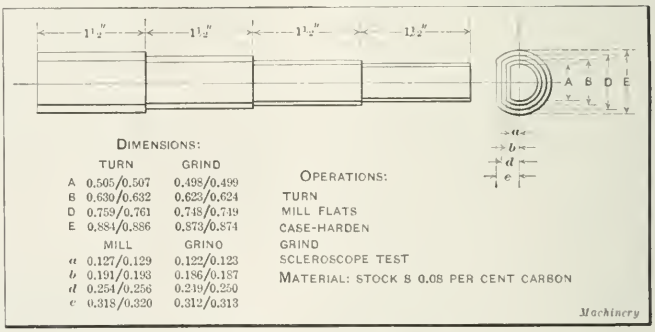


Fig. 2. Pieces milled from Bar, with Flats to ascertain Effect of Curvature on Results of Hardness Test

The following conclusions were drawn from the results of the tests: On pieces up to ⅞ inch in diameter, the scleroscope reading for the same hardness is less for small diameters than for large. For any one cross-section, the reading is higher on a flat than on a cylindrical surface. With a casehardened piece there may be as much as 30 points difference in the scleroscope reading, depending on the volume of the piece at the point tested and the shape of the surface. Both cylindrical and flat surfaces were finely ground so that the differences in readings were not to be laid to that factor. Seemingly, stock B gave about five points better results than stock A. Whether this was

* For additional information on the use of the scleroscope see also "Influence of the Scleroscope in Metallurgy and Manufacturing," by A. F. Shore, published in MACHINERY for August, 1909.

† Address: 40 Flushing Ave., Jamaica, N. Y.

due to greater suitability for casehardening, to its being better adapted to the casehardening treatment adopted, or to the more favorable distribution of the metal could not be told from the data of this test.

Shop Instructions

The following method is now employed in the manufacture and testing of the journals. A minimum limit was set for each diameter of journal. Two samples from each lot of casehardened material are roughly ground on a wheel of standard grit for that service and tested under the scleroscope. If these are found satisfactory, the entire lot goes to the grinding room; if not, they are retreated. After grinding, each journal is tested several times on each cylindrical portion to make certain that it is uniform all over, and it is then either sent to the stock room or returned. Since these precautions have been observed, the proportion of work found below standard is negligible. No trouble is ever found with soft parts in service.

TABLE I. RESULTS OF SCLEROSCOPE TESTS ON JOURNALS SHOWN IN FIG. 1

Piece No.	½ inch diam. (A)		⅝ inch diam. (B)		⅝ inch diam. (C)		¾ inch diam. (D)	
	Round	Flat	Round	Flat	Round	Flat	Round	Flat
1	55–57	64	72–78	78	68–71	75	78–82	82
2	53–56	61	67–69	75	70	81	82–85	87
3	59–62	59	71–74	72	71–72	75	86–88	88
4	61–62	70	70–72	72	72–79	78	78–83	79
Average	58	63	72	74	72	77	83	84

Machinery

Conclusion

The results of the scleroscope are now depended upon in that shop—when used in the proper place and in the proper manner. It is valued for what it tells about metal without injuring the finest finished surface.

* * *

JAPAN'S MACHINERY TRADE

The importations of machinery to Japan during 1914 had a value of about $12,500,000 as compared with $18,750,000 in 1913. Fifty per cent of this machinery came from the United Kingdom during both the years mentioned. Very few orders have been placed since the war broke out, but confidence is gradually returning, and it is believed that within the next few months the buying of machinery for Japan will be resumed. The Japanese government, however, is ardently supporting a policy to favor the home industries and encourages the placing of orders in Japan whenever it is possible to do so. Another important factor is that Japanese engineering works are increasing in number and capacity. It has been pointed out that makers of machinery of a class that is not too large and that is made in standard sizes should keep a small stock in Japan, so that the buyer could obtain immediately what he requires, in which case he would be more likely to buy from the importer than from a Japanese builder; but if he has to wait eight or nine months for delivery he is tempted to try the Japanese machine which he can obtain quicker and cheaper. As the importing firms are unwilling to tie up their capital in stock, manufacturers whose products can be regularly sold in Japan must be willing to place their machines in the warehouses of the local importers.

One of the interesting features of the machine shop business in Japan, according to a trade report by the British commercial attaché at Yokohama, is the very large number of small establishments consisting of a shop with one lathe and two or three employes. These small shops make a great deal of government work at low prices, as they have very small overhead charges. They do not quote on work directly, as they are too small to do that, but a sort of broker takes the order from the arsenal or other departments and then sub-lets it to these different shops. As they are conducted on such a small scale, there is considerable irregularity in the output and the rejection is large, but the competition from these small works is very keenly felt by the larger concerns. A peculiar condition existing in Japanese machine shops and other industrial plants is that the foremen are invariably in sympathy with the men and opposed to the management in case there is any labor trouble. Men of the "middle class" never gain practical experience by putting in a certain number of years in the works. Apparently they are above manual work; hence the engineers are nearly all graduates of technical colleges with little practical experience. The workmen on the whole are industrious, but their rice diet appears to be unsuitable for machine shop work, as they lack the necessary bodily weight for heavy work, and the percentage of days that they are absent on account of sickness is very high. The wages of the machinists are generally very low.

* * *

Attention is called in the *Travelers Standard* to the relation of noise to accidents. As is well known, fatigue has a notable influence in causing accidents, and anything that will tend to reduce or increase fatigue among workers is therefore, an important factor. Noise, therefore, has a prominent place in the items causing accidents, because loud noises, even if produced for only a short time, irritate the average person, and if they are continued every day and all day they will have a serious effect on the nervous system and become a serious factor in causing fatigue. Older employes in a noisy shop become more or less accustomed to noise and can generally detect any new or unusual sound that may indicate that something is out of order or that some danger is present. New men are likely to be confused by the constant loud noise and are less likely to note warning sounds. A systematic effort to suppress noise wherever possible in shops and factories will work to the advantage of all concerned. It will increase the safety of the workmen, and it is quite likely to increase their efficiency and working capacity.

* * *

The Ljusne-Woxna Co. of Ljusne, Sweden, has a power plant where power on a large scale is probably produced more cheaply than anywhere else in the world. This power plant is designed for a maximum output of 4200 horsepower, although the first installment provides for only 2200 horsepower. The fuel consists of a mixture of from 80 to 90 per cent sawdust, and from 10 to 20 per cent wood shavings This mixture is charged into gas producers. The consumption of fuel is about four pounds per horsepower-hour, the fuel costing about 24 cents per ton at the mill. It is estimated that the cost of production with a plant of 2200 horsepower, including overhead charges and depreciation at the rate of 10 per cent per annum, will be about 0.11 cent per kilowatt-hour

TABLE II. RESULTS OF SCLEROSCOPE TESTS ON SAMPLES SHOWN IN FIG 2

Piece No.	½ inch diameter (A)				⅝ inch diameter (B–C)				¾ inch diameter (D)				⅞ inch diameter (E)			
	Round		Flat		Round		Flat		Round		Flat		Round		Flat	
	Loose	Firm	Loose	Firm	Loose	Firm	Loose	Firm	Loose	Firm	Loose	Firm	Loose	Firm	Loose	Firm
1	58–70	65	71	72	78–79	82	83	85	85–89	91	92	92	92–93	88	92	92
2	65–66	66	69	73	75–77	76	83	86	84–86	82–84	93	91	88–91	92	93	94
3	67–69	76	71	72	78–79	83	84	86	89–91	87	91	91	91–92	90	92	95
4	65–66	69	71	75	72–77	81	83	86	88–89	89	92	90	92–94	92	93	96
Average	66	69	70	73	77	80	83	86	88	87	92	91	92	91	92	94

Machinery

TAP AND SCREW LIMITS

THE IMPORTANCE OF OBTAINING MORE INTELLIGENT SPECIFICATIONS FOR TAPS AND THREADING DIES

When one stops to consider the accuracy demanded in taps and threading dies at the present time, and analyzes the problem from all standpoints, it is interesting to note how little the close limits generally specified by buyers and users of these tools, really amount to in general practice. In fact, it is hard to see how so many intelligent buyers and users of taps and dies are led to specify ridiculously close limits, thereby causing their firms a lot of unnecessary expense and making a lot of unnecessary trouble for the tap and die makers. The only explanation of this useless refinement in specifications for taps and dies seems to be that the purchasers obtain their ideas in regard to the requirements of these tools from theorists who have little practical knowledge of the subject. If purchasers and users of taps and dies would stop to consider the cutting action of these tools, the holders in which they are used, the method of driving them, the machines in which they are used, and the condition of the tools themselves, there would undoubtedly be an immediate change in the method of drawing up specifications.

It would be quite natural for makers to believe that these close limits were specified because very accurate fits were required between the screws and tapped holes in certain lines of manufacture, such as machinery that is subjected to shocks or excessive vibration. But even in such cases, why should the taps be required to take care of all inaccuracies, *i. e.*, not only the inaccuracies in the taps themselves, but in the screws which are to be fitted into the tapped holes? Taps are always subject to inaccuracies caused by distortion during the hardening process, and it is practically impossible to eliminate errors resulting from this source, unless the taps are ground after hardening, which would add so much to their cost that few users could afford to pay for this additional work. But the dimensions of a threading die can be easily controlled; and this statement applies with equal force to both the diameter and the lead of the thread. In cases where absolutely accurate fits are required, the screws can be made by special machinery or they can even be threaded in lathes so as to obtain accurate dimensions for the diameter and lead, so that the only errors to be contended with would be those of the tap.

Another reason why a screw should be subjected to closer limits than a tap is that, as anyone at all familiar with the subject knows, a tap hardly ever duplicates its own size in the tapped hole, the hole nearly always being larger than the diameter of the tap. This result is saving many users and buyers of "close limit" taps a lot of trouble, as their specifications are generally given without any thought as to the relation between the error in the diameter and lead of the tap or screw, which serves as a further illustration of the utter lack of study and analysis of the subject which precedes the drawing up of many specifications. And if it were not for the fact that the diameter of the threaded hole is usually larger than the tap which cut the thread in it, many screws would not enter the full distance into the holes in the work. The intention in this article is to outline the conditions regarding taps and dies, their production, use and relation to each other as they actually exist in practice, with the view of familiarizing the users and buyers of the tools with these conditions in order that they may be in a better position to help solve the problem of drawing up specifications, which, at the present time, is apparently in a state bordering upon chaos.

The conditions to be considered may be briefly outlined as follows: First: The relation existing between the error in diameter and lead of the tap and of the screw; and the same relation between the screw and the tapped hole. Second: The length of the hole or nut to be tapped. Third: The relation of the accuracy of one portion of the tap to another. Fourth: The condition of the threaded portion of the tap itself. Fifth: The method of holding the tap while tapping. Sixth: The method of starting and feeding or "following up" the tap. Seventh: The relief of the threads on the tap. Eighth: The material being tapped. In order to be able to more clearly illustrate the first point given, we will take as an example a specification for a 1-inch United States standard tap, the diameter of which is not to exceed the standard size by more than 0.003 inch, while the error in the lead must not be over 0.002 inch in one inch of length. Such a specification is not at all out of the ordinary; in fact, it very closely approaches the commercial limits on this size of tap. We will also assume that the length of the nut is equal to the diameter of the tap, this being the case with both United States standard

OVERSIZE OF ANGLE DIAMETERS REQUIRED ON TAPS WITH LEAD ERRORS AS SHOWN, TO ENABLE SCREWS TO GO THROUGH TAPPED HOLES

A. Amount of oversize of angle diameters of taps, which is required to enable a screw of standard angle diameter and standard lead to go through a tapped hole, where the lead error is as given below in a length equal to the diameter of the tap.

Pitch or Angle Diameter	Threads per Inch	Oversize Necessary: 0.002-inch Lead Error per Inch	Oversize Necessary: 0.003-inch Lead Error per Inch	Pitch or Angle Diameter	Threads per Inch	Oversize Necessary: 0.002-inch Lead Error per Inch	Oversize Necessary: 0.003-inch Lead Error per Inch
1/16	64	0.0002	0.0003	1 3/8	6	0.0048	0.0071
1/8	40	0.0004	0.00065	1 1/2	6	0.0052	0.0078
3/16	32	0.00065	0.00097	1 5/8	5 1/2	0.0056	0.0084
1/4	20	0.00087	0.0013	1 3/4	5	0.006	0.0091
5/16	18	0.0011	0.0016	1 7/8	5	0.0065	0.0097
3/8	16	0.0013	0.00195	2	4 1/2	0.0069	0.0104
7/16	14	0.0015	0.0023	2 1/8	4 1/2	0.0074	0.011
1/2	13	0.0017	0.0026	2 1/4	4 1/2	0.0078	0.0117
9/16	12	0.00195	0.0029	2 3/8	4	0.0082	0.0123
5/8	12	0.0022	0.00325	2 1/2	4	0.0087	0.013
11/16	11	0.0024	0.0036	2 5/8	4	0.0091	0.0136
3/4	10	0.0026	0.0039	2 3/4	4	0.0095	0.0143
13/16	10	0.0028	0.0042	2 7/8	3 1/2	0.010	0.0149
7/8	9	0.003	0.00455	3	3 1/2	0.0104	0.0156
15/16	9	0.00325	0.0049	3 1/4	3 1/2	0.0113	0.0169
1	8	0.00346	0.0052	3 1/2	3 1/4	0.0121	0.0182
1 1/8	7	0.0039	0.0058	3 3/4	3	0.013	0.0195
1 1/4	7	0.0043	0.0065	4	3	0.0139	0.0208

B. Conditions as given for section A of the table, except that the screw has a lead error equal to that of the tap and in the opposite direction. For example, if the tap should be 0.002 inch long in the lead for a distance of 1 inch, the lead of the screw would be 0.002 inch short in distance of 1 inch.

Pitch or Angle Diameter	Threads per Inch	Oversize Necessary: 0.002-inch Lead Error per Inch	Oversize Necessary: 0.003-inch Lead Error per Inch	Pitch or Angle Diameter	Threads per Inch	Oversize Necessary: 0.002-inch Lead Error per Inch	Oversize Necessary: 0.003-inch Lead Error per Inch
1/16	64	0.0004	0.0006	1 3/8	6	0.0096	0.0142
1/8	40	0.0008	0.0013	1 1/2	6	0.0104	0.0156
3/16	32	0.0013	0.00194	1 5/8	5 1/2	0.0112	0.0168
1/4	20	0.00174	0.0026	1 3/4	5	0.0120	0.0182
5/16	18	0.0022	0.0032	1 7/8	5	0.0130	0.0194
3/8	16	0.0026	0.0039	2	4 1/2	0.0138	0.0208
7/16	14	0.0030	0.0046	2 1/8	4 1/2	0.0148	0.0220
1/2	13	0.0034	0.0052	2 1/4	4 1/2	0.0156	0.0234
9/16	12	0.0039	0.0058	2 3/8	4	0.0164	0.0246
5/8	12	0.0044	0.0065	2 1/2	4	0.0174	0.0260
11/16	11	0.0048	0.0072	2 5/8	4	0.0182	0.0272
3/4	10	0.0052	0.0078	2 3/4	4	0.0190	0,0286
13/16	10	0.0056	0.0084	2 7/8	3 1/2	0.0200	0.0298
7/8	9	0.0060	0.0091	3	3 1/2	0.0208	0.0312
15/16	9	0.0065	0.0098	3 1/4	3 1/2	0.0226	0.0338
1	8	0.0069	0.0104	3 1/2	3 1/4	0.0242	0.0364
1 1/8	7	0.0078	0.0116	3 3/4	3	0.0260	0.0390
1 1/4	7	0.0086	0.0130	4	3	9.0278	0.0416

Machinery

and Whitworth standard nuts. (See MACHINERY'S Handbook, pages 765 and 766.) We will also assume that the screw is allowed to have the same amount of error in lead as the tap, *i. e.*, 0.002 inch in 1 inch of length, and that the pitch diameter is allowed to be the same amount under the standard size as the tap was allowed to be over the standard size, *i. e.*, 0.003 inch. The tap will be assumed to cut its own correct size, a condition which is not actually the case, but which seems to be the generally accepted idea.

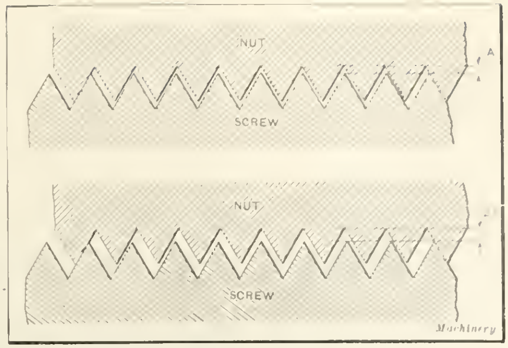


Fig. 1. Upper Illustration shows Condition when Lead of Thread in Nut is Correct and Lead of Screw Thread is Inaccurate; Lower Illustration shows Condition when Lead of Thread in Both Nut and Screw is Inaccurate, with the Errors in Opposite Directions

Conditions which are likely to be found in the tap are as follows: First, it is of the correct diameter with no lead error, but such a tap will not be seriously considered as its production is a practical impossibility. Second, the tap has the maximum diameter and the maximum lead error. Third, it has the correct (standard) diameter and maximum lead error. Fourth, it has the maximum diameter and no lead error. Conditions which are likely to be found in the screw are as follows: First, the screw is of the correct (standard) diameter with no lead error. Second, it is of the correct diameter and has the maximum lead error in a direction opposite to that of the tap. Third, it is of the correct diameter with the maximum lead error in the same direction as that of the tap. Fourth, it is of the minimum diameter with no lead error. Fifth, it is of the minimum diameter with the maximum lead error in the opposite direction to that of the tap. Sixth, it is of the minimum diameter with the maximum lead error in the same direction as that of the tap.

Comparing each of the conditions of the tap with those of the screw, the following results will be found: Comparing the tap of maximum diameter and maximum lead error with the screw of correct diameter and no lead error, it will be found that the screw will not go through the tapped hole. In order to allow the screw to go through the hole, the tap would have to be 0.00046 inch larger on the diameter, or the screw should be 0.00046 inch smaller on the diameter. (See table.)

Comparing the tap of correct diameter and the maximum lead error with the screw of correct diameter and no lead error, it will be found that the screw will not go through the tapped hole. In order to do so, the tap should be 0.00346 inch larger on the diameter or the screw 0.00346 inch smaller.

Comparing the tap of maximum diameter and no lead error with the screw of correct diameter and no lead error, it will be found that the screw will go through the tapped hole. The screw will have 0.003 inch play all the way through.

Comparing the tap of maximum diameter and maximum lead error with the screw of correct diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. In order to have it do so, the tap should be 0.00346 + 0.00046 = 0.00392 inch larger on the diameter, or the screw should be the same amount smaller on the diameter.

Comparing the tap of correct diameter and maximum lead error with the screw of correct diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. In order to do so, the tap would have to be 2 × 0.00346 = 0.00692 inch larger on the diameter or the screw would have to be the same amount smaller on the diameter.

Comparing the tap of maximum diameter and no lead error with the screw of correct diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. In order to do so, the tap would have to be 0.00046 inch larger on the diameter or the screw would have to be the same amount smaller on the diameter.

Comparing the tap of maximum diameter and maximum lead error with the screw of correct diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will go through the tapped hole. The screw will have 0.003 inch play all the way through.

Comparing the tap of correct diameter and maximum lead error with the screw of correct diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw has a perfect fit in the tapped hole.

Comparing the tap of maximum diameter and no lead error with the screw of correct diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will not go through the hole. In order to do so, it would have to be 0.00046 inch smaller on the diameter or the tap would have to be the same amount larger on the diameter.

Comparing the tap of maximum diameter and lead error with the screw of minimum diameter and no lead error, it will be found that the screw will go through the tapped hole. The screw will have 2 × 0.003 − 0.00346 = 0.00254 inch play in one end and 2 × 0.003 = 0.006 inch play in the other end of the tapped hole.

Comparing the tap of correct diameter and maximum lead error with the screw of minimum diameter and no lead error, it will be found that the screw will not go through the tapped hole. In order to do so, it would have to be 0.00046 inch smaller than standard or the tap would have to be the same amount over the standard size.

Comparing the tap of maximum diameter and no lead

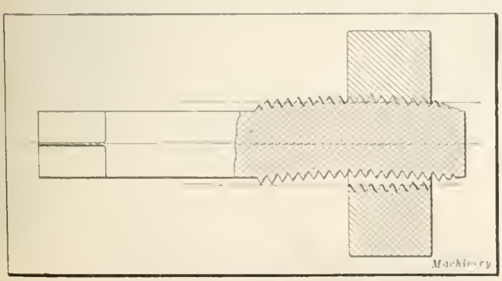


Fig. 2. Threaded Portion of Tap is bent, which results in producing an Oversize Hole

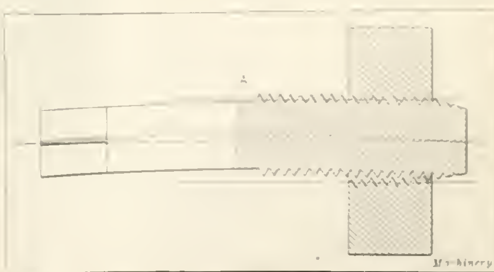


Fig. 3. Tap bent over its Entire Length, which results in producing an Oversize Hole

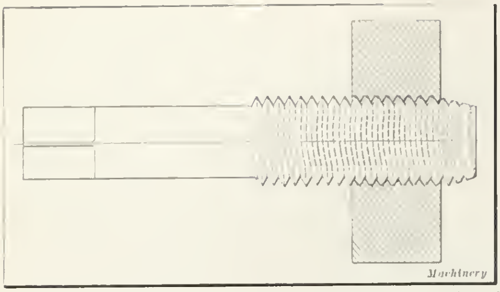


Fig. 4. Tap with So-called "Drunken" Thread, which cuts unevenly and produces Oversize and Roughly Threaded Holes

error with the screw of minimum diameter and no lead error, it will be found that the screw will go through the tapped hole. It will have 0.006 inch play all the way through the hole.

Comparing the tap of maximum diameter and maximum lead error with the screw of minimum diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. In order to do so, it would have to be $2 \times 0.00046 = 0.00092$ inch under the standard size, or the tap would have to be the same amount over the standard size.

Comparing the tap of correct diameter and maximum lead error with the screw of minimum diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. To do so, the screw would have to be $0.00046 + 0.00346 = 0.00392$ inch under standard size, or the tap would have to be the same amount over standard size.

Comparing the tap of maximum diameter and no lead error with the screw of minimum diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will go through the tapped hole. The screw will have $0.006 - 0.00346 = 0.00254$ inch play.

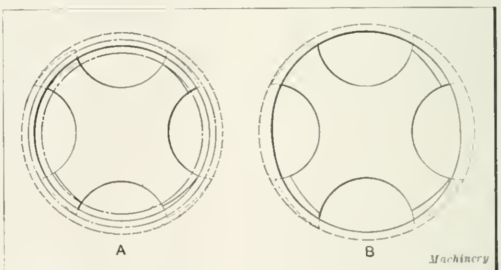


Fig. 5. A. Tap out of Round; Dot and Dash Lines show Correct Size of Hole. B, Hole in Nut out of Round

Comparing the tap of maximum diameter and maximum lead error with the screw of minimum diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will go through the tapped hole. The screw will have 0.006 inch play all the way through the hole.

Comparing the tap of correct diameter and maximum lead error with the screw of minimum diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will not go through the tapped hole. In order to do so, it will have to be 0.00046 inch under the standard size or the tap will have to be the same amount over the standard size.

Comparing the tap of maximum diameter and no lead error with the screw of minimum diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will go through the tapped hole. It will have 0.00254 inch play.

From the preceding, it will readily be seen that were it not for the fact that taps generally cut a thread larger than their own diameter, and that screws are generally allowed larger undersize limits than taps are allowed to be oversize, there would be a majority of cases where the screw would not go through the tapped hole. Why screws in general, and more especially those used in connection with "close limit" taps, should be allowed to be a greater amount under standard size than taps are allowed to be over the standard size (and not only this, but that the screws are allowed wider limits between their maximum and minimum sizes and a greater lead error than allowed in the taps) is a condition which has not been satisfactorily explained, unless it is due to lack of study of the subject by those who are responsible for the drawing up of specifications. Before proceeding further with the subject, attention should be called to the fact that the diameter, as referred to in this article, means the pitch or "angle" diameter. The outside diameter of a tap, as long as it is up to the standard size or any amount over standard, has no particular bearing upon the fit between the screw and the tapped hole; of course, in order to have no bearing upon the fit of the screw in the tapped hole, the outside diameter of the screw must not be over the standard size.

The accompanying table has been figured out to give the minimum oversize of 0.002 inch for the "angle" or pitch diameter of taps, with 0.003 inch error per inch in the lead, to allow screws of standard diameter to go through the holes in nuts tapped with them. The nuts are assumed to be of the same length as the diameter of their respective taps; and the holes in the nuts are supposed to be the exact size of the taps in all cases. As it is reasonable to expect that the screws will have at least the same amount of error in lead as the taps (in most cases this error is very much greater than in the taps), figures have also been tabulated for screws having the same lead error as the taps, these figures being given for screws with lead errors in the opposite direction to that of the error in the taps, in order to show the great amount that the diameters of the taps are required to be oversize in order to allow the screws to go through the holes tapped with them. As in the preceding cases, these figures are based on the assumption that the taps cut to their true diameters. To thoroughly understand the preceding statements, the reader is referred to Fig. 1.

The accompanying illustrations show clearly that, contrary to the general opinion, taps do not cut to their true diameter, but generally cut a certain amount over this size; and a few words of explanation may not be out of place. One of the reasons for this cutting action of the tap is due to the threaded portion being bent, this condition being shown exaggerated in Fig. 2. This fault is very hard to remedy, and even to detect, and it is also very difficult to compensate for such an error no matter how the tap may be made, held or used. It can also be readily seen that the deeper or longer the hole to be tapped with such a tap, the greater will be the error in the hole being tapped. Of course, it may be claimed that the tap could be ground in cases where extreme accuracy is needed; but while this may sound feasible, and although it is actually done at times, the difficulty of doing such an operation

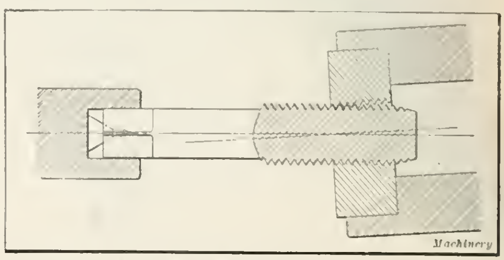


Fig. 6. Result when Center Line of Tap is not Perpendicular to Face of Work

and the added expense of such taps makes the procedure impracticable for general use. It is difficult and expensive enough to grind a plug thread gage, as anyone familiar with this work knows, and such a tool has a short thread and an uninterrupted thread surface. In a tap, the long thread and constant interruption of the thread surface by flutes, together with the provision of relief to give the required cutting action, makes the grinding very difficult.

While the preceding error in the size of a hole cut by a tap is probably the most frequently found defect due to the distortion of taps in hardening, there are other errors introduced by this operation which cause undesirable results that a close study has shown to be equally hard to remedy. A possible exception to this statement is the condition illustrated in Fig. 3, which shows a tap bent along its entire length. If this tool is not straightened, it will produce a hole tapped as shown; and even if a tap bent in this manner is straightened to run true at *A*, the defect shown in Fig. 2 will often remain, which is much harder to remedy as the portion to be straightened is short, hard all over, hard to test while straightening, etc. Two other defects resulting from the hardening operation are shown in Fig. 4 and at *A* in Fig. 5, the former illustration showing what is called a tap with a "drunken" thread, and the latter an end view of an "out of round" tap. While the illustrations clearly show the results of these errors in taps in introducing inaccuracies in the holes in which they work, it may not be amiss to mention that evenly fluted taps which are out of round will not cut uniformly, but will chatter, etc.; and this results in producing oversize and roughly threaded holes. Both of the latter defects in taps may be attributed more to the material from which the taps are made than to the method of conducting the hardening operation. Steel which has been unevenly rolled or unevenly annealed, or where the tap blank was not straight before it was turned so that the tool cut to different depths below the decarbonized surface, are conditions which are likely to cause the tap to be out of round. Aside from these sources of error, there are many minor defects of workmanship in taps, such as uneven chamfers on the different lands, excessive rake of the chamfered portion of the tap on top of the thread, an excessive amount of undercut in the flutes, an excessive amount of relief in the thread angle, etc., all of which are easily remedied, but any of which may make the taps cut holes larger than their own diameter.

In addition to the preceding undesirable conditions in the taps themselves, there are several factors connected with the use of taps which should not be passed by unnoticed, as they may also result in the production of oversized holes.

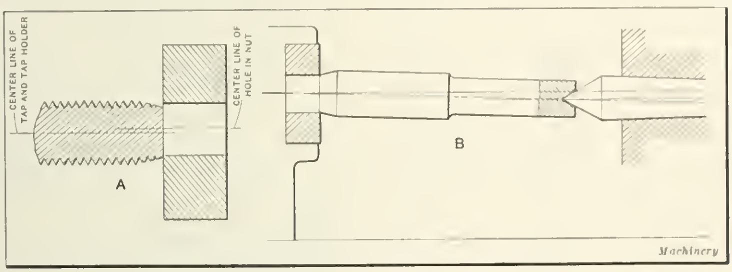


Fig. 9. A, Center Line of Tap and Center Line of Hole to be tapped are out of Alignment. B, Work-holder is out of Alignment with Center of Tap-holder

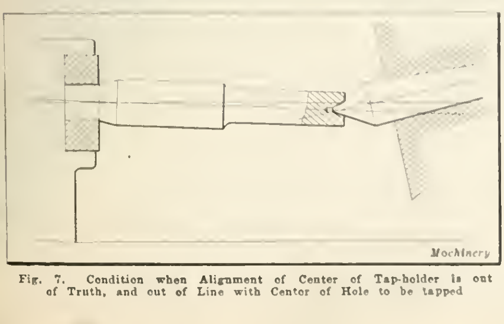


Fig. 7. Condition when Alignment of Center of Tap-holder is out of Truth, and out of Line with Center of Hole to be tapped

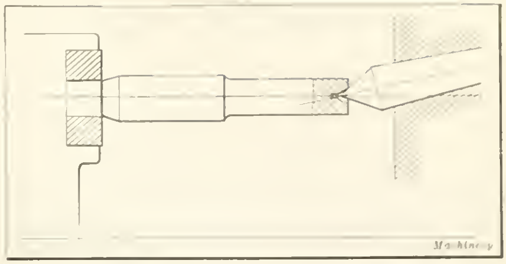


Fig. 8. Condition when Alignment of Center of Tap-holder is out of Truth, but in Line with Center of Hole to be tapped

The one most frequently found is undoubtedly that of the center of the tap-holder being out of line with the center of the hole which is to be tapped, as shown at *A* in Fig. 9. Few machine tools after they have been in use for any length of time will have the centers in accurate alignment, due to wear in the bearings and slides. These conditions are shown at *B* in Fig. 9, and in Figs. 7 and 8. Other ways in which a tap can produce an oversize, or at the best a roughly threaded hole, are shown in the following illustrations. At *B* in Fig. 5 the tapped hole is shown out of round, and at *B* in Fig. 9 the holder for the work is out of line with the center of the tap-holder, while in Fig. 6 the tap is out of true with the face of the nut. These are all common conditions and the errors which they produce can readily be appreciated. If a floating tap-holder is used, greater accuracy should be obtained, the increase of accuracy depending upon the style of floating tap-holder employed, the amount of float, the amount of error in the alignment of the centers, etc.

The condition shown in Fig. 9 would result if the shank of the tap were out of line with the threaded portion, which is a condition not infrequently found in manufactured taps. Another common condition which results in tapping oversize holes is that the tap is relieved too much in the angle of the thread or given too much of a "hooking" flute for the material which is to be tapped, and when such taps are forced to take hold of the work either by hand or mechanically they produce holes that are too large. While arguments may be put forth that taps cut oversize when working under the best conditions, and hence there is all the more reason for making them to close limits, it must be contended that the tap manufacturer or toolmaker should make a more thorough and careful study of the minor causes which make taps cut oversize, i. e., such conditions as the effect of varying the fluting, relief, etc., with a view to removing those causes which are easy to overcome. This would involve no extra expense in the cost of manufacture. It must also be contended that the tap user or buyer should concentrate his efforts along the line of producing screws and bolts to close limits for those cases where great accuracy is a necessity. This is at least possible, and certainly does not require any great expenditure to be made. If those who are using taps would occasionally examine their machines, tap-holders, holes to be tapped, etc., and correct errors found in this way, they would find it unnecessary to expend large sums of money for "close limit" taps, but would be able to use those made to commercial limits. A further benefit of such a course would result from the fact that such taps are usually carried in stock by all manufacturers of taps and threading dies.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

THE ANGLE OF TORSION

The article on the "Angle of Torsion" by W. B. Gilbert, that appeared in the June number of MACHINERY, shows that he has understood my contribution on the same subject which was published in November, 1914. The illustration accompanying Mr. Gilbert's article shows one of the numerous cases where the elastic strength of shafting must be equalized, either for economical reasons or otherwise. Mr. Gilbert said that the only question in his mind was whether it would be as satisfactory to apply the motive power at a point off center. For the sake of uniformity it is desirable to have the power applied midway between the loads, or

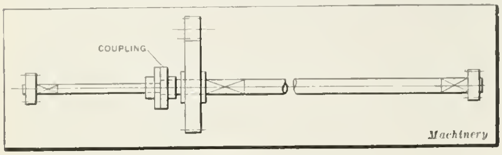


Fig. 1. Proper Position of Coupling

proportionately with reference to the angles of torsion if the loads are unequal.

I have experienced trouble of the nature Mr. Gilbert refers to, and have remedied it by equalizing the angle of torsion. A case in point was in the design of a gantry that spanned two freight tracks and a small warehouse; but in this case I had to correct the angular difference by employing a spring equalizing sprocket, as the shaft diameters could not be changed. The best and most reliable way, however, is to correct the shaft diameters by the method I have already explained. The nature of crane service is such that the angle of torsion should not exceed 0.05 degree per foot—a condition which would bring the shaft under Class I, as referred to in my article in November, 1914. Mr. Gilbert shows the shaft diameter reduction as occurring in the "distance of greatest torsion." This will cause trouble in keeping the key tight in the coupling, and even shrinking the coupling onto the shaft is not satisfactory where one end of the shaft carries the maximum load momentarily.

Fig. 1 shows the corrected position of the shaft coupling with reference to Mr. Gilbert's illustration, and Fig. 2 shows a preferable method of design. The shaft diameter at the

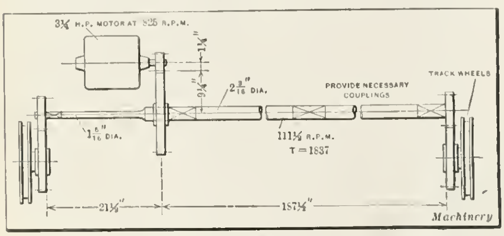


Fig. 2. Preferable Layout for Shafting of the Same Installation as Fig. 1

short end is reduced, and a shaft coupling employed to connect the shafts of equal diameters. The shaft diameters are corrected for service which comes under Class I which has already been referred to. The short length of shaft should be of high carbon steel with a carbon content of from 0.30 to 0.45 per cent, on account of the reduction in the shaft diameter; and the remainder of the shaft may be made of cold-rolled steel. In dealing with such problems in shaft design, the reader will be assisted by the table giving the modulus of torsion for various materials which appeared in connection with my article on page 198 of the November, 1914, number of MACHINERY.

Newport, Ky. B. D. PINKNEY

HISTORY OF THE MICROMETER CALIPER AGAIN

In the article "How we came to have the Slocomb Shop Micrometer," by J. T. Slocomb, in the August number of MACHINERY, Mr. Slocomb quotes from a number of past Brown & Sharpe Mfg. Co.'s employes and expresses views regarding the early development of the micrometer caliper so contrary to the facts that for the sake of historical accuracy they should not stand uncorrected. The fact that Mr. Slocomb did not work in the micrometer department when he was employed by the Brown & Sharpe Mfg. Co., may account for his having so little knowledge of what was then being done in the micrometer line as to publish under his name statements regarding this matter that were not borne out by fact.

1. Mr. Slocomb quotes Mr. Thurston as writing, regarding the use of micrometers at the Brown & Sharpe works, that up to July, 1882, "the micrometer was very little in use, there being only two or three in the entire plant." However, the Brown & Sharpe Mfg. Co.'s stock-book, listing tools in use January 1, 1882, shows that the tool-rooms were liberally provided with micrometers, seventeen being used in the works at that date, besides those privately owned by workmen in the plant.

2. Mr. Slocomb quotes old employes as saying, regarding the use by the Brown & Sharpe Mfg. Co. of two-inch micrometers during the years 1885-90, that "as far as they knew, there was not a two-inch tool in use anywhere except the one belonging to Mr. Burnham." The stock list of January 1, 1885, shows that there were then three two-inch micrometers in use in the works and that on January 1, 1889, there were ten in use, these being in addition to those which were privately owned, such as the one referred to as belonging to Mr. Burnham.

3. Mr. Slocomb further quotes to the effect that "some time about 1880 they (Brown & Sharpe Mfg. Co.) started to make a lot of fifty one-inch micrometers." In 1880, the Brown & Sharpe Mfg. Co. was regularly making one-inch micrometers in lots of five hundred, and had been making them in lots of this size for several years prior to that date. A year or two later one-inch micrometers were made in lots of one thousand.

4. Mr. Slocomb further quotes to the effect that with the goods purchased by the Brown & Sharpe Mfg. Co. from the Victor Sewing Machine Co. "there was a precision screw made by the Pratt & Whitney Co., Hartford, Conn., and this was afterward used for making accurate micrometer screws." All that is correct about this statement is that there was such a screw at the time of the transfer of the micrometer business of the Victor Sewing Machine Co. to the Brown & Sharpe Mfg. Co. This screw and the lathe in which it was mounted were not wanted by the latter company and were sold to other parties. The Brown & Sharpe Mfg. Co. had already perfected its own machines and methods for making accurate screws and were not dependent upon the Victor Sewing Machine Co. for the accuracy of their work.

As to matters of opinion expressed by Mr. Slocomb, such as that he is the only one able to commercially cut accurate threads on tool steel and as to the value or lack of value of the clamping device for micrometers, etc., while much might be said on these points, it is not the purpose of this comment to enter into such a discussion, but simply to deal with matters of historical fact. I would, however, add in closing that in reviewing the whole situation the surprise to me is that the micrometer found its way so rapidly into use among mechanics who had been trained in the use of the vernier caliper and this especially in the Brown & Sharpe Mfg. Co.'s shop, where the latter tool had its origin.

Mr. Slocomb quotes several Brown & Sharpe workmen as remembering that half of the men owned one-inch micrometers at the time he is discussing. If this is true it would indicate a very decided appreciation of the value of this tool, being as it was in a shop so well supplied both in tool-rooms and other departments with vernier and micrometer calipers which the workmen could take for use at any time on check.

Providence, R. I.

LUTHER D. BURLINGAME
Brown & Sharpe Mfg. Co.

TWO USEFUL TYPES OF BORING-BARS

Two useful types of boring-bars that were designed to speed up operations where the adjustment or changing of tools had formerly consumed too much time, are shown in the accompanying illustrations. The bar shown in Fig. 1 is for performing recessing operations, and it can be very quickly set to bore a recess of specified depth. The feature of the second type of bar, shown in Figs. 2 and 3, is the holder in which the bar is mounted. This is particularly useful in cases where the roughing and finishing operations have to be performed with separate bars, the holder enabling the change of tools to be made in a very short space of time. The same type of holder could be used for carrying the reamer used for the following operation.

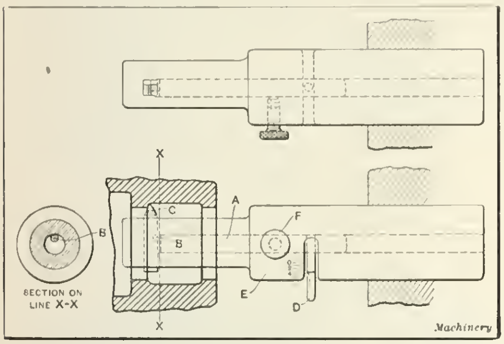


Fig. 1. Handy Type of Boring-bar for performing Recessing Operations

It will be seen that the recessing bar shown in Fig. 1 is made with a hole through the center in which a shaft A is mounted. This shaft has an eccentric teat B turned on one end to fit into a slot cut in the side of the recessing cutter C. In operation, the hole in the work is first bored out, after which the recessing is done in the following manner. The shaft A is turned by means of the pin D which swings in a slot cut in the body of the bar E, until the teat B has carried the recessing cutter C back a sufficient distance to enable it to enter the hole that has already been bored in the work. The bar is then advanced into the hole to be recessed and located in the correct position to start the cut, after which the shaft A is again turned until the cutter C has been advanced into the work to the depth to which it is required to machine the recess. This depth is easily determined by means of the line on the pin D which is brought into coincidence with the proper graduation on the body of the bar. After the cutter has been located in this way, the shaft A is locked by tightening the binding screw F, and when this has been

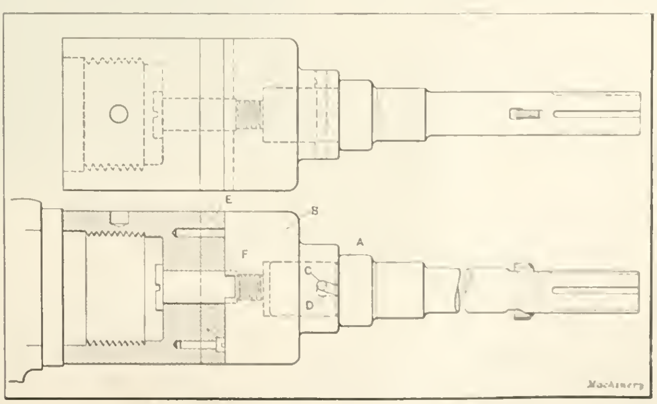


Fig. 2. Boring-bar and Holder suitable for Plain Boring

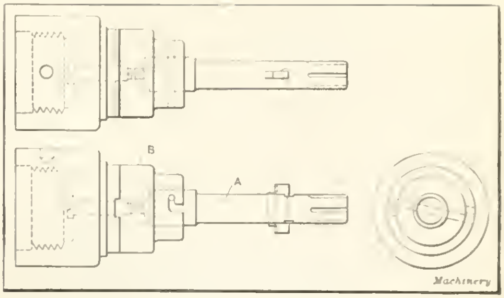


Fig. 3. Back-facing Bar with Holder similar in Purpose to the one shown in Fig. 2

done the recessing operation is performed. The cutter is then drawn back into the bar to enable the bar to be removed.

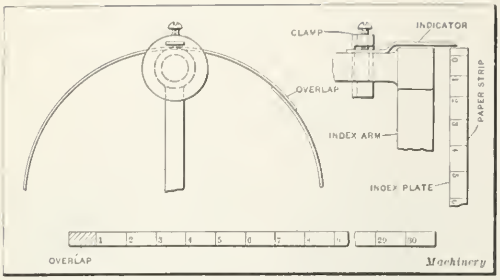
It frequently happens that a number of holes are to be drilled and reamed in a single piece, or that roughing and finishing operations require the use of different tools, and considerable time is occupied in making such changes. To overcome this difficulty, the spindle-nosed fixture shown in Fig. 2 was designed. This consists of any form of boring-bar with a shank which is shouldered at A and which is of the proper size to fit into the socket in the driving unit B in the manner shown. A driving pin C is mounted in the shank of the boring-bar, this pin being of suitable size to slip into the slot D in the driving unit. In back of the unit B there is a steel driver E which is secured to the socket B by means of a screw F, thus enabling different units B to be employed for holding different sizes of boring-bars. The driver E is secured to the cast-iron member which is screwed onto the threaded end of the spindle. It will be seen that the slot to receive the pin C is cut on a slight angle which tends to draw the boring-bar back and hold it in place while cutting.

The driving unit shown in Fig. 2 is suitable for a variety of boring and reaming operations but cannot be used where there is any back facing to be done. For such work the driving unit shown in Fig. 3 was designed. Referring to this illustration it will be seen that the pin in the boring-bar A is held in a slot which has a right angle bend in it. In placing the bar A in the driving unit B, the pin is slipped to the end of the straight part of the slot, after which the bar is twisted to bring the pin to the position shown in the illustration. When held in this way, it will be evident that back-facing operations can be performed without danger of the bar pulling out of the holder. This type of holder is equally suitable for ordinary boring, reaming and similar operations.

F. SERVER

A DIVIDING HEAD KINK

Sometimes when it is required to get a certain number of divisions by means of the milling machine dividing head and the machinist starts to set up a machine for handling the job, he finds that there is not an index plate with a circle of the proper number of holes. If the work is in a hurry, or if it is not of sufficient importance to warrant ordering an index plate for the purpose, satisfactory results may be obtained by employing the simple method which it is the purpose of the following article to describe.



Method of making Temporary Index Plate with Circle of any Required Number of Holes

A fairly satisfactory index plate can be made by taking a strip of paper about ¼ inch wide by ½ inch longer than the circumference of the index plate on which it is to be used. This strip of paper is divided up into the number of spaces it is required to obtain, using a sharp lead pencil for this purpose. The strip of paper is then pasted to the circumference of the index plate with the additional ½ inch of length overlapping. A piece of sheet metal, cut to the shape shown in the illustration, may now be clamped to the index arm so that the point extends over the divisions provided on the circumference of the plate to form an indicator.

Although the results obtained by this method are not as reliable as where a regular index plate is used, they will be found reasonably satisfactory. Assuming that 40 revolutions of the index arm are required for one revolution of the work, and that the diameter of the work is the same as that of the index plate, it will be seen that it would require an error of 0.040 inch in the indexing to produce an error of 0.001 inch in the work.

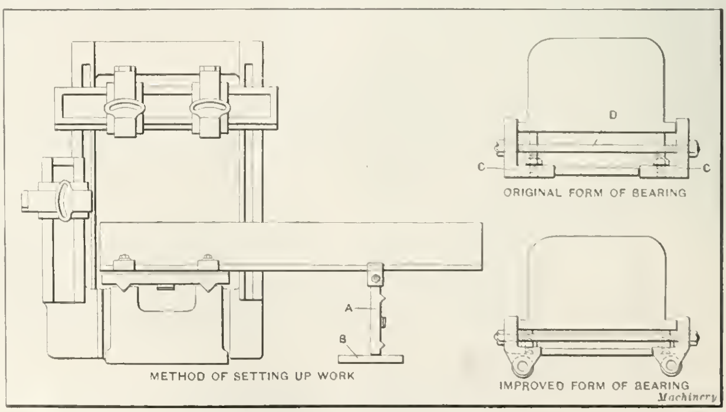
Newark, N. J. GUSTAVE A. REMACLE

HANDLING LARGE WORK ON A SMALL PLANER

The accompanying illustration shows a method that has proved very satisfactory for finishing the ends of a number of long castings on a small planer. The castings were located on the planer table in the position shown, and the cutting tool was carried by the auxiliary housing. To support the overhanging end of the work, an old planer table *A* was set up on edge, and fastened to a cast-iron baseplate *B* on the floor. The form of sliding bearing originally used for supporting the extended end of the work, is shown in detail, as well as the improved bearing now in use. Two right-angle castings *C* were clamped to the side of the work by means of the long bolt *D*, their bottom surfaces acting as the sliding bearing on the edge of the planer table *A*. The work was adjusted to the correct level by means of the studs threaded into the bearings.

This form of bearing was later changed to a roller bracket, which developed less friction. The edge of the planer table used as the bearing surface was well lubricated. It would appear at first sight that the overhanging end of the work would lag and tend to shift the position of the casting at the moment of reversal of the planer table, but no difficulty was experienced from this cause. This probably would have occurred if the casting had been supported under the extreme end. The planer used for this work measured about 3 feet 6 inches between the housings, and the castings were about 8 feet long. This method can be used only when the distance from the cutting tool to the housing face is greater than the width of the work.

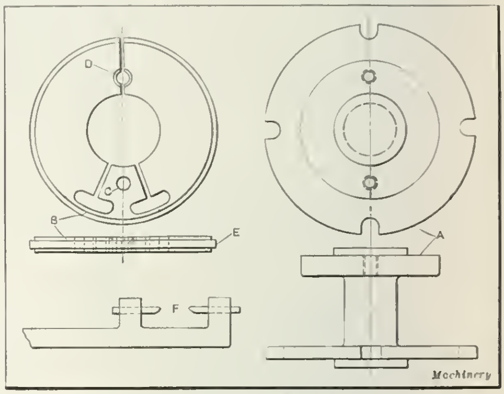
Moore, Pa. JOHN LEAFSTROM



Method of handling Long Work on Small Planer and Enlarged View of Two Types of Supporting Bearings

FACING PISTON RINGS

In the following is described a fixture for facing piston rings. Referring to the accompanying illustration, the part *A* is made of cast iron and fitted to the nose of the lathe spindle in order to make it come central, while the four slots enable the fixture to be bolted to the faceplate. The part *B* is made of machine steel about ¾ inch in thickness and is a running fit on the pilot of fixture *A*. Part *B* is secured to part *A* by means of one straight screw at *C* and one tapered screw at *D*, the tapered screw spreading the plate *B* and tightening it against the inside of the piston ring.



Fixture for Use in facing Piston Rings

The offset *E* on the plate *B* is provided to accommodate rings that are of less thickness than the plate. Plates *B* of various sizes to hold the different piston rings which are to be faced, can be used on the same fixture *A*. The facing is done by tools held in a tool-holder of the form shown at *F*. The tools are made of square high-speed steel and held in position by set-screws in the usual way. They are set at the correct distance apart, and one cut taken with the cross feed reduces the ring to the desired thickness and makes its sides parallel.

Franklin, Pa. A. F. MANSBERGER

UNIVERSAL LINK-CUTTING DIE

We had to make a number of links of various lengths, all of which were ⅜ inch wide by ⅛ inch thick, with a 3/16-inch hole at each end, as shown at *A* in Fig. 1. Instead of making a separate punch and die for blanking out each length of link, we made the universal tool shown in Figs. 1 and 2. The cost was no more than that of a single-purpose tool for making any one size of link; and in making the links in this way there is very lit-

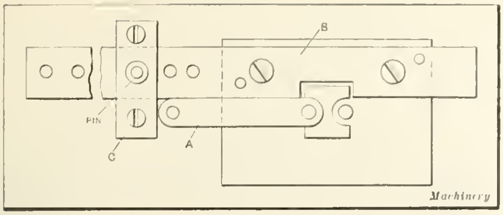


Fig. 1. Universal Link-cutting Die

tle scrap produced. The stock bought was of the correct width and thickness, and the only loss amounts to about ⅛ inch between the ends of successive links.

The die is shown in Fig. 1 with the stripper removed, in order that the design and method of operation may be more clearly illustrated. It will be seen that the stop-bar *B* is doweled to the die and extends beyond it for a distance equal to the length of the longest link that it is required to make. The stop *C* slides on the bar, in which there is a dowel-pin hole to locate the stop in the proper position for each length of link. This arrangement makes it very easy to change the die for making any size of link which comes within its range. No description of the punch will be necessary to make its design clear.

To use this punch and die, the operator first runs the stock under the punch to round off the end and punch the first hole. He then advances the finished end of the stock until it contacts with the stop *C* and again trips the press. This stroke

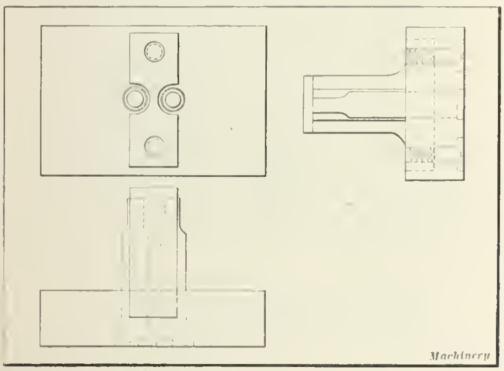


Fig. 2. Link Blanking and Piercing Punch

results in completing one link and rounding and piercing one end of the following link. It will be evident that each stroke of the press now results in the completion of one link.

Belleville, Ill. B. Geist

RELATIVE VALUE OF SODA AND SODA ASH

There are few substances which are used in greater quantities in American factories than soda; it is employed for cleaning machine parts, for scrubbing floors, and for numerous other purposes. Many shops have had experience in trying other cleaning compounds for which great claims are made, but eventually they come back to the use of soda. It is not the intention to say that there are not a great many good cleaning compounds on the market, but in most cases the difference between their cost and the cost of ordinary washing soda does not warrant using them.

In answer to the question "What is soda?" it may be said that it is a chemical compound known as sodium carbonate which has the formula Na_2Co_3, and that the greatest supply comes from Syracuse, N. Y. The actual method of manufacture is a secret process, but it is known that limestone and common salt are used in large quantities. It may be a surprise to some people to learn that nearly two-thirds of the weight of washing soda is due to the water which it contains; and that this so-called "water of crystallization" has no value as a cleaning medium. As a result, the purchaser will obtain more for his money by buying soda ash instead of soda. Soda ash has the same chemical composition but does not contain any water, and as the cost per pound is only about 10 per cent more than that of soda, it is far more economical to use. Soda ash contains certain impurities which are not found in soda, but the amount of these is less

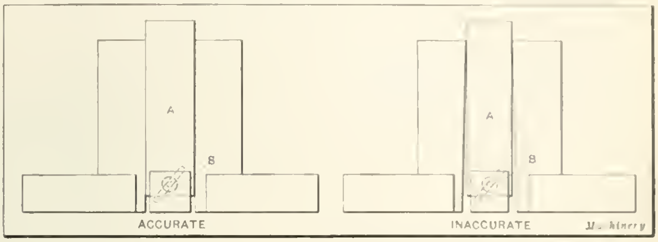


Fig. 1. Method of testing a Square with a Straightedge and Surface Plate

than 1 per cent and the impurities are of such a character that they are harmless.

If you wish to convince yourself of the relative strength of soda and soda ash, weigh out exactly equal amounts of the two materials and place them in beakers. Add enough water to each beaker to dissolve its contents and then run in the required amount of commercial muriatic acid to neutralize the solutions, as shown by testing with blue litmus paper or some other indicator. This test will show that the soda ash requires about 2¼ times as much acid to neutralize it as is required to neutralize the same weight of soda, *i. e.*, the soda ash is 2¼ times as strong as the soda, and one ton of it will go as far as 2¼ tons of soda.

Buffalo, N. Y. George B. Morris

TESTING A SQUARE

It is common though incorrect practice to test a square by comparing it with some other square. This method is unreliable because the discovery of an error does not necessarily mean that the inaccuracy is in the square being tested. Fig 1 shows a simple test that gives satisfactory results. A strip of stock *A* with two parallel sides should be held in a clamp *B*, with the parallel sides protruding beyond the sides of the clamp. Laying this upon a surface plate, the parallel strip is brought square with the plate by tapping it at one side or the other. The square is accurate if no light can be seen when the blade is held against either side of the parallel strip If the strip is square with the surface and the square is inaccurate, the error will appear to be of equal magnitude on each side of the strip.

Fig. 2 illustrates another method of testing a square. The cylindrical test block should be hardened and ground, and

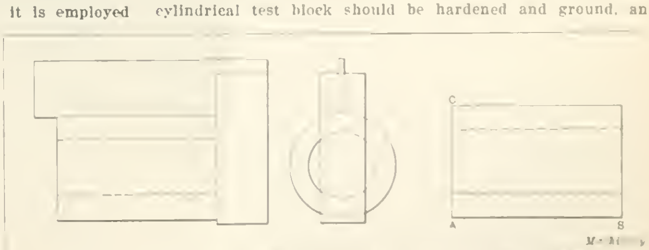


Fig. 2. Testing a Square with a Ground Cylindrical Block

when such a block has been made it can be preserved as a permanent reference gage for this purpose. In grinding, care should be taken to keep the diameter the same at all points; and the end faces of the block should be ground at the same setting. While grinding, the work should be held on a plug arbor. Assuming that the block has been ground in accordance with the preceding instructions, it will readily be seen that *AB* and *AC* form an almost perfect square, which can safely be employed for testing purposes.

Newark, N. J. GUSTAVE A. REMACLE

MICROMETER DIALS FOR AN OLD BORING MILL

For some months I have been operating a ten-foot boring mill which is not provided with graduated dials on the feed-screws, as this is quite an old machine. Machinists who have operated this boring mill in the past have evidently felt the need of graduated dials, for the collar on each of the feed-screws bears evidence of attempts to graduate it with scribers, prick-punches or cold chisels. To set a tool with any degree of precision by such a substitute for accurately graduated dials, certainly requires a man to be a clever guesser.

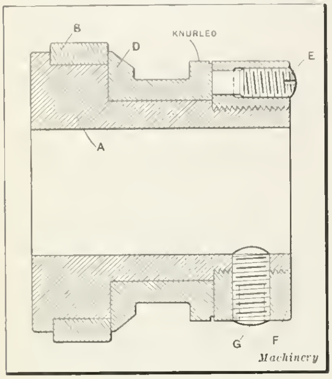


Fig. 1. Dial and its Mountings used on Feed-screws

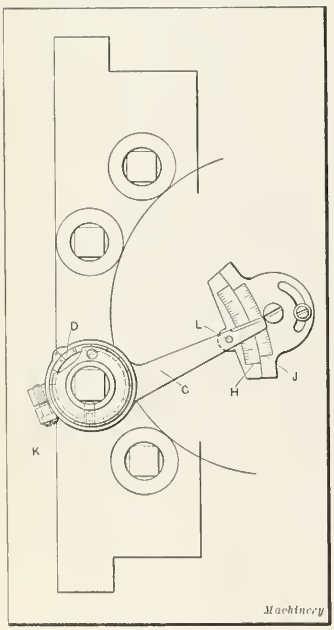


Fig. 2. Assembly View of Auxiliary Feed-screw Dial

With the view of getting something better for this purpose, the device which forms the subject of this article was developed. It consists of two principal parts, one being a dial and its mountings which may be fitted on either of the feed-screws, and the other a plate mounted on the stud which carries the gear that drives the feed-shaft pinions. Fig. 1 shows the cross-sectional view of the part used in connection with the feed-screws, and referring to this illustration it will be seen that the hub *A* carries a split collar *B* on which the pointer *C* that is shown in Fig. 2 is mounted. The dial *D* is divided into sixteen spaces, each of which corresponds to a movement of the tool of 1/32 inch. The dial may be moved around the hub for the purpose of adjusting it to the zero position, and it will be seen that it is locked in position by means of a set-screw *E* which is carried in a collar *F* threaded onto the hub. The hollow set-screw *G* holds the entire mechanism in place on either of the feed-screws on the boring mill.

Reference to Fig. 2 will show that the second part of the mechanism consists of two scales *H* and *J*, one of which indicates the traverse feed and the other the vertical feed of the tool. The traverse feed is 1/2 inch per revolution, and the vertical feed 7/16 inch per revolution of the feed-shaft. Both scales are divided into thirty-one divisions, and both have a range of 1/32 inch, so that each division indicates a movement of 0.001 inch of the tool.

Assuming that the device is to be used for a boring operation, it is set up on the machine as shown in Fig. 2, and the screw *K* is adjusted to locate the pointer *C* in the required position, the screw being left loose enough so that the pointer may be moved by hand. A pin placed in the hole *L* locks the pointer *C* to the scale. The tool is now adjusted to the work by means of the dial *D* and the work is brought to within 1/32 inch or less of the required size. The pin is now removed from the hole *L*, after which the work is finished to size by means of the scale *J*, which is the one used to regulate the traverse feed of the tool. Should more than 1/64 inch of final adjustment be required, it is advisable to move the pointer to the end of the scale *J* before starting the final finishing cut. This device can be easily shifted to any of the feed-screws; and it offers a means of improving the efficiency of the machine by providing an accurate method of showing the amount of traverse and vertical feed, where the usual form of dials cannot be used on the feed-screws.

Butte, Mont. W. WHITLEY

TO PREVENT FOUNTAIN PENS LEAKING

Fountain pens are likely to leak at the joint where they part for filling. While this leak is small, being simply a capillary effect, it is none the less annoying, for no matter how dry the joint is wiped, the fingers are bound to become smeared whenever the pen is used, because they touch at this very joint. To prevent this trouble, use "tanglefoot" such as found on sticky fly paper or painted on trees to keep the insects from climbing. Put a small amount on the threads and joint with the point of a toothpick, screw the joint together and wipe off the surplus. This "tanglefoot" always remains sticky, never dries up and no ink can ever pass by it. One application will last at least a year in continuous use.

Newport News, Va. OSBORN P. LOOMIS

MILLING MACHINE INDICATOR

The accompanying illustration shows a very simple and dependable form of indicator for use on milling machines in cases where it is required to bore a hole at a certain distance from a finished surface, or for locating the table at a given distance from the center of the spindle. The tapered bushing *A* fits in the milling machine spindle and is bored with a tapered hole to receive the spindle *B* on which the ball bearing *C* is mounted. This spindle can be made any required length, or several spindles of different lengths can be made to fit in the same bushing *A*. The diameter of the projection *D* on the spindle is made of such a size that the inner race of the ball bearing can just be pressed onto it by hand, and this part of the spindle should be turned with the indicator in place in the milling machine spindle. For this purpose the turning tool is held in a vise on the table of the machine.

To use the indicator, the finished face on the work is fed against the outer race, and as soon as the work touches, the race will stop rotating. The dial of the feed-screw is then set to zero, the table backed clear of the work, and then moved longitudinally or vertically, as the case may be, through a distance equal to one-half the diameter of the outer race. This brings the center of the spindle exactly in line with the finished face on the work. The dial on the feed-screw is again set to zero, after which the work is

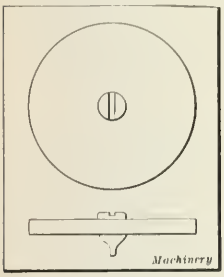
Simple Type of Milling Machine Indicator adapted for Hard Service

moved through the required distance to locate it in the proper relation to the spindle for boring the hole in the work. A steel disk may be used on this type of indicator in place of the ball bearings, but it is not nearly so sensitive.

Denver, Colo. STANLEY EDWARDS

DIE-SETTER'S SCREW-DRIVER

The accompanying illustration shows a convenient form of screw-driver for use in setting up tools in a power press, which is especially useful when it is desired to replace the stripper without taking the cutting die out of the bolster. An ordinary screw-driver could not be used because there would not be enough room under the plunger of the press. In cutting out stock for jewelry, the stripper plate is generally removed and the stock sheared to fit the guide slot in it. In the meantime, the punch and die have been set up in the press, and when the operator receives the stock and stripper plate, the use of this tool enables him to attach the stripper very easily.



Die-setter's Screw-driver

A screw-driver of this form is much easier to handle than the common form of offset screw-driver. The forefinger of the left hand is placed at the top of the disk to apply the necessary pressure and the disk is turned with the thumb and second finger of the right hand. The edge of the disk is knurled so that a good grip may be obtained. I have also made tools of this type with the edge of the disk scalloped, and also with a star shaped handle in place of the disk, but the form of tool shown in the illustration has given the best all-around results. The disk has a square hole in the center and the screw-driver is milled so that it can first be driven into the hole, and then riveted over at the top. In hardening the screw-driver, care must be taken to leave the shank soft enough so that it can be headed over. The foreman of the press department came into the tool-room where the writer is employed, saw this tool lying on the bench, and carried it right out to the press room. After using it, he declared it the handiest screw-driver for the purpose he had ever seen.

Attleboro, Mass. T. E. WARD

FIXTURE FOR GRINDING THREADING TOOL CUTTERS

The grinding of threading tool cutters of the form shown in Fig. 1, which are used in spring or so-called "gooseneck" holders, is often found difficult because the cutter is quite short and hard to hold while grinding. Furthermore, it is difficult to grind the angle true for the entire length of the cutting face, so that when the tool is sharpened it will only need grinding at the top. The fixture shown in Fig 2 was designed for doing this work and has given satisfactory results.

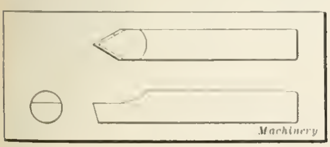


Fig. 1. Type of Threading Tool Cutter to be ground

The baseplate *A* has a ridge planed on it at an angle of 15 degrees, which will give the cutter the proper clearance. Plate *B* is secured onto the ridge on the baseplate, and a Starrett protractor *C* is screwed to the plate *B*. The tool to be ground is carried in a toolpost *D* which is held stationary by the lock-nut *E*. In setting the fixture ready for grinding any required tool, the indicator *F* carried by the toolpost, enables the proper setting on the protractor to be made.

In using this fixture, the tool is first tightened in the toolpost; then the lock-nut is unscrewed and the indicator set to one-half the included angle which is required on the cutter.

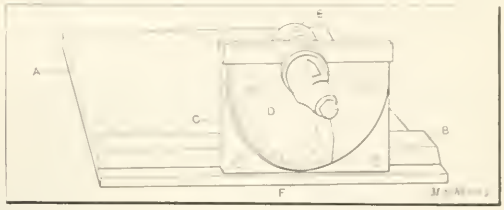


Fig. 2. Fixture for grinding Threading Tool Cutters

The lock-nut is then tightened to secure the tool in place preparatory to grinding. The fixture can be used by passing it under the surface grinder by hand or it may be strapped to the table of the surface grinder and the machine used in the regular way.

Waterbury, Conn. CHARLES GRILLEY

METHOD OF HOLDING LONG DRAWINGS

In the drafting-room where the writer is employed some very long drawings are made, and as the longest available board is only 6 feet in length, the following method is used to hold the portion of the drawing that is not being worked on. A roller and guide are secured to each end of the drawing board by strips, as shown in the accompanying illustration; one end of the paper is pasted onto each roller and it is then wound up tight on one roller. As the work progresses, it will be apparent that the paper is drawn off one roller and wound up on the other one until the entire drawing has been completed.

JAMES B NELSON
Toronto, Ontario, Canada.

Fig 1 Plan View of One End of Drawing Board

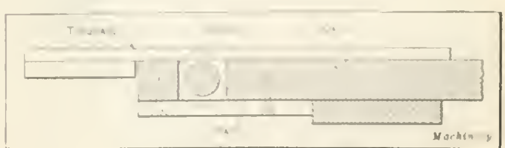


Fig. 2. Cross-sectional View of One End of Drawing Board to a Larger Scale

TWIST DRILL DESIGN

We have read with much interest the editorial entitled "Standard Twist Drill Design" in the August number of MACHINERY. The implication seems to be that the business of manufacturing twist drills has been, until very recently, a "rule-of-thumb" affair in which a certain design has happened to become standard because each new arrival in the field has blindly accepted the traditions of his predecessors. This state of affairs is now somewhat altered, however, by the fact that "a *new* development has recently been made by a twist drill maker in changing the angle of lead of the flute".

We are inclined to think it will be interesting news to the majority of twist drill manufacturers to learn that there has heretofore existed a standard design for such tools other than the separate standards of individual makers. As to the matter of the angle of spiral, let me quote from a little booklet, "Twist Drills—Their Uses and Abuses", first published by the Cleveland Twist Drill Co. some fifteen years ago:

"There are various shapes of flute and angles of spiral on the drills made by different manufacturers, the shapes of flute varying by only a small amount, while the angles of spiral range from 18 to 35 degrees. Theoretically, the finer the pitch of the spiral grooves, or the greater the angle of spiral to the axis, the easier it should be to sever and bend or curl the chip; but there are practical considerations which counteract the advantage of mere ease in severing chips, and it becomes advisable to make this angle somewhat more acute than would otherwise be the case. Among the practical objections to a very fine pitch of spiral may be mentioned the weakness of the cutting edge and its inability to carry off the heat generated. Such a groove also packs up with chips more readily. From a large number of tests we have found that angles of spiral ranging from 25 to 30 degrees give the best results in drills for average work—*i. e.*, where the holes are between one and three diameters deep. For deeper holes than this, a coarser pitch (with less angle to the axis) might be desirable, and for shallower holes, a finer one."

The recognition of the value of various angles of spiral for various purposes is, therefore, not new, and twist drills differing considerably with respect to this angle have been on the market for a number of years. The question is asked: "Is there any assurance based upon practical tests carried out with scientific precision, that twist drills are made of a form most advantageous for the rapid removal of metal?" In our judgment the answer to this question hinges largely on the meaning of the words "scientific precision". We do know, however, of several lengthy tests that were made on a carefully prepared apparatus by expert workmen, to determine the very points in question. (A description of this apparatus appeared in the *American Machinist*, May 30, 1901, and will also be found, together with a review of the tests, in the booklet "Twist Drills—Their Uses and Abuses.") The result was that one manufacturer expended large sums of money (1) to change the angle of spiral on the bulk of his product from within the range between 33 and 35 degrees to within that of 25 to 27½ degrees, and (2) to procure an entirely new equipment of cutters to produce a shape of flute which should, while consuming practically no more power, free itself of chips more readily. We also know that a 1½-inch twist drill has removed 113 cubic inches of metal in one minute.

We quite agree that because a thing has been made a certain way for a long time it does not follow that it is the best way, and we do not believe that one angle of spiral or of point could be found that would be best for all kinds of work. There are too many varying conditions, some of which require the sacrifice of a certain amount of power to accomplish the work at all.

We question, however, if any data sheets which attempted to cover these points would be of much practical value to efficiency engineers, unless the whole experience of a drill maker went with them. The makers of twist drills sell "holes" these days as the criterion of value for their products, and it strikes us that the shortest and most direct road to drilling efficiency is for the man that has a difficult drilling problem to put it up in detail to several of the leading twist drill manufacturers and let them furnish samples that in their judgment are best suited for the work. If these are then run under the conditions recommended by each manufacturer the user can readily select the tools that show the highest productive capacity in the job. In our judgment the twist drill manufacturers would be glad to submit their product to such competitive conditions, and would welcome any improvement in design that might be thus scientifically demonstrated to be such.

E. C. PECK,
Cleveland, Ohio. General Superintendent,
Cleveland Twist Drill Co.

GRADUATING LATHE BEDS

In operating long lathes I have found it a convenience to have graduation marks 1 foot apart stamped in the metal between the ways, with numerals beside them which show the distance from the face of the chuck. This device will enable the operator to locate the tailstock and steadyrest when setting up the machine for long work, without having to use a rule for making measurements. These graduations will not disfigure the machine, and as they are permanent they are always ready for instant use. This has been found a great time saver in handling certain classes of work.

Los Angeles, Cal. JOHN A. WOOD

DRAFTSMAN'S PEN-WIPER

For cleaning my ruling pens, and especially bow pens and compass pens, I find an old tooth-brush much more satisfactory than the time-honored "rag." By drawing the point of the pen across the brush, it is thoroughly cleaned without leaving any lint. This method of cleaning with a brush is much easier than squeezing a piece of cloth between the pen points. The brush lasts longer and looks better. It can be conveniently kept in an instrument tray.

Amite, La. CHARLES F. KOPP

LUBRICANTS FOR DRILLING AND TAPPING

For drilling and tapping nickel steel, linseed oil is one of the best lubricants I have ever used. Where tool steel is being drilled with fine drills, sweet milk is a very efficient lubricant. It is important to note in this connection that sour milk will not give satisfactory results. Using a 0.020-inch drill in tool steel, I have found that the tool lasted ten times as long with sweet milk as a lubricant than it did when any other cutting compound was used.

Dayton, Ohio. O. E. VORIS

CLEANING THREADED HOLES IN HARDENED WORK

There are many toolmakers who use a tap to remove the scale from threaded holes in a die after it has been hardened. I have found that by taking a screw and filing a few flutes in it, I can make a tool that will clean out the threads of a die just as well as a regular tap, and its use avoids damaging an expensive tool.

Long Island City, N. Y. E. KERN

* * *

CORRECTIONS

In the March, 1915, number of MACHINERY, page 558, in the article on "Wire Springs," it is stated that D = outside diameter of spring. This is an error, as D = mean diameter of spring. This correction should be taken account of throughout the article.

In the article "Spacing of Bolts for Wrench Clearance," on page 982 of the August number of MACHINERY, there is an error in Formula (4). This formula should read:

$$D_1 = 1.75d + 0.062 + 0.86d + 0.072 + 0.5d = 3.11d + 0.134.$$

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

GARDNER DISK GRINDER

The No. 50 disk grinder illustrated and described herewith is a recent product of the Gardner Machine Co., Beloit, Wis. The design represents a departure from standard practice in the construction of disk grinding machines, and the present machine is adapted for an unusually wide range of work. The grinder is said to have a high productive capacity and it is a complete unit, each machine being equipped with a dust exhauster, a water system, and a cast-iron hood. The spindle is made of crucible steel and accurately ground to a diameter of 3 inches; it is mounted in S. K. F. radial ball bearings, and the end-thrust is also taken by ball bearings of the same make. The spindle pulley is 12 inches in diameter by 10 inches face width, which provides an abundance of power. It will be noted that the rocker-shaft has a bearing at each end, in which it oscillates when the table is rocked back and forth to move the work over the grinding wheel. This design has resulted in a rigid construction which enables a high degree of accuracy to be obtained in the product.

When the work is forced against the grinding wheel, it will be evident that there is a tendency for the rocker-shaft to move to the right, but this is resisted by a heavy collar just outside the left-hand bearing. A second collar at the right prevents movement of the rocker-shaft in the opposite direction; and this second collar also has a ledge formed on its under side in which there is an elongated curved slot. This slot carries a stop-screw, and by adjusting the collar on the rocker-shaft and locking it with a set-screw, the limits of oscillation of the table may be accurately regulated. The table column and top are heavily constructed, the column being 5 inches in diameter. The column extends into the counterweight at a point directly over the center of the rocker-shaft, and is held in the required position by two locking-screws which pass through the left-hand side of the weight. A graduated clamp collar just above the counterweight on the column can be employed when it may be desired to set the table at an angle with the grinding wheel.

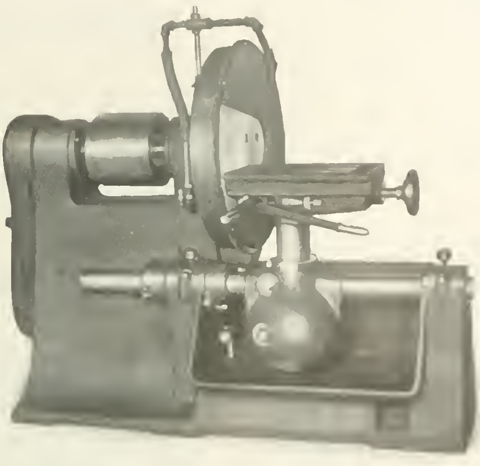


Fig. 1. Front View of Gardner No. 50 Disk Grinder

There are three ½-inch T-slots in the table and the working surface of the table is 18 by 10 inches in size. A channel surrounds the table, which is provided with the necessary pitch to carry the water off into a drainage basin when wet grinding is being done on the machine. The feed mechanism which moves the table toward the grinding wheel is a feature of the design of this machine. Provision is made for employing either lever, screw or spring-actuated feed. When the lever feed is employed, the screw wheel is disengaged by removing a taper pin which fits through its hub, so that the travel may be actuated by a pinion secured to the inner end of the lever shaft, which engages a rack secured to the under side of the table. The second handle mounted on the lever shaft, which projects toward the front, is for the purpose of assisting in rocking the table. The positive screw feed is obtained by replacing the taper pin in the hub of the wheel and turning the handwheel to the right. A spring pressure of from 1 to 300 pounds can be obtained by adjusting the screw handwheel when the latter is disengaged. When the spring feed is used, the hand lever is employed to secure any additional pressure which may be required, and for backing the table away from the grinding wheel. A micrometer stop-screw, shown in the front view of the machine, provides for accurately governing the forward movement of the table.

This machine may be equipped with either a 30-inch steel disk wheel or a 20-inch ring-wheel chuck. The abrasive wheel is used when it is desired to do wet grinding and the disk wheel when dry grinding is to be done. There are two openings at the bottom of the cast-iron hood, one of which is for the water and the other for the dust. When one of these openings is in use, the other is closed by means of a hinged cover. When the machine is used for wet grinding,

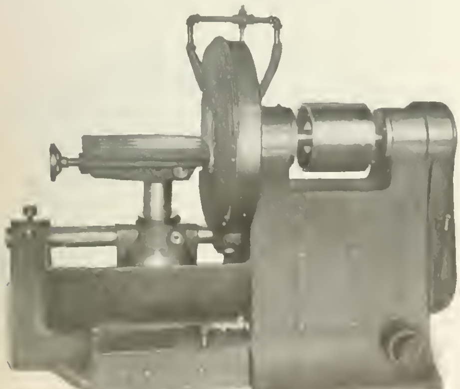


Fig. 2. Opposite Side of Machine shown in Fig. 1

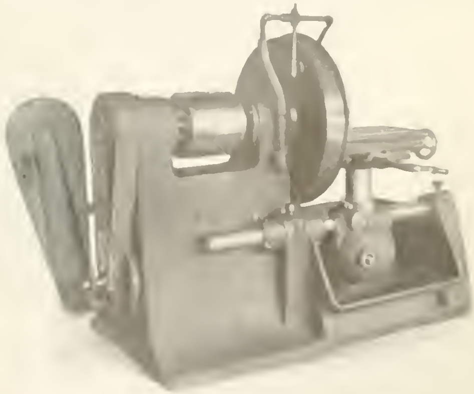


Fig. 3. End View of Grinder showing Drive to Water Pump

the water is carried off into a drainage basin from which it overflows into the removable reservoir which will be seen in the rear view of the machine; and from this reservoir it is pumped back to the grinding wheel. The water pump is of the geared type and is driven from the machine spindle by a sprocket-and-chain drive. The dust exhauster is contained within the base of the machine and is driven by a belt; it is connected with the bottom of the hood and discharges at a point near the base of the machine at the rear, where a thimble is provided for connection to the exhaust pipe. The front of the hood is enclosed with cast-iron sections which can be removed or inserted to make the opening of the required size for the work. The chain and belt which drive the water pump and exhauster, respectively, are enclosed by a cast-iron guard which has a hinged door to give access to the drive.

Fig. 4 shows the machine engaged in surfacing the bottoms of electric sad irons, and this operation reveals some interesting data. The area to be surfaced was approximately 21 square inches and the parts were ground on the Gardner No. 50 disk grinder at the rate of six per minute. In order to obtain comparative data, some of the same irons were ground on a Gardner No. 7 disk grinder of standard design, which is also equipped with a 30-inch disk wheel. On the latter machine it was only possible to finish two irons per minute. When grinding on this machine, there was also a

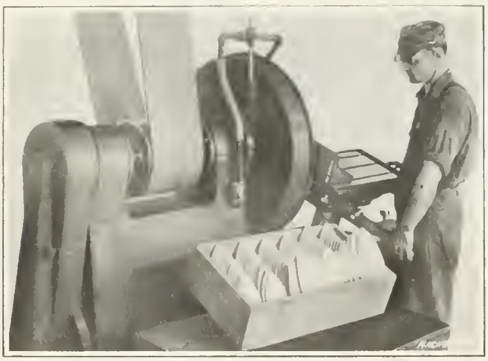


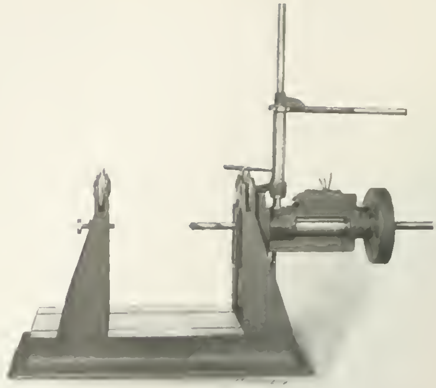
Fig. 4. Facing Electric Sad Irons on Gardner No. 50 Disk Grinder

tendency for the operator to merely grind through the scale on the work, but when the No. 50 machine was used more stock was frequently removed than was actually necessary to clean up the surface, owing to the rapidity with which the machine cut. As regards the relative cutting speeds of the two types of machines, it may be stated that the No. 50 machine will grind away twenty ounces of iron per minute, while the No. 7 machine only removes 4½ ounces of iron per minute.

ROCKFORD COMBINATION DRILLING AND BALANCING MACHINE

The accompanying illustration shows a combination drilling and balancing machine which is a recent product of the Rockford Tool Co., Rockford, Ill. It will be seen that the shaft which carries the part to be balanced is supported by two pairs of hardened disks. These disks are mounted on standards which may be adjusted on the bed of the machine to give various distances between the standards up to thirty inches. The machine is intended for use in balancing pulleys and flywheels ranging from 10 to 18 inches in diameter, and it can be arranged either for individual motor drive or for belt drive.

This machine is very convenient to operate; the disks always remain true and do not require to be leveled up. The provision of the drill on the balancing machine does away with the necessity of removing the work from the standards and taking it to the drill after each test for balance has

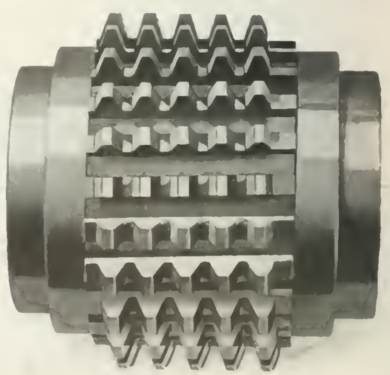


Combination Drilling and Balancing Machine made by the Rockford Tool Co.

been made. As a result, alternate drilling and balancing operations can be readily performed until the work is found to be perfectly balanced. An adjustable stop is provided which prevents the work from sliding up against either of the standards—a condition which would hinder it from revolving freely.

LEES-BRADNER HYPERBOLOID HOB

For years the technical papers have discussed the merits of the hobbing process, pro and con; but much of the criticism of results obtained by the hobbing process has arisen either directly or indirectly from errors in the hob or from poorly designed hobbing machines. The fundamental principle of gearing must be observed in the case of gears produced on hobbing machines. Obviously, the bearing must be concentric with the pitch circle of the gear, and the sides of the teeth must be uniform if satisfactory results are to be obtained, but many writers have shown that the teeth of certain hobbed gears were not uniform, and that the pitch circle was not concentric with the bearing. These defects were due to errors in the hob and hobbing machines, respectively. In practically all cases the flats on the teeth of hobbed gears were caused by inaccuracies in the hob. These inaccuracies were due to the combined effect of theory and practice, *i. e.*, the outline of the hob was theoretically wrong, and it was found practically impossible to harden the hob without distortion The gear hobbing machine must also be designed in such a way that it is powerful and rigid enough to take advantage of the multiple cutting edge of the hob. The Lees-Bradner Co., Cleveland, Ohio, which is a pioneer in the art of hobbing gears, has been making a careful study of this subject for a number of years, as a result of which the "hyperboloid"



Lees-Bradner Hyperboloid Hob

hob shown in accompanying illustration has been developed. The theoretical considerations calling for the use of a hob of this form are that the cutting edges of each series of teeth must enter and depart simultaneously on a theoretical line, which has been designated the "generating plane".

It will be apparent in a hob of the solid cylindrical type, which is fluted at right angles to the lead, that the row of teeth which is generating presents an elliptical outline to the gear being cut. In addition, the helical flute presents a warped surface with one end of the flute stubbed and the other end raked, as far as the generating plane is concerned. This can be readily seen if the fact is grasped that a section taken through a cylinder at right angles to the axis is a circle, that a section taken through a cylinder parallel to the axis is a rectangle, while a section taken through a cylinder at an angle to the axis is an ellipse. As a result, it will be evident that with the hob set at its working angle, an elliptical outline will be presented to the work. Therefore, to obtain a hob that will produce a rectangle under these conditions, it is necessary for the tool to be of hyperboloid outline. The hyperboloid hob developed by the Lees-Bradner Co., which is shown in the accompanying illustration, is made up of a series of high-speed steel racks which are ground for lead, side relief, top relief, and to provide sharp cutting edges. These racks can be renewed as they become worn out, and as the housing is hardened and the bore ground to a plug gage fit it will last indefinitely.

HEALY VALVE TOOLS

For use in reseating motor valves the Healy Tool & Appliance Co., Buffalo, N. Y., is now manufacturing a set of

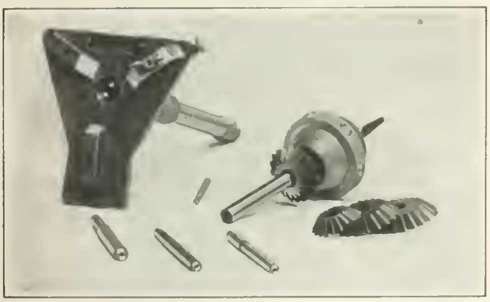


Fig. 1. Set of Healy Valve Tools

tools which is illustrated and described herewith. Fig. 1 shows the tools and Figs. 2 and 3 show the use of a face cutter in the dresser head, and of the seating cutter. The dresser head, shown in Fig. 2, has a tube to receive the valve stem and there is a long adjusting screw to form an end bearing. There is also an inside chuck which has a double-ended bearing, and by means of the adjusting mechanism this chuck is closed and locked onto the valve stem,

Fig. 2. Use of Face Cutter in Dresser Head

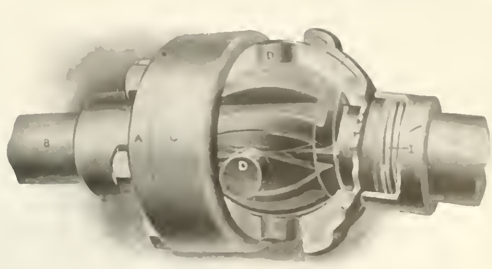
just permitting the stem to rotate with the bit-brace. The dresser head is provided with one guide and two face cutters which are set by micrometer screws, so that a very fine cut may be taken on the head of the valve

The seating cutters, one of which is shown in use in Fig. 3, are made of tool steel and have from 20 to 24 cutting edges, according to size. Means are provided to permit a cutter which is 1/4 inch larger than the valve to enter the port; a cutter the same size as the valve will not take off the shoulder, but a larger cutter will do so. The pilots are made of steel, ground to within 0.001 inch of the standard size and hardened to afford the required durability. The port steadyrest is an important feature of this tool; each end of the rest is made with a running thread on the taper so that the rest will engage a port of any size

Fig. 3. Way in which Seating Cutter is used

COOPER UNIVERSAL JOINT

The Cooper universal joint, which is illustrated and described herewith, provides for securing absolute uniformity between the angular velocity of the driving and driven members at all points of the revolution. The driving member consists of a flange *A* which is carried by the shaft *B*, with provision for locking the flange securely to the shaft. A shell *C*, which is spherically shaped internally, is fastened to flange *A* by means of a dovetailed spline and from two to eight hexagonal headed cap-screws, according to the size of the joints. There are four holes spaced 90 degrees apart in this shell, and four V-shaped trunnions *D* are inserted in these holes. The driven member of the joint consists of four cross-heads *E* which have three flat surfaces at right angles



Cooper Universal Joint which provides a Uniform Angular Velocity between Driving and Driven Members at All Points of the Revolution

to each other, while the remaining surface is spherical. These cross-heads are inserted in the spherical-shaped shell *C* so that they come between the four trunnions *D* and leave a square opening from the shaft. The backs or spherical shaped sides of the cross-heads are grooved at *F* to form recesses for a sufficient volume of lubricant to last for one year. A cover *G* mounted on a squared driven shaft *H* and held against the exterior of the shell by a spring *I* serves to exclude dust and retain the lubricant in the joint.

In operation, the cross-heads *E* oscillate between the trunnions *D* and against the spherical interior of the shell *C* the movement being through a number of degrees corresponding to the included angle between the shafts. Owing to the large flat driving surface, ample lubrication and slight movement of the parts, friction losses are prac-

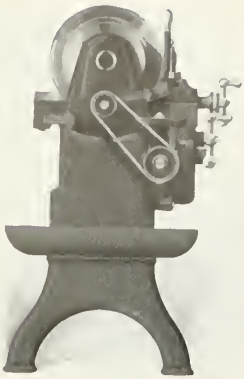


Fig. 1. End View of Rockford Lathe

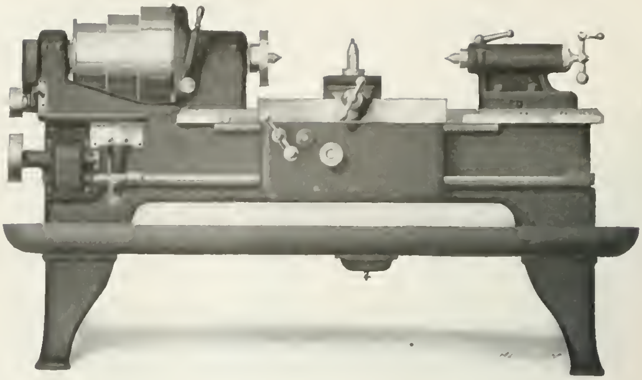


Fig. 2. Rockford 16-inch High-power Manufacturing Lathe

tically negligible. Varying the angle of this joint does not cause the driving or driven member to shorten centers during a revolution, and as a result the angular velocity of the driven member is the same as that of the driving member at all points during each revolution. Consequently, the use of the second compensating joint is unnecessary. All working parts of the joints are made of hardened steel and ground to size so that satisfactory wearing properties are assured. This universal joint is made by the Cooper Flexible Transmission Co., Inc., 8th Ave. and 18th St., Brooklyn, N. Y.

ROCKFORD 16-INCH LATHE

The design of the 16-inch high-power lathe which has been placed on the market by the Rockford Tool Co., Rockford, Ill., has been particularly worked out to meet the requirements of those manufacturers who produce duplicate parts in large quantities. To adapt the machine for heavy work, the headstock is ribbed to provide ample rigidity, and the spindle is made from a crucible steel forging. The spindle bearings are provided with babbitt metal liners which are seated in dovetailed slots; the front bearing is 2¾ inches in diameter by 6¼ inches long. An oiling system supplies lubricant to all the bearings.

The manipulation of a single lever operates a powerful friction clutch and also applies a brake which stops the spindle almost immediately. The bed is of deep section and adequately ribbed; especially wide V-bearings are provided. The tailstock is clamped by two bolts, and to provide for taper turning operations, the tailstock may be set over. The carriage has a wide bearing surface, and the apron is heavy and deep. A heavy plain rest is regularly furnished which has a dovetail slide 7½ inches wide. This slide has tapered gibs which affords a means of compensating for wear. A large dial graduated in thousandths of an inch is mounted on the cross-feed screw. Power longitudinal feed is provided with four quick changes; the cross-feed is operated by hand. A large pan for oil and chips is regularly furnished with this lathe. The drive is from a two-speed friction countershaft which should be arranged to run at from 80 to 225 R. P. M. The countershaft pulley is 14 inches in diameter and carries a belt 4 inches in width.

The principal dimensions of this machine are as follows: Hole through spindle, 1 7/16 inch in diameter; swing over bed, 16½ inches; swing over plain rest, 8¼ inches; maximum distance between centers for a machine with a 6-foot bed, 2 feet 2 inches; length of carriage, 24 inches; width of cross-slide, 7½ inches; and weight of machine with 6-foot bed, 2200 pounds.

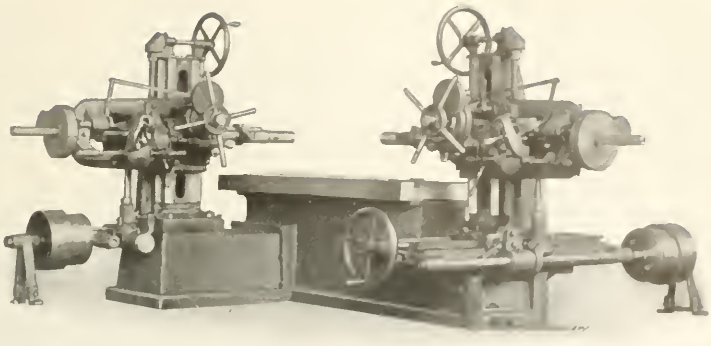
FORD-SMITH SHRAPNEL SHELL GRINDER

The accompanying illustration shows a heavy type of wide-wheel grinder which has been developed by the Ford-Smith Machine Co., Hamilton, Ontario, Canada, for use in grinding shrapnel shells, high-explosive shells, and other types of wide-wheel work which come within its range. The machine is especially adapted for grinding shrapnel shells in a single operation, and is designed along lines which provide for obtaining the maximum output from the best abrasive wheels. It will be obvious that the power requirements of the machine for driving both the wheel-spindle and work-spindle are unusually high, and to provide an abundance of power the wheel-spindle is driven by two 6-inch belts, while the work-spindle is driven by a 4-inch belt and a 1 to 4 geared drive. During the early stages of the development of this machine, trouble was experienced in obtaining suitable formed grinding wheels, but several manufacturers are now producing grinding wheels which cut freely and hold the required shape for a reasonable length of time. It is stated that 65 shells can be ground accurately to gage without truing the wheel, and where the wheel is touched up occasionally with a hard dresser, without the use of a diamond, it is possible to grind 150 shells.

Ford-Smith Heavy Type of Wide-wheel Grinder for finishing Shrapnel Shells

This machine pro-

vides for finishing the outside of the shell at a single operation, and the work is perfectly concentric, symmetrical, and true to shape and size. The machine can be operated by unskilled labor, and the expense of diamonds for truing the wheels has been largely eliminated through the use of a hard dresser for keeping the wheel in condition. In the article entitled "Shrapnel and Shrapnel Manufacture", published in the April number of MACHINERY, a complete description was given of the method of truing the wheel. The equipment of the machine includes a pump, tank, water connections and a formed truing device for the grinding wheel. The principal dimensions of the machine are as follows: Height from floor to center of spindle, 39 inches; diameter of grinding wheel, 20 inches; width of form face of wheel, 8¼ inches; diameter of wheel-spindle bearings, 3⅜ inches; diameter of headstock bearings, 4 inches; length of headstock bearings, 7½ inches; length of bed, 5 feet 6 inches; width of bed, 5 feet; speed of wheel countershaft, 575 R. P. M.; speed of work countershaft, 275 R. P. M.; power required to drive the machine, 25 horsepower; and net weight of machine and countershaft, 7500 pounds.



Rockford Double-head Boring, Drilling and Tapping Machine with Spindles set at Right Angles

ROCKFORD BORING, DRILLING AND TAPPING MACHINE

The double-head horizontal boring, drilling, and tapping machine which is illustrated and described herewith is a recent addition to the line of the Rockford Drilling Machine Co., Rockford, Ill. This machine is built in two different types, one of which has the right- and left-hand heads arranged as shown in the illustration, with the spindles at right angles to each other. The other type of machine is built with the right- and left-hand heads at opposite ends of the bed, so that the spindles are opposed to each other. Both types of machines are made in three different styles, one of which has both heads arranged with a lateral adjustment of 36 inches and a vertical adjustment of 18 inches; another, which has both heads provided with only vertical adjustment; and a third style in which one head is provided with both vertical and lateral adjustment, while the other head has only the vertical adjustment.

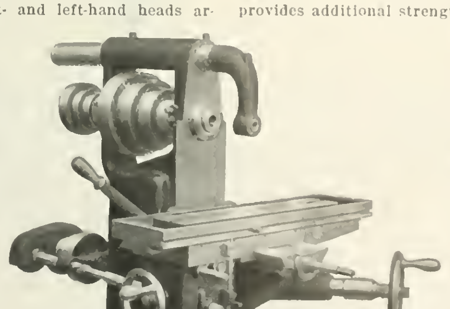
The machines have a capacity for driving high-speed drills up to 3 inches in diameter, and boring tools up to 8 inches in diameter when boring out cored holes in cast iron. The principal dimensions are as follows: Diameter of spindle, 2 1/16 inches; diameter of spindle sleeve, 3¾ inches; maximum spindle travel, 25 inches; hole in spindle, bored No. 5 Morse taper; and size of table, 24 by 72 inches. There are eight changes of feed, any of which is instantly obtainable. There are four different drives. In one style of drive there is a two-, three-, or four-step cone pulley; in the second style, the machine is equipped with a tight and loose pulley and a gear-box which gives eight changes of speed; in the third style, the drive is through a constant-speed motor and gear-box; and the fourth style of drive is from a variable-speed motor.

FOX MILLING MACHINE

In the No. 3½ milling machine made by the Fox Machine Co., 641 Front Ave., N. W., Grand Rapids, Mich., both hand and power feed are provided; the machine is suitable for a variety of light tool work and manufacturing operations which come within its range. Micrometric dials are provided on the screws which govern the vertical and transverse movements. Both the front and rear spindle bearings are of hard bronze which possesses excellent wearing properties, and each bearing is independently adjustable. The thrust is carried on the main column, and as it is transmitted through the driving cone, none of the thrust is carried by either of the bearings.

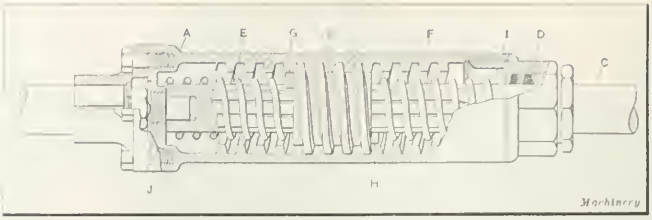
The saddle is made exceptionally long, being designed to afford a maximum rigidity; and the table has been made proportionately heavy so that vibration is reduced to a minimum. The knee bearing is extended so that it comes practically flush with the top of the table, and this extended bearing, in addition to having a tendency to reduce vibration, provides additional strength for the knee. The knee is raised and lowered by a telescopic screw which does not require a hole to be cut in the floor. A locking screw is provided on the dial which enables it to be loosened so that it can be set back to zero, after which the screw is retightened and the table raised or lowered, as may be required. The design of the feed mechanism has been carefully worked out to combine the features of simplicity and durability. The regular equipment furnished with the machine consists of an overhanging arm, a plain countershaft and a suitable equipment of cranks, wrenches, levers, etc. Either a ⅞- or 1-inch arbor is provided with the machine.

The principal dimensions of this No. 3½ milling machine are as follows: Automatic longitudinal movement in either direction, 18 inches; transverse movement, 6 inches; vertical movement, 16 inches; maximum distance from table to spindle, 15½ inches; size of working surface on table, 6 by 20 inches; and taper hole in spindle,



Fox No. 3½ Milling Machine with Hand and Power Feed

No. 9 Brown & Sharpe. The machine is provided with six available feeds of 0.003, 0.005, 0.006, 0.007, 0.010, and 0.014 inch per revolution of the spindle, and the available spindle speeds range from 21 to 425 revolutions per minute. The net weight of the machine, including countershaft and other equipment regularly provided, is 855 pounds.



Cooper Shock Absorbing Shaft for Use in Automobile Transmissions, Hoisting Machinery, Spinning Frames, etc.

COOPER SHOCK ABSORBING SHAFT

The shock absorbing shaft which forms the subject of this article has been developed by the Cooper Flexible Transmission Co., Inc., 8th Ave. and 18th St., Brooklyn, N. Y., for the purpose of supplying a simple mechanism which is applicable for use in connection with all forms of power transmission systems where a gradual application of power is desirable. The construction of this device and the principle on which it operates will be readily apparent by referring to the accompanying illustration. For convenience of explanation it will be assumed that the case *A* is the driving member. This case is threaded internally to receive a worm *B* that is carried by the splined shaft *C* which extends through the stuffing-box *D* at the end of the case. Two springs *E* and *F* are mounted on each side of the worm, one end of each spring being engaged by the projections *G* and *H* on the worm, and the opposite ends by the projections *I* and *J* on the stuffing-box and at the bottom of the case, respectively. The case is filled with oil and an adjustable by-pass is provided through the worm. When the case or driving member *A* is rotated, it will be found that the worm *B* moves toward the solid end of the case. This results in the displacement of the oil, which escapes through the by-pass to the opposite side of the worm, and at the same time the spring *E* is wound up.

During the initial part of the movement, the driven shaft *C* remains stationary and continues to do so until the combined pressure of the worm on the oil and the tension of spring *E* exactly balance the torque which is required to start shaft *C* rotating. After starting the rotation, the speed of the driven shaft will be gradually accelerated until it reaches its normal speed. As soon as shaft *C* has reached its maximum speed—which is slightly in excess of the normal speed—a reaction takes place and the starting torque is reduced to the normal running torque. This allows the worm *B* to move slightly toward the right-hand end of the case, thus reducing the pressure on the oil and the tension of spring *E* sufficiently to reduce the torque and running speed to the normal condition. The absence of sudden strains in starting reduces the amount of wear and tear on all parts of the transmission system. This device is primarily intended for use on automobiles, and in such cases it is built right into the transmission. It is also suitable for drives that transmit power to many types of machines, and wherever it is used it will be the means of eliminating vibration and wear due to the sudden application of the drive.

VICTOR SHRAPNEL SHELL TAP

For use in machining shrapnel shells to receive the timing fuse, the Victor Tool Co., Waynesboro, Pa., has developed a collapsible tap which is shown in the accompanying illustrations. The body of this tool is made of a tough grade of machine steel which gives plenty of strength to enable it to stand up under the conditions of rapid production which are usually maintained in factories working on ammunition orders. The chasers are adjusted by the hardened set-screw *A* at the front end, which has 32 threads per inch, so that very fine adjustments may be made. After the chasers have been set to size, they are rigidly clamped in such a way that there is no chance of their slipping. The screw *B* at the rear end of the holder adjusts the tension of the spring which controls the tripping device.

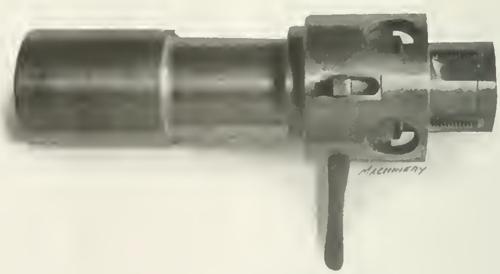


Fig. 1. Victor Collapsible Tap used in machining Shrapnel Shells

All parts of the tap which are subject to wear are hardened and ground. The chasers are of high-speed steel and are made exceptionally heavy to stand up under the strains which exist in cutting shrapnel or high-explosive shells made of crucible steel. This tap may be used in either a turret head or in the lathe spindle, and gives equally satisfactory results in either type of machine. In operation, the tap is fed in until the collar is engaged by the work. This releases the tripping device and allows the spring to draw back the central plug *C*. The result is that the chasers are moved in toward the axis of the holder so that the tap may be withdrawn from the work. The tool is reset by moving the lever *D* forward to the position shown in Fig. 2, which expands the tap and locks the chasers in place ready for taking the next cut.

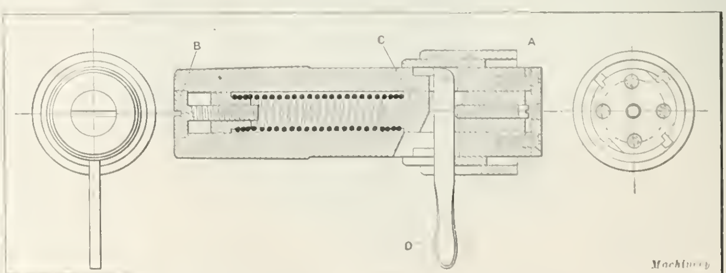


Fig. 2. Cross-sectional View of Victor Collapsible Tap shown in Fig. 1

DYNAMIC BALANCING MACHINE

In order to bring a body into dynamic balance, the following principles must be observed: First, a body cannot be in dynamic balance unless it is also in static balance, and the first step is to secure a condition of static balance. This simply means that the center of gravity of the body must be made to lie on the axis of rotation. Second, a body which is statically balanced can be brought into

dynamic balance by introducing a so-called "centrifugal couple", *i. e.*, by adding two weights or drilling two holes in the plane in which the disturbing centrifugal couple is acting. In special cases, such as a three-throw crankshaft, it may be necessary to split up one of the weights or holes between two adjoining cranks so that the resultant added weight or drilled hole will be in the same plane with the other weight or hole and the axis of rotation of the body. These principles have been applied by the Dynamic Balancing Machine Co., Philadelphia, Pa., in the development of the machine which forms the subject of this article.

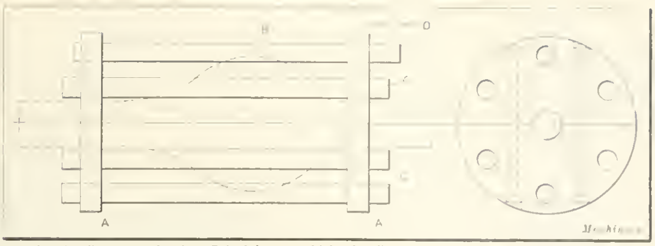


Fig. 1. Diagram showing Principle on which the Dynamic Balancing Machine operates

In this machine the balancing device consists of a so-called "squirrel-cage" system made up of two or more disks *A* which are made in halves and fitted over the unbalanced body *B*, that is indicated by the dotted lines in Fig. 1. To explain the action of the device, imagine an even number of rods *C* to be located at the same radial distance from the axis of rotation, all of the rods being of the same weight and size. Under these conditions the cage is perfectly balanced so that any lack of balance can only be due to the body *B* which is under test. It will be evident that if means are provided to bring about a condition of perfect dynamic balance by moving one of the rods *C* through some distance *D*, it would enable us to know the exact value of the necessary centrifugal couple which must be introduced by drilling or adding weights in order to secure a perfect condition of dynamic balance in the body *B*. Knowing the weight of each rod, its radial distance from the axis, and the necessary displacement *D* that is required to bring the system into a condition of dynamic balance, all of the necessary data is available. The product of these three quantities is the required centrifugal couple, and any oppositely applied centrifugal couple of the same numerical value will place the system in a condition of dynamic balance, *i. e.*, it will then run true when all the rods *C* are kept central.

In drilling the holes in the body or adding weights to bring it into a condition of dynamic balance, there is only one condition to be considered; i. e., that the resultant centrifugal couple which is introduced must be numerically equal to the value determined by moving one of the rods *C*. There are three elements to be considered: The change of weight to be brought about by drilling or adding material; the distance from the axis at which metal is added or removed, and the longitudinal distance of this point from the corresponding point at the opposite side of the body. These conditions can be made to suit the practical requirements of each case, so that there are a great variety of solutions for any given problem. It will be seen that the relative longitudinal position of the rods *C* in the cage does not alter the static balance of the system, and that the displacement of the rods not only locates the plane of unbalance, but also the exact numerical value of the correction which must be made. With a cage comprising six rods, the body can be balanced in only three planes located 120 degrees apart; and with a greater number of rods the body can be balanced in a correspondingly greater number of planes. In practice, it is so easy to fix the cage around the body in some other position than that in which the test has already been made, that the number of rods can be kept down to three or four.

Fig. 2 shows the method of procedure in testing a crankshaft and flywheel for a six-cylinder motor. In this illustration, the cage is clearly shown at the center of the shaft. Means of moving the rods *C* to and fro while the system is revolving are provided by means of compressed air nozzles supplied from pipe *E* which deliver the air against the small fans *F*, one of which is located on each rod. There are three pairs of fans located in corresponding positions on opposite rods, and independent valves *G* control the air delivered from the respective nozzles to each pair of fans. The holes in the disks *A* are tapped to receive the threaded ends of the rods *C*. Lack of space makes it impossible to refer to all of the refinements which are provided. This machine is suitable for use in balancing a great variety of parts, such as turbo-rotors, armatures, pulleys, propellers, crankshafts, etc.

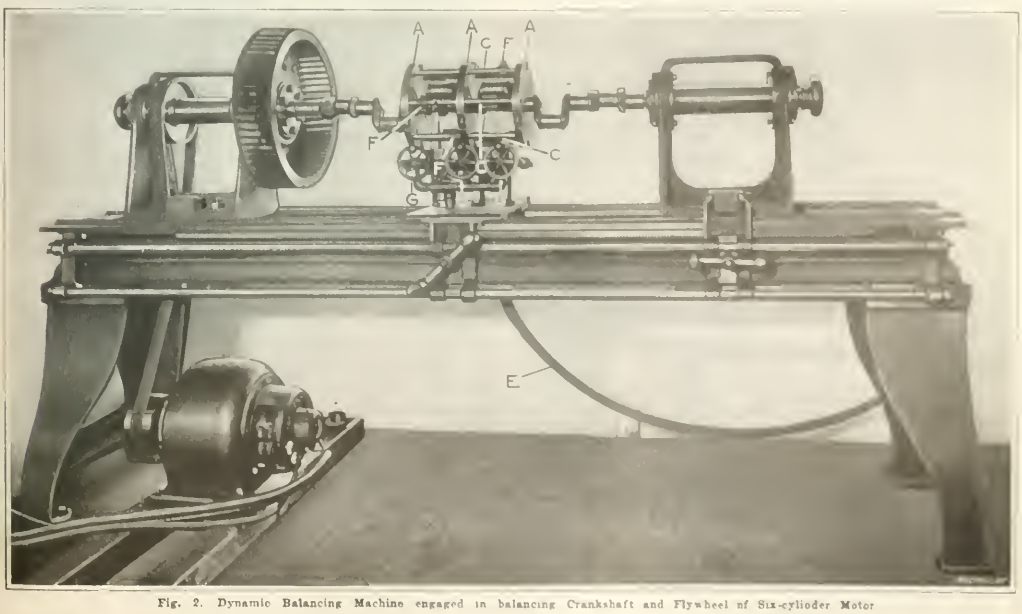


Fig. 2. Dynamic Balancing Machine engaged in balancing Crankshaft and Flywheel of Six-cylinder Motor

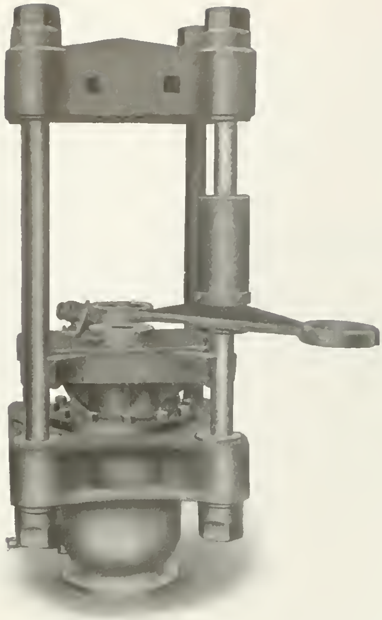


Fig. 1. Shrapnel Shell Nosing Press made by the Hydraulic Press Mfg. Co.

HYDRAULIC NOSING AND BANDING PRESSES

For finishing steel shells after they have been forged and drawn into shape, two pressing operations are required, *i. e.*, the shells must be subjected to a "nosing" operation in which the end of the shell is partially closed in, and then the copper band must be shrunk around the shells. The Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio, is now building two hydraulic presses for performing these operations. The nosing process is illustrated in Fig. 1; and Fig. 2 shows the press for shrinking the copper band onto the shells.

Reference to Fig. 1 will show that the nosing press is of the upward pressure type. After the shells have been formed from the solid billets, drawn into shape and partially machined, the ends of the shells are heated and the shell is placed in a centering die on the platen of the press. A die having a conical shape to correspond with the nose of the finished shell is attached to the head of the press. As the ram rises, the shell is forced into this die and the edges are turned in to form the nose or point of the shell. A revolving loading attachment is carried on one of the strain-rods, and as a

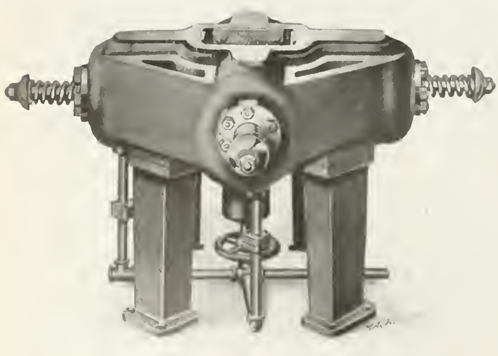


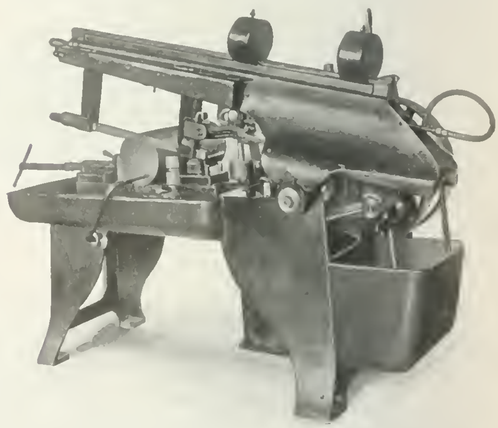
Fig. 2. Shrapnel Shell Banding Press made by the Hydraulic Press Mfg. Co.

result, the operator can be setting up a shell in the outer end of the loading attachment while the press is working on another shell. This press is capable of exerting a maximum pressure of 150 tons; and to enable it to stand up under this severe strain, steel is used throughout the construction. The press is operated either direct from an individual pump or from an accumulator system.

After the nosing operation has been completed it is still necessary to shrink the copper band onto the shell, and for this operation the Hydraulic Press Mfg. Co. has developed the four-cylinder horizontal hydraulic press shown in Fig. 2. It will be seen that the rams from four cylinders operate in the direction of a common center, which results in compressing the band from four sides. In order to secure the band properly at all points, the shell is turned two or three times during the pressing operation. From 20 to 75 tons pressure is necessary for performing this work. During the pressing operation, the shell is supported in the center of the press by a detachable table or stand. This press will develop a pressure up to 75 tons.

MASSACHUSETTS HIGH-SPEED HACKSAW

The No. 5 high-speed hacksaw machine which is illustrated and described herewith is a recent product of the Massachusetts Saw Works, Springfield, Mass. The machine is particularly designed for the rapid cutting of all metals in sizes up to 9 by 9 inches and is heavily constructed with all intricate mechanism eliminated, so that the necessary strength and durability are provided. The machine is set low on a solid foundation with wide-spread legs to give the maximum rigidity and steadiness. The bed of the machine is surrounded by



No. 5. High-speed Hacksaw made by the Massachusetts Saw Works

a pan which is provided with a 9-gallon tank covered by a screen to exclude chips. The tank, pan, bed and legs are cast in a single piece. The head of the machine, which carries all working parts, swings on a shaft-center, and the design has been worked out in such a way that a very steady silent motion is obtained. Particular attention has been paid to the provision of means for lubricating all working parts.

The manufacturers of this machine state that the trials to which it has been subjected have shown that the tendency to break the saw blades before they are worn out is practically eliminated. This is largely due to the smoothness and accuracy of the stroke, resulting from the extreme rigidity of the machine, which is an important factor in assisting the shock-absorber to take up vibration. Means are provided for lifting the saw clear of the work on the idle or non-cutting stroke. The principal dimensions of the machine are as follows: Capacity for cutting stock up to 9 inches square; size of blades used, from 12 to 17 inches in length; size of pulleys, 16 inches in diameter by 3 inches face width; floor space occupied, 5 feet 3 inches by 2 feet 8 inches; and weight of machine 845 pounds.

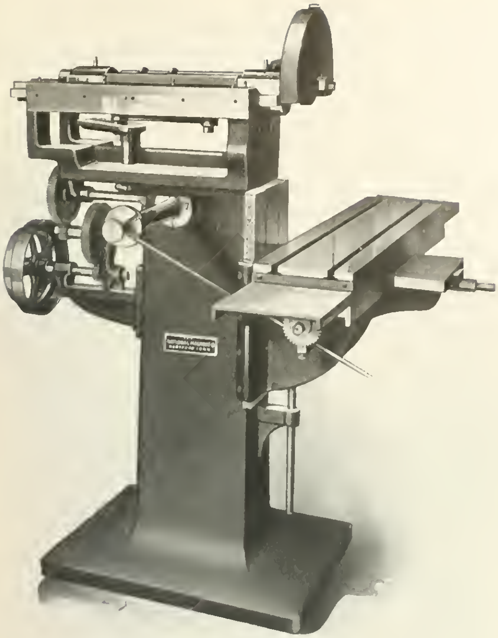


Fig. 1. "Hartford" Surface Grinder provided with Automatic Feed in Either Direction

"HARTFORD" SURFACE GRINDER

The accompanying illustration shows the "Hartford" surface grinder which is manufactured by the National Machine Co., Hartford, Conn. This machine is suitable for grinding and finishing flat surfaces on punches, dies and hardened machined parts where the finished surfaces are required to be flat and true. The machine is said to have a high productive capacity and to produce very accurate work. Reference to Fig. 1 will show that the wheel-spindle is carried by a horizontal slide, with provision for giving the wheel a reciprocating travel across the face of the work. The arrangement of the drive for transmitting power to the crank, which actuates the movement of the wheel-slide, will be evident from the illustration. It will also be noticed that the work table provides for movement in three directions. The wheel cuts easily and wears evenly.

By moving the crankpin in the slotted crank on the under side of the wheel-slide, the length of stroke of the wheel may be quickly adjusted. The wheel-spindle runs in phosphor-bronze bearings mounted in the slide, and there are guards over the ways to prevent them from being damaged by dust and grit. The work may be held to the table by means of adjustable clamps; and in some cases, it is found desirable to use a regular milling machine vise or a special work-holding fixture. The machine is made in two sizes which will grind work to 8 inches wide by 18 inches long by 12 inches high, and 14 inches wide by 32 inches long by 12 inches high, respectively. In both cases, the height of 12 inches is based upon the use of an 8-inch wheel. The countershaft which drives the machine is equipped with tight and loose pulleys 6 inches in diameter by 3½ inches face width, and should run at 350 revolutions per minute. The net weight of the No. 1 machine is 900 pounds, and the No. 2 machine has a net weight of 1200 pounds. These grinding machines are used extensively for sharpening powder cutter knives, and when used for this purpose, they are equipped with the special attachment shown in Fig. 2.

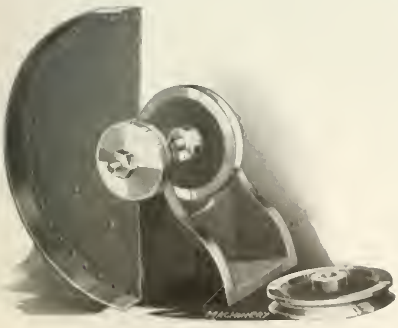


Fig. 2. Attachment for "Hartford" Surface Grinder for sharpening Powder Cutter Knives

KEYES-DAVIS SCRAP REEL

The Davis automatic scrap reel, for winding up the scrap from punch presses so that it may be conveniently handled, is manufactured by the Keyes-Davis Co., Inc., Battle Creek, Mich. These reels reduce the amount of labor required to operate punch presses, and where they are employed one operator can attend to several presses equipped with automatic feeds. The machines are kept running continuously on blanking operations, and the punches and dies are safeguarded by a device which stops the press instantly in case the strip of scrap metal is broken, so that the press tools cannot be damaged by the scrap piling up between the punch and die. On blanking operations where ribbon stock is used, all the operator has to do is to put the coil of material on the stock reel at the left-hand side of the press, run it through the automatic feed rolls and attach the opposite end to the reel at the right-hand side of the press. When the feed rolls release the end of the strip, the reel speeds up and the press is instantly stopped.

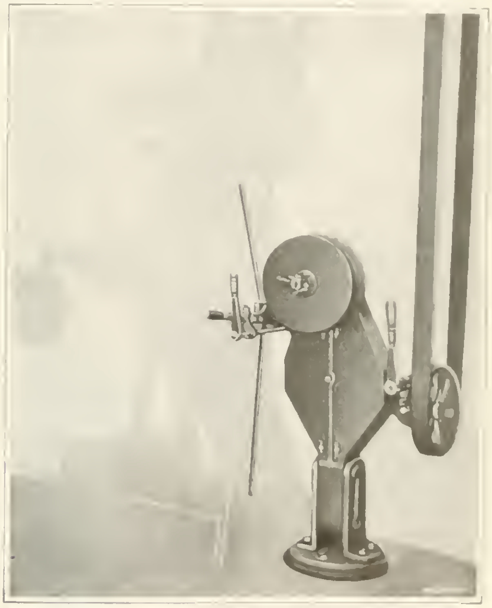


Fig. 1. Keyes-Davis Scrap Reel set up on a Punch Press

It takes only 1½ to 2 minutes to remove the scrap and put on another reel, and as a result one operator can attend to a number of presses, depending on the length of the stock and the rapidity with which it is run through the dies. Under average working conditions, the operator can look after from five to eight presses, so that the labor cost is very low. Fig. 1 shows a Davis automatic scrap reel attached to a power press, and the way in which the mechanism oper-

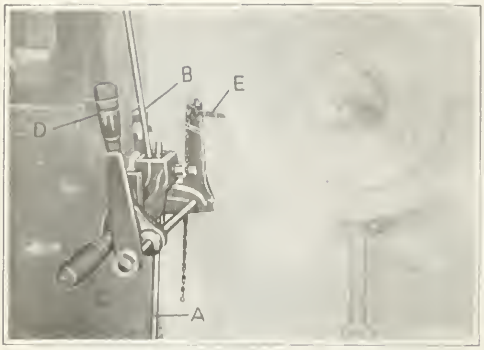


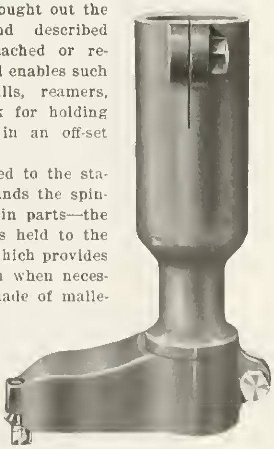
Fig. 2. Details of Operating Mechanism

ates will be readily understood by reference to Fig. 2 in connection with the following description:

In this illustration the clutch-operating rod which makes connection with the foot-treadle is shown at *A;* the bracket bolted to the side of the press at *B;* the starting lever at *C;* stopping lever at *D;* and the stopping lever operated by a chain from the clutch on the reel at *E.* In case the strip of scrap breaks, lever *E* operates to stop the feed. This scrap reel may be readily attached to any type of power press and it is capable of handling scrap up to 3½ inches in width. The starting lever *C* supplements the foot-treadle and makes it possible to start the press either by hand or foot. The press can be instantly stopped by means of lever *D.* This scrap reel is adjustable both vertically and horizontally, and it can be tilted to any angle to which an inclinable press may be set. The spring by which the reel is operated must be kept wound up by the belt shown in Fig. 1, the clutch connecting the pulley with the winding mechanism being controlled by a lever shown at the right-hand side of the reel.

OFF-SET DRILL PRESS ATTACHMENT

To provide for performing various operations with a drill press in a position that could not be reached by a tool mounted directly in the spindle, the Off-Set Tool Co., Bridgeport, Conn., has recently brought out the attachment illustrated and described herewith. It is easily attached or removed from the machine and enables such tools as counterbores, drills, reamers, milling cutters, or a chuck for holding various tools, to be used in an off-set position in the drill press.



Drill Press Attachment made by the Off-Set Tool Co.

The attachment is fastened to the stationary sleeve which surrounds the spindle and consists of two main parts—the body and arm. The arm is held to the body by a clamping screw which provides for the use of a longer arm when necessary. The attachment is made of malleable iron, with hardened steel gears and bronze bushings. It is made in three sizes. These are designated as the A-1, A-2 and A-3 sizes, and have minimum arm lengths of 2, 3, and 4 inches, respectively. The cutting tool is held by a slot and set-screw, and is centered by the shaft which passes through the bevel pinion. This tool saves considerable time when the work is of such a character that it can not be reached by a tool mounted in the usual way.

* * *

The yearly index to the twenty-first volume of MACHINERY, completed with the August number, is ready for distribution, and copies will be sent to any address on receipt of request.

NEW MACHINERY AND TOOLS NOTES

Engine Lathe: Putnam Machine Co., Fitchburg, Mass. A 42-inch lathe intended for use on exceptionally heavy reduction work and especially for the machining of heavy forgings. The machine is of unusually heavy construction, and it is claimed that it will work high-speed steel cutting tools to the limit of their capacity.

Dust Collector: Whiting Foundry Equipment Co., Harvey, Ill. This device is used for collecting the dust from tumbling mills, emery wheels, sand-blast equipments, etc. Cloth-screen dust arresters are employed inside of a sheet metal case, which are relied upon to remove the dust from the air and still allow the air to pass through freely.

Self-Adjusting Wrench: Hayward Wrench Co., St. Louis, Mo. A self-adjusting pipe wrench in which the movable jaw is operated by a link mechanism which gives an almost parallel motion. The wrench may be adjusted so rapidly that it is said to constitute almost the equivalent of a ratchet. It is suitable for use on bolts, nuts and pipe.

Cutting-off Machine: Williams Tool Co., Erie, Pa. A special cutting-off machine designed for facing the bottom or closed end and cutting off the ragged end of 4½-inch shrapnel shells. The machine is of rugged construction, to enable it to stand up under the severe conditions of rapid production for which it is intended. The weight is 3800 pounds.

Shell Turning Lathe: Amalgamated Machinery Corporation, Chicago, Ill. On this machine both the headstock and the tailstock are cast integral with the bed; and the bed is heavily ribbed to provide ample strength. This is essentially a single-purpose machine. It occupies a floor space of 6 feet 2 inches by 10 feet, and weighs 4200 pounds.

Horizontal Keyseater: Chattanooga Machinery Co., Chattanooga, Tenn. A machine designed for keyseating holes of unusual length, and especially for cutting the keyseats in long rolls. The machine consists of three essential parts, i. e., a jig for holding and centering the work, a bar and cutting tool, and mechanical means for reciprocating the bar.

Elevating Truck: Columbus Lift Truck Co., Columbus, Ohio. In this truck the elevating of the freight platform from the floor is accomplished by means of four levers, two of which are located at each end of the truck. Each lever is pivoted to the truck frame, and the ends of the levers are raised by cams which are rotated by operating the lever at the front of the truck.

Hose Coupling: National Hose Coupling Co., Peoples Gas Bldg., Chicago, Ill. This coupling is adapted for use on hose lines carrying compressed air, steam or water, and may be attached without the use of clamps, straps or special fastening tools. The sockets are made of malleable iron, and all other parts of steel, so that a high degree of strength and durability is assured.

Multiple Punching Machine: Bertsch & Co., Cambridge City, Ind. The special features of this machine consist of the use of a cored section frame, and of the employment of a special type of coupling for the gagged punches. The head of the machine contains twenty punching units, each of which is provided with a gag, so that any number of punches from one to twenty can be used at a time.

Screw Press: Charles Stecher Co., Chicago, Ill. A press designed especially for testing all kinds of cutting, stamping, embossing and forming dies. The slide is fitted with a regular press cap instead of a set-screw, and has long guides and liberal bearing surfaces. The press will hold tools with shanks up to 3 inches in diameter. As its name implies, the slide of this press is operated by a screw.

Friction Clutch Pulley: L. W. Carroll Mfg. Co., Batavia, Ohio. This clutch pulley is of simple and compact construction, and is equipped with a friction disk of large diameter, which affords a firm grip when the clutch is engaged. The sleeve which carries the friction disk is threaded on the end to receive the clutch dog and fingers, thus providing means for making accurate adjustments.

Shrapnel Shell Spraying Machine: Spray Engineering Co., Boston, Mass. A machine developed for use in spraying the inside of shrapnel shells or any other work where the surface on which the protective coating is to be applied is relatively inaccessible. The shells are sprayed with asphaltum paint or other non-corrosive material, and the machine applies a uniform coating to the shell without wasting any of the paint.

Cutting-off Machine: Brightman Mfg. Co., Columbus, Ohio. A special type of machine developed for use in cutting off all sizes of round vanadium and special alloy steel bars and shafting. Means are provided for backing out the tools by power after the cut has been completed; and the machine is capable of cutting short pieces from both ends of a long bar, or of cutting the work up into disks. This cutting-off machine weighs approximately 11,000 pounds.

Surface Gage: W. D. Forbes, New London, Conn. A surface gage of simple construction which can be made to sell

at a low price. Rapid vertical adjustment is obtained by sliding the supporting arm on the column, and a thumb-screw permits the arm to be shifted to any desired position. A coarse vertical adjustment may be obtained by tilting the supporting arm, and micrometer adjustment of the needle is secured by operating a knurled thumb-nut.

Cylindrical Grinder: Queen City Machine Tool Co., Cincinnati, Ohio. The design of this grinder follows lines similar to those of the machine which this company has been manufacturing. The chief point of difference lies in the fact that many parts are made heavier. The present machine was primarily designed for performing grinding operations on explosive shells, and it is also adapted for any plain cylindrical, taper or formed grinding which comes within its capacity.

Drilling Machine: Charles Stecher Co., Chicago, Ill. A high-speed bench drilling machine, which can either be provided with a bench or set up on the work bench, according to the requirements of individual users. The head of the drill is stationary, but provided with means of compensation for wear in the spindle sleeve. The spindle is counterbalanced and provided with a drift hole of the usual form; it is bored No. 1 Morse taper and runs in bronze bushed bearings.

Belt Shifter: Dearborn Steel & Iron Co., Chicago, Ill. A belt shifter which eliminates the use of a pole when changing the belt from one step of the cone pulley to any other desired position. This shifter can be readily attached to a machine, and provides for shifting the belt by means of two convenient handles. The provision which is made for shifting the belt by a purely mechanical means, does away with the danger of accidents which sometimes occur in the shifting of belts with a pole.

Portable Electric Drill: Standard Electric Tool Co., Cincinnati, Ohio. A portable drill in which the motor is suspended from a trolley track, making it easy to move the tool from one piece of work to another. The motor is for use in connection with 110-volt direct current, but special motors may be furnished for connection with any voltage up to 250. Ball bearings are employed throughout the machine, and these bearings are packed with grease and carried in dust-proof chambers.

Boring and Threading Tools: Rigid Tool Holder Co., 149 Carroll St., S. E., Washington, D. C. This concern is manufacturing three types of tool-holders and a boring-bar, which have been designed with the view of securing maximum rigidity. The boring-bar is held in a yoke which can be raised or lowered in order to bring the point of the cutter into any desired position. Of the three tool-holders, one is of the adjustable type, one is a single reversible holder, and one is a "gooseneck" holder for threading tools.

Spur Gear Planing Machine: George A. Schipper, Aurora, Ind. One of the noteworthy features of the design of this machine is that a roughing and a finishing cutter are carried in the same slide in such a way that the tools work alternately. The cutters are formed so that they may be ground all over after hardening. The work spindle is mounted in such a way that the maximum rigidity is obtained; and there is said to be no tendency for the tool-slide to chatter when the machine is working at high speed. This machine is particularly adapted for manufacturing, and is said to possess a high capacity for producing accurately finished spur gears.

Thread Milling Machine: A. R. Williams Machinery Co., Ltd., 64-66 Front St., W., Toronto, Canada. This machine is built by the Holden-Morgan Co., Ltd., of Toronto; and the A. R. Williams Machinery Co. has the sales agency. The machine is designed for threading high explosive shells, and will produce a perfect thread in the base of a shell in approximately 2½ minutes. One machine is required for recessing and threading the base of the shell and one machine for threading the nose of the shell. The shell is placed inside of a revolving spindle, where it is automatically centered; and the machine is fitted with an automatic stop which comes into action when the thread has been completed. The cutter used on this machine is of such a shape that it can be sharpened without changing the form; the cutter is designed to mill the top of the thread as well as the sides. One operator can run several machines, and it is claimed that their operation is so reliable that all risk of having shells rejected on account of stripped threads is overcome.

* * *

The cost of a moderate sized heat-treating department, including a coal fired furnace, five to seven barrels of hardening oil, one barrel of drawing oil, tanks for holding the oil, and a pyrometer, varies from $500 to $600. This equipment is sufficient for ordinary hardening. When casehardening is required, casehardening boxes and carbonizing compound must be added to the equipment mentioned, and a second furnace is desirable. Hence, the equipment for casehardening costs more than that required for regular hardening.

CAMERA FOR READING METERS

To provide a reliable method of reading gas, electric, and water meters, in which the possibility of error is eliminated and a permanent record is available in case of dispute, the Eastman Kodak Co., Rochester, N. Y., has developed a special camera which is known as the "factograf". Another application is in reading the "peak" on demand meters before they are reset for the next month, where the application of the camera is particularly valuable in that it records with photographic accuracy. The meter-reader can not only work more accurately with a "factograf" camera than he could by

Fig. 1. Eastman "Factograf" for Use in recording Readings of Meters

the old method, but he can also work more rapidly; and when his record is turned in at the office there can be no doubt as to its reliability. The reading of a meter is taken by placing the front of the camera against the meter dial and pressing down on the exposure lever. This automatically turns on the light, opens and closes the shutter, and turns off the light. After each exposure, the shutter is automatically locked and remains locked until the film for the next exposure has been wound into place. The shutter is then automatically returned to the "set" position. In this way, the possibility of a double exposure is eliminated; and there can be no blanks, because the film cannot be wound off until the exposure has been made. These results are obtained by having the winding reel and shutter interlocked.

The camera is shown in Fig. 1, which gives a good idea of its general appearance. It measures 4¼ by 5¾ by 12¼ inches and is made from a selected grade of mahogany which is specially treated to withstand the action of moisture. The camera is equipped with an anastigmat lens working at F 6.3 and a simple automatic shutter. Exposures can be made varying from 1/5 to ½ second, according to the light conditions. The necessary light for the exposure is furnished from two four-cell dry batteries which are stored at each side of the camera and supply current to four 3.8-volt miniature tungsten lamps. The exposure is recorded upon a special sensitive emulsion on a paper support, the size of the picture being 1½ by 2¼ inches. The film is supplied in the familiar cartridge form and the camera may be loaded in daylight. Storage space for two extra rolls of films is provided in the dark chamber of the camera so that the capacity is for 225 readings. There is a small drawer in front of the camera carrying six extra lamps, and the camera is equipped with a reinforced handle by which it is carried; by pressing a small button located below the exposure lever, the lights may be turned on to convert the camera

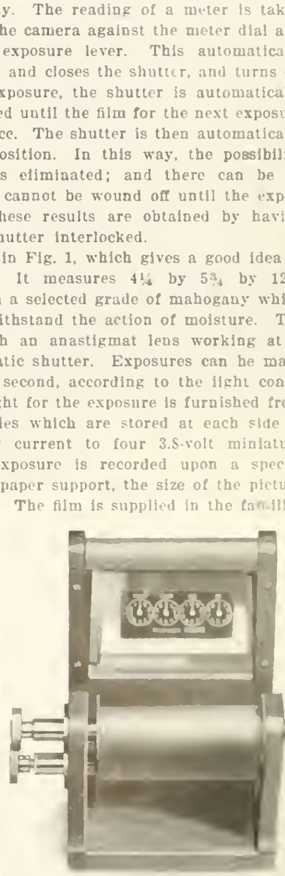


Fig. 2. Desk Holder for Use in reversing Reading of Negative

into the equivalent of an electric torch for locating meters or finding one's way through dark cellars.

A desk-holder is provided with the camera, equipped with a mirror for reversing the readings which are negative. The camera may be provided with a card showing the meter reader's name, route number, and the date, which may be placed against the front of the camera and photographed to identify the record. There appear to be a variety of applications for the "factograf" camera in factory use. The first actual application has been made in electric central-stations for photographing the meter readings; and there is the same application in reading the meters in the works of gas companies and water pumping stations. In machine shops, the camera could be used to advantage in recording the readings of gas, water and electric meters.

* * *

THE WILZIN PROCESS FOR FLAT-WARE MANUFACTURE

For use in the manufacture of all kinds of flat-ware from the different metals used in this industry, Arthur Wilzin, managing director of the E. W. Bliss Co.'s branch in Paris, has developed an improved process which is described in the following article. The principal merits of this process are that not more than 10 per cent of the material is wasted in the form of scrap, that imperfections in the material are remedied by the process so that very few defective parts are produced, and that unskilled labor can be utilized. It will thus be evident that this process provides for making a material reduction in the cost of manufacture. The first patents were issued in France in 1909, and since that time a series of special presses, tools and dies has been developed in the factory of the E. W. Bliss Co., St. Ouen, France, under the personal direction of Mr. Wilzin. Foreign patents have been obtained and the Wilzin Process Corporation, 60 Wall St., New York City, has recently been organized for the purpose of licensing American flat-ware manufacturers to operate under the Wilzin patents. That this process has been developed to a point where it is entirely ready for practical application is attested to by the fact that a number of the leading European manufacturers are now using it. The process is applicable in the manufacture of all styles and patterns of flat-ware, regardless of the base metal that is used.

The successive steps involved in this process and the manner in which they are conducted are well shown by the accompanying illustrations. Figs. 1 to 3 show different classes of flat-ware in the successive steps through which the work passes before reaching completion. Figs. 4 and 5 show the Wilzin quadruple expansion profiling press, and Fig. 6 shows the profiling dies used in this machine. Fig. 7 shows the die used for cutting up the blanks and for preparing the ends for subsequent treatment, and Fig. 8 shows the tools used for performing the "bowl spreading" operation on spoons. These tools will be referred to in detail in subsequent paragraphs.

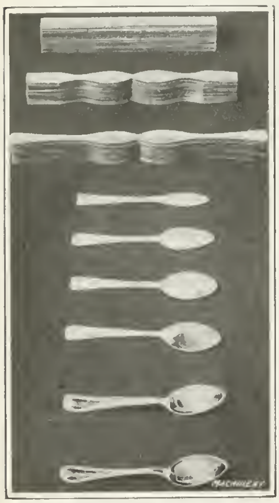
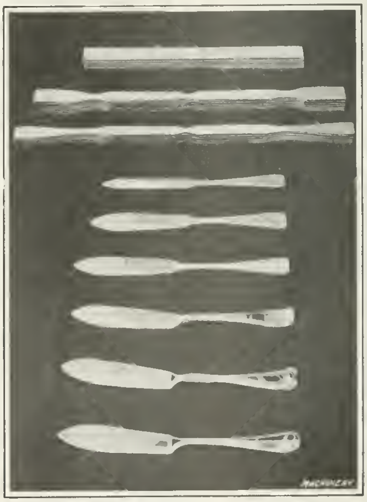
Strip Cutting and "Package" Assembling

The material used is ribbon stock, and the first step consists of cutting this material up into strips of suitable length. For this purpose, a standard form of power press is employed which is equipped with a cutting-off attachment that provides for the production of all sizes of strips. In most cases, the strips contain sufficient metal to produce two blanks, but in the case of very small spoons, the strips are made large enough to produce four blanks. The rate of production is from 50 to 60 strips per minute, one strip being cut off at each operation. The strips are next assembled into packages as shown at the top of each illustration, in Figs. 1 to 3, each package containing from 8 to 18 strips, according to the gage of metal being used. Each package contains sufficient metal to produce from 16 to 48 blanks, *i. e.*, 8 to 18 two-blank strips or 12 four-blank strips.

The Profiling Operation

The packages of strips are next subjected to a profiling operation in a Wilzin quadruple expansion press; one of these presses is shown in Fig. 4, and Fig. 5 shows a close view of the working mechanism with the die-holder drawn forward to the position which it occupies while changing the tools. The press applies a pressure of from 150 to 250 tons on all sides of the material, and two or three profiling operations are required, according to the character of the work. It will be seen from Fig. 5 that two sets of dies are employed in the profiling press. At each side of the metal there is a flat die which serves to restrain the material from flowing sidewise, and the same flat dies can be used for all classes of work. The profiling dies are shown in place in Fig. 5, and a detailed view of different types of these dies is presented in Fig. 6. The profiling dies act on the edges of the strips and cause the metal to flow longitudinally without change of thickness, the condition of the work after successive profiling operations being shown in Figs. 1 to 3 for different examples of flat-ware.

It will be evident from the illustrations that the profiling dies are of very simple construction so that they are inexpensive to make, and one set of tools has been found to have a capacity for producing over 1,000,000 pieces. The time required for changing and setting up the profiling tools is less than two minutes, their correct longitudinal and lateral positions being determined without having to make careful measurements. End blocks center the punches longitudinally and


Figs. 1 to 3. Successive Steps involved in the Manufacture of Spoons, Fish Knives, and Forks by the Wilzin Process for Flat-ware Manufacture

the lateral position is determined by side pressure blocks, so that the only adjustments required are for height and back gage. The Wilzin quadruple expansion profiling press was especially designed for this work, and it embodies well-known features of E. W. Bliss power presses, which insure rapid and reliable operation. Each press is equipped with a pressure indicator which records the pressure for each stroke of the press and enables the operator to set the plunger adjustment without danger of injury to the dies and without resorting to any cut-and-try methods. It was mentioned in the introductory paragraph that one of the features of this process consists of overcoming imperfections in the material, so that no defective pieces are produced. This is due to the high pressure applied to the surface of the metal from all four sides, which results in improving its structural qualities, so that slight flaws are closed up. This feature stands out in marked contrast to the results obtained by other methods, where the working of the metal serves to accentuate any defects in the material.

The number of profiling operations that are necessary differs with the character of the work. For spoons of all sizes two operations are required, with one change of profiling dies. For forks of all sizes, three profiling operations are required with two changes of dies. Other articles need two or three profiling operations, according to the size and shape of the work. All the profiling operations are performed on the cold metal with the exception of blanks for the larger sizes of tablespoons, in which case the work requires one annealing treatment. The capacity of the profiling press is for seven to ten operations per minute and 16 to 48 blanks are produced at each operation.

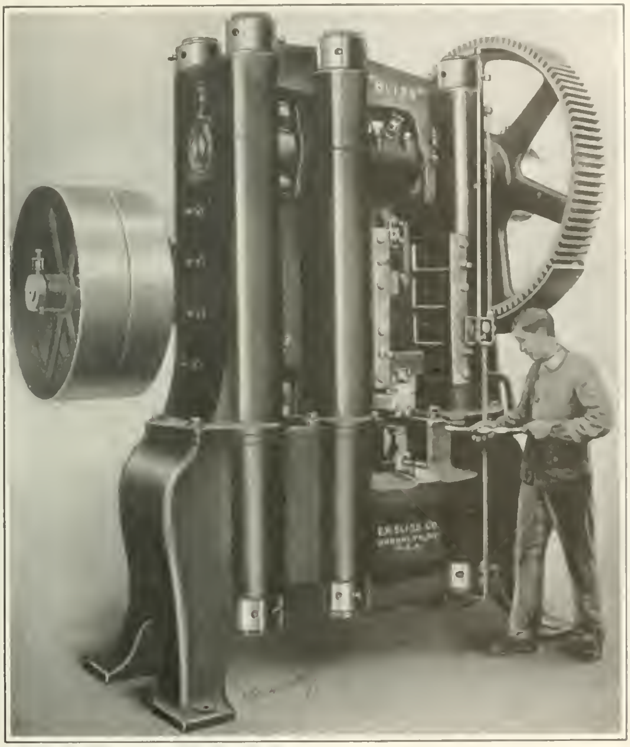


Fig. 4. Wilzin Quadruple Expansion Profiling Press

Parting the Blanks

The strips of metal, as they leave the profiling press, are next cut into individual blanks in a press fitted with a parting tool. For spoons, the entire package of strips is parted in one or two operations, according to the size of the spoons, one operation being employed for each package of two-blank strips, and two operations for each package of four-blank strips. Twenty operations are performed per minute; sixteen to thirty-six blanks are cut off per operation on the two-blank packages, and twenty four blanks per operation from the four-blank packages. For forks of all sizes, the strips are parted separately with the combination parting and end-preparation die shown in Fig. 7. Twenty operations are performed per minute and two blanks are produced at each operation.

End Preparation

The individual blanks are next submitted to the action of end-preparation dies, one of which is shown in Fig. 8; these are fitted to presses of suitable capacity according to the size of the blanks. This operation completes the shaping and grading of the blank with the exception of the stem. The end-preparation dies shown in Fig. 8 are for use on spoon blanks; the lower tool is a hardened tungsten steel block with its working surfaces absolutely straight, so that it is easily ground. This tool may be employed for all shapes and sizes of bowls, the contour of which is determined by the edge confining pieces that are simple to make and easy to place in the gaging pieces, which are standard for all sizes of spoons. The exact grading of the bowl is secured by the action of surface punches. It will be understood, of course, that by convexing their surfaces, the bowls are graded to secure the desired distribution of the metal; i. e., thin in the center and increasing gradually in thickness toward the edge. By hollowing out the punches at the base, it is an easy matter to accumulate any amount of metal required for the relief of flowered or figured designs. For spoons and similar articles, two operations are required with one change of dies, while for forks only one operation is required. For spoons, the rate of production is twenty operations per minute and one blank is produced at each operation; the rate of production is the same for forks.

Upsetting, Flat Polishing, Embossing, Trimming and Final Polishing

The stems of all blanks are next submitted to the action of a simple stem-upsetting die which is fitted in a flywheel press of standard design. The rate of production is twenty operations per minute, and one blank is produced at each operation. After this work has been completed, the flat blanks are next polished on a cotton buff. This operation is generally done by hand, and the output depends largely upon the experience of the operator. In some cases, an automatic polishing machine is used, which greatly increases the rate of production. The blanks produced by the Wilzin process have an even surface, due to the high pressure to which the metal is subjected and, as a result, very little polishing is required. The blanks are then ready for the final stamping and embossing operations for which one-piece embossing dies are used in E. W. Bliss embossing presses especially designed for use in the manufacture of flat ware. The rate of production is from eight to twelve operations per minute, depending upon the size of the pieces, and one piece is produced for each operation. The embossed pieces have a slight "flash" around the entire edge, which is removed by a suitable size of press fitted with a simple trimming die. The amount of scrap metal produced in this way never exceeds 10 per cent. The rate of production is twenty operations per minute, one piece being produced at each operation. The final polishing operation consists of smoothing and rounding the edges of the work after the flash has been removed, and of giving the surfaces

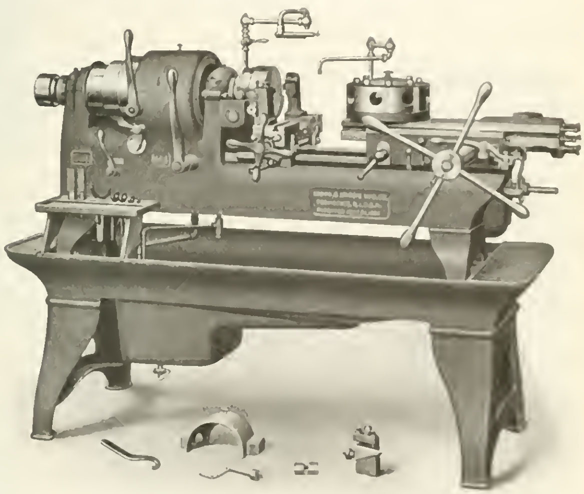
READ PAGE 79

A Good Machine for Making Parts From Bar Stock in Small Lots

In many shops there is a good deal of work, such as screws, studs, bolts, nuts, small machine parts, etc., made from bar stock, that comes in lots too small to make it worth while setting up on an automatic screw machine. Some of the jobs, unless handled on an efficient machine, would take longer to set up than to finish. To do this work economically a machine is necessary that can be quickly set up and rapidly operated. Another point—short jobs will not warrant the expensive special tooling that is often required when a job is long enough for an automatic machine, so it is necessary to provide a machine that will handle the work with simple tool equipment. Meeting all these requirements the

B. & S. No. 4 Wire Feed Screw Machine

effectively supplements a group of automatic screw machines and makes a valuable addition to the equipment in the shop for handling work that comes mainly in small lots.



Our Automatic Chuck, an exclusive Brown & Sharpe feature, saves much time in setting up. It operates as quickly as a spring collet, by a single lever, but has the added advantage of being self-contained and universal in range. It is adjustable for any size of stock within its capacity by simply turning with a wrench like a universal chuck. There is no hunting around for loose parts every time a job is set up. A few turns of a wrench and the chuck is set. Any standard shape of stock can be handled without special jaws.

The Automatic Roller Feed, another important feature, is operated in conjunction with the chuck by the same lever. Like the Automatic Chuck it is universal in range and is very quickly adjusted. It feeds to any length without adjustment, and being located directly behind the chuck, will feed practically to the end of the bar.

The turret is indexed each time it is returned and when brought into working position it is automatically locked and clamped, thus insuring proper alignment at all times. Eight changes in feed for the turret slide are available for each spindle speed. This feed is driven direct from the spindle by sprocket and chain. Many other features are outlined in detail in our descriptive literature. Send for it.

Providence, Rhode Island, U. S. A.

CANADIAN: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, [illegible]

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. G. F. Kr[illegible] Germany; V. Lowener Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, [illegible] Paris, France, [illegible] Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; F. W. Horne Co., Tokio, Japan. [illegible] A. Vail, Melbourne, Australia. [illegible] Strong, Manila, P. I.

of the work the final polish; this is done with a cotton buff, without requiring the use of an emery belt. The labor involved in the performance of the latter operation is materially reduced owing to the fact that a high burnish and luster is imparted to the work by the embossing dies.

Advantages of the Wilzin Process

The advantages of the Wilzin process for the manufacture of flat-ware may be briefly summarized as follows: (1) It eliminates the cross and grade rolling operations. (2) It reduces the applied labor costs of manufacturing the flat graded blanks. This saving is due to the low labor cost of the press operations, to the possibility of profiling the blanks in packages containing from 16 to 48 blanks, and to a reduction of the number of annealing treatments that are necessary or the complete elimination of annealing. (3) Absolutely uniform blanks are produced. (4) The applied labor costs of grinding, polishing and buffing are materially reduced. (5) The pressure applied to the metal in the profiling operation improves its structural qualities; and the high pressure applied in subsequent operations produces an extremely hard burnished surface. (6) The combination of the polished blank, the highly burnished embossing die, and the slow elastic squeeze of the embossing press, transfers the high luster of the embossing die to the surface of the work. (7) The amount of material lost in the form of scrap does not exceed 10 per cent. (8) The cost of the tools required is relatively small, as these are of simple design.

The Wilzin Process Corporation has acquired the exclusive rights to this process of flat-ware manufacture in the United

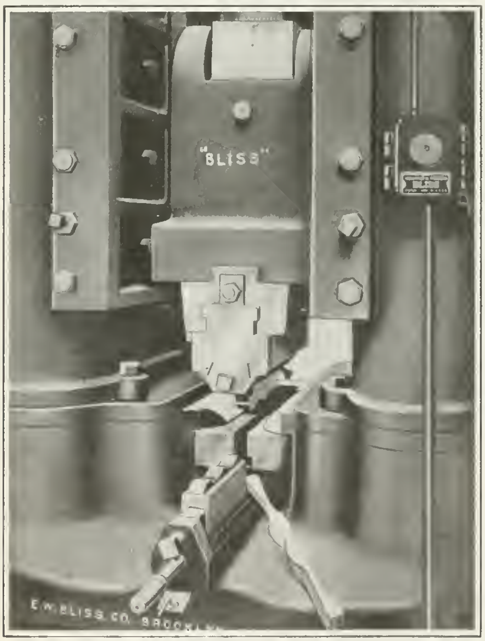


Fig. 5. Close View of Profiling Tools with Die-holder drawn Forward

States, and is prepared to grant licenses to flat-ware manufacturers to operate under its patents. The plan is to lease the Wilzin quadruple expansion profiling presses and to sell

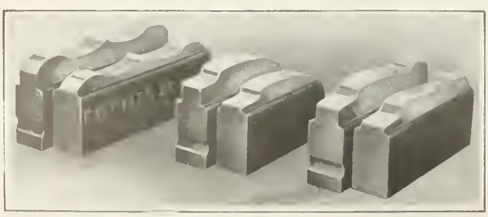


Fig. 6. Different Types of Profiling Tools used in the Wilzin Process

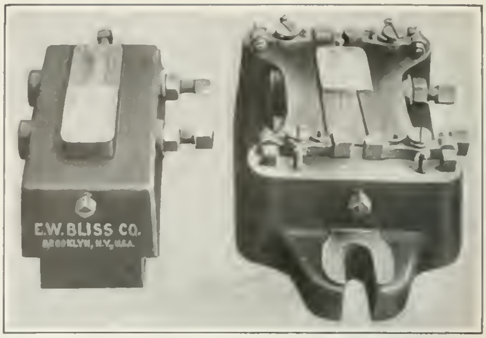


Fig. 7. Combination Parting and End-preparation Tools for Use on Forks

the necessary equipment of the E. W. Bliss power presses, tools, and dies which are required. The Wilzin Process Corporation will act as selling agent in the United States

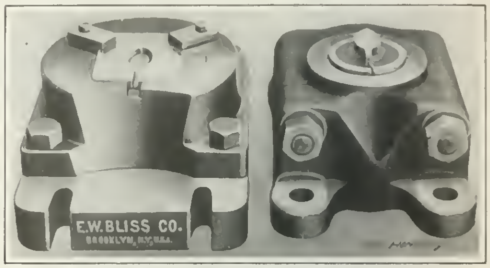


Fig. 8. Tools used for performing Bowl Spreading Operation

for all equipments required in using the Wilzin process, and the equipment will be built by the E. W. Bliss Co., Brooklyn, N. Y. A service department will be maintained for the regular inspection of the quadruple expansion profiling presses, and the services of the engineers of the Wilzin Process Corporation will be available in making estimates of the manufacturing cost of any piece or series of pieces by the Wilzin process, and in giving expert advice to licensees.

* * *

PERSONALS

J. O. Hobby, Jr., was appointed treasurer of the American Locomotive Co., 30 Church St., New York City, at the meeting of the board of directors held August 11.

Albert J. Ott, formerly with the Landis Tool Co., is now Western representative for the Modern Tool Co., Erie, Pa., makers of self-contained grinding machines and precision tools, with offices at 32 North Clinton St., Chicago, Ill.

W. S. Burgess has disposed of his interest in the Stoddard-Burgess Co., 426 S. Clinton St., Chicago, Ill., to E. B. Stoddard, who will continue the business. Mr. Burgess has been salesman for eight years with the Imperial-Brass Mfg. Co., and is well acquainted with brass foundry and machine-shop practice.

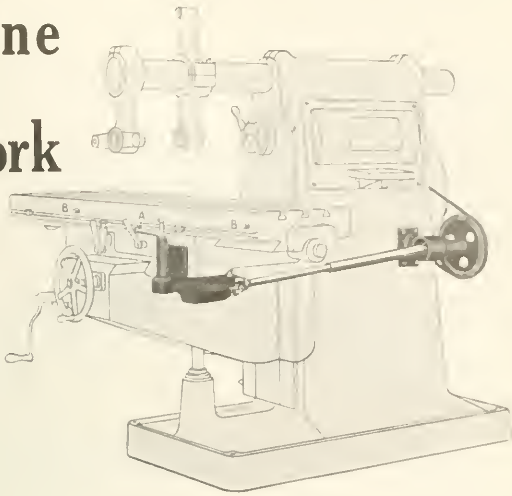
Fred. H. Moody, mechanical editor of the *Canadian Railway and Marine World*, has joined the Canadian expeditionary force and gone to the front. He has been promoted to the rank of captain and is second in command of his company. Mr. Moody was formerly associate editor of MACHINERY.

J. F. Richman, formerly factory production manager of the Cole Motor Car Co., Indianapolis, Ind., has been promoted to the position of factory manager of the standardized plant. Mr. Richman has been with the Cole Motor Car Co. for about three years. His practical knowledge of the gas engine and motor car has been an important factor in perfecting the Cole eight-cylinder car.

O. P. Hand has been appointed director of publicity of the Burd High Compression Ring Co., Rockford, Ill., manufacturer of Burd high compression piston rings. Mr. Hand, who will assume his new duties at once, comes to Rockford after fourteen years' experience as advertising manager for the Minneapolis Iron Store Co. and an extended connection as editor of a prominent trade journal.

Howard E. Coffin and Andrew L. Riker, past-presidents of the Society of Automobile Engineers, have been selected to serve on the civilian advisory board, which will be organized by the United States Navy Department in September. Mr.

Let the Machine
Not the Operator
Do the Heavy Work



One of the big features introduced on our Semi-automatic Millers several years ago was the Power Quick Traverse and Return. Now you can have it on any CINCINNATI High Power Plain or Vertical Miller.

It is entirely divorced from the feed mechanism. That avoids running the feed-shafts and gears at excessive speeds.

Most simple to use. Direction the lever is moved indicates direction the table will travel and the instant the operator's hand leaves the lever, the table stops. He can't turn and talk politics with Jim Smith and let the table travel on towards trouble. He can't engage it when the regular feed is being used; no accidents possible that way. He can use it when setting up, when the machine itself is stopped.

It is always available, forward or reverse, the instant the regular feed is tripped.

It saves all the time and all the energy the operator formerly wasted in moving the table to the work, returning it again after the cut and moving the table back and forward when setting up.

Let us show you how it will save money on your work.

THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI, OHIO, U. S. A.

ltiker was the first president of the Society of Automobile Engineers, serving in this capacity three terms. Mr. Coffin became its president in 1910, and was the prime originator of the movement which has resulted in the standardization of component materials and parts of automobiles.

* * *

OBITUARY

John Parker, for over twenty years in charge of the milling machine designing for the Brown & Sharpe Mfg. Co., died July 23, following a brief illness, aged fifty-one years. Mr. Parker's whole life was practically devoted to the mechanical field, and many successful developments in the design and construction of machine tools are largely due to his efforts. His first employment, covering four years, was in the drafting department of the Corliss Steam Engine Co., Providence, R. I. Leaving this company, he went to the Brown & Sharpe Mfg. Co. in 1891; and in 1893 took active charge of the milling machine designing. In connection with this position he also held that of assistant chief draftsman, from 1895 to 1902, when the volume of work on milling machines at this time became so great that it required almost exclusive attention. As assistant chief draftsman he developed good executive ability in putting work through correctly and efficiently, and this stood him in well in after years. During his service Mr. Parker gained a wide and valuable experience, for he was called upon at different times to assist in the designing of machines for almost every line of work carried on by the company. Many patents were granted him, chiefly in connection with his work on milling machines. Few men have devoted more careful study and given greater effort to develop these machines than Mr. Parker. Largely due to his credit stands the modern constant-speed drive machine with speeds and feeds independent. He was a member of the American Society of Mechanical Engineers, before which body he presented and discussed several papers. He also contributed some important articles to the technical press on milling machines and other subjects. Mr. Parker's quiet disposition won him many friends, and his firm, yet kind and liberal personality had a strong influence on the men who worked under his direction. His methods were such as tended to develop the full ability of men, by placing on them as great responsibility as possible; at the same time he always stood ready to give them the benefit of his wide experience. His clear logical manner of solving problems and his patience and willingness to explain at length those points which often troubled his men will long be remembered. In his dealing with the men in both the drafting department and the shop he seldom made a ruling or gave an order that he could not consistently follow himself. Mr. Parker had a remarkable capacity for details, and his ability to answer correctly and off-hand many questions connected with his work was often a great help to those working with him. He is survived by his widow, a son, a daughter, five sisters and two brothers.

COMING EVENTS

September 7-10.—Twenty-third annual convention of the Traveling Engineers' Association, Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, East Buffalo, N. Y.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

September 25-October 2.—Annual exhibit of the Foundry & Machine Exhibition Co., Atlantic City, N. J., in conjunction with the American Foundrymen's Association convention. Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 27-October 1.—Annual convention of the American Foundrymen's Association, Atlantic City, N. J.

SOCIETIES, SCHOOLS AND COLLEGES

Swedish Engineering Convention in the United States. Program of the convention to be held at the LaSalle Hotel, Chicago, September 9, 10 and 11, 1915, containing useful information and outlining the program, which consists of two engineering sessions with four papers, as well as visits to a number of industrial works in and around Chicago, including the Gary Steel Works, the Pullman Co. Works, the Fiske St. Power Station, the Western Electric Co., and the Union Stock Yards. C. G. Axell, Room 619, City Hall Square Bldg., Chicago, Ill., is the secretary of the convention. A party of engineers from the East will leave New York City September 6, stopping over at Schenectady and Niagara Falls, and visiting industrial plants at these points.

NEW BOOKS AND PAMPHLETS

An Investigation of Iowa Fire-Clays. By Milton F. Beecher. 115 pages, 6 by 9 inches. Bulletin No. 40, published by the Engineering Experiment Station, Iowa Stage College of Agriculture and Mechanic Arts, Ames, Iowa.

Wind Stresses in the Steel Frames of Office Buildings. By W. M. Wilson and G. A. Maney. 88 pages, 6 by 9 inches. 32 charts and tables. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill.

This is Bulletin No. 80 of the Engineering Experiment Station of the University of Illinois, and contains a description of an accurate method used for determining wind stresses. Copies of the bulletin may be obtained free of charge by application to C. R. Richards, acting director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

Directory of Piston Ring Sizes. Applicable to automobiles, motorcycles, cycle cars, trucks, tractors and engines. Published by Burd High Compression Ring Co., Rockford, Ill. Price, 50 cents.

This little book gives information intended for the owner and repair man of automobiles, motorcycles, etc., as well as for the dealer. It specifies the number of rings per piston and the number of cylinders, as well as the sizes of the rings of a great number of automobiles and motorcycles, trucks, etc. These piston rings are supplied by the Burd High Compression Ring Co. The book contains instructions for fitting rings into the piston groove, fitting cylinders, etc.

Combustion and Smokeless Furnace. By Joseph W. Hays. 118 pages, 6 by 9 inches. Illustrated. Published by Combustion Appliances Co., Rogers Park, Chicago, Ill. Price, $2.

The importance of smokeless combustion is appreciated by all who have given any attention to elimination of smoke, and the elimination of smoke in great cities means great saving of property spoiled by soot, the general promotion of personal comfort, etc. The damage caused by smoking chimneys in Chicago alone is estimated by one writer to be $40,000,000 annually. This is the second edition of the book that was first published in 1906. It has been revised and brought up to date, and treats of heat and combustion, combustion and the boiler furnace, combustion and the steam boiler, the chimney evil, smokeless furnaces in general, mechanical stokers and hand-fired furnaces.

Mathematics for Machinists. By R. W. Burnham. 229 pages, 5 by 7 inches. 175 illustrations. Published by John Wiley & Sons, New York City. Price, $1.25.

This is one of the volumes in the Wiley Technical Series for Vocational and Industrial Schools, and has been prepared especially for the use of trade schools and for home study. Beginning with fractions, the book aims to give, in an elementary form, an explanation of the calculations most frequently met with in machine shop work. The treatment has been made as simple as possible. An attempt has been made to show the steps in a calculation in logical order, and it is believed that the material presented in this book and the method of treatment will be found well adapted for trade school education. The book contains chapters on common fractions, decimal fractions, percentage, blueprints, measurements, powers of numbers, square root, lathe work, threads and thread cutting, simple machines, work, power, ratio, gear calculations, milling machine indexing, volume and weight, shop trigonometry, and business organization.

Electrical Measurements and Meter Testing. By David Penn Moreton. 328 pages, 4 by 6½ inches. 191 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, bound in cloth, $1.

This work was prepared to meet the needs of practical men desiring to obtain a working knowledge of electricity as applied to electrical measurements and meter testing, but who are unable to take a complete course in electrical engineering. The author is assistant professor of mechanical engineering, Armour Institute of Technology, Chicago, and has prepared the work in plain language to meet the needs of this class. It treats of the direct-current circuit, magnetism, electromagnetism and electromagnetic induction, inductance and its measurement, capacity and its measurement, alternating-current circuit, calculation and measurement of resistance, measurement of current and pressure, construction and operation of wattmeters, construction and operation of watt-hour meters, methods of distributing energy, calibration of galvanometers, ammeters, voltmeters and wattmeters, testing watt hour meters and special indicating and recording instruments. The work is one that should be found generally satisfactory to those who wish to get a working knowledge of electrical measurements in the simplest terms.

Modern Plumbing Illustrated. By R. M. Starbuck. 407 pages, 7 by 10¼ inches. 58 full-page illustrations. Published by Norman W. Henley & Son, New York City. Price, $4.

This is a comprehensive and thoroughly practical work on the modern and most approved methods of plumbing construction, intended especially for plumbers, architects and builders, as well as for trade classes in plumbing. It should be useful also for property owners, boards of health, and plumbing inspectors. Great changes have taken place during the last decade or two in relation to plumbing, and in bringing out the third edition of this book the required revisions to bring the work up to date have, therefore, been made. The work is designed to cover the entire field of plumbing as far as possible, and the subjects considered cover a variety of lines of work, including fixture work in detail, the construction of the drainage and vent systems in detail, and complete plumbing systems of buildings of various kinds. While the work is intended to cover subjects pertaining to drainage alone, the subject of water supply is in many instances closely associated with the drainage problem, and the author has therefore found it advisable, in many instances, to take up the subject of water supply. It would be impossible to give an idea of the contents of the book in a brief review of this kind, as each of the fifty-eight full-page illustrations is accompanied by a chapter of descriptive matter, every one of which deals with some particular phase of plumbing. The work gives evidence of the fact that the author has endeavored to convey the information in as complete and concise a manner as possible, making it at the same time entirely clear and comprehensible. Unnecessary and obsolete matter has been excluded in the new edition, and as far as possible the work has been kept up to date.

NEW CATALOGUES AND CIRCULARS

Moore & White Co., Philadelphia, Pa. Catalogue of friction clutches and variable speed changes.

Reed & Prince Mfg. Co., Worcester, Mass. Catalogue of taps, micrometer calipers and screw gages.

Automatic Drill Chuck Corporation, Detroit, Mich. Circular of "Quictite" full automatic chucks for drilling machines.

Rub-on Mfg. Co., Inc., Brayton St., Buffalo, N. Y. Circular on a combination jack, auto-turn jack, and towing truck for garage use and for towing in crippled cars.

Templeton, Kenly & Co., Ltd., 1020 S. Central Ave., Chicago, Ill. Bulletin 115 describing "Simplex" jacks for steam and electric railroads, automobiles, and general purposes.

D & W Fuse Co., Providence, R. I. Booklet of D & W enclosed fuses, illustrating and describing construction, and listing fuses from 30 amperes to 1000 amperes capacity.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet about graphite brushes for commutators of electric motors and generators. The booklet describes how the characteristic lubricating qualities of graphite reduce commutator troubles to a minimum.

National Machinery Co., Tiffin, Ohio. Folder relating to "Tapping Nuts 'Square' on the National Automatic (Bent Tap) Nut Tapper". The folder contains illustrations showing clearly the action of the machine in tapping nuts.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of alligator shears of the stationary and portable types and the low-knife and high-knife types. The heaviest shear has a capacity of four-inch square bars in soft machinery steel or iron.

Offset Tool Co., Bridgeport, Conn. Circular of an offset drilling machine attachment for drilling, reaming, counterboring, countersinking, hollow-milling, etc., under ledges and in other places inaccessible to the ordinary drilling machine spindle.

Ellsworth Haring, 114-118 Liberty St., New York City. Catalogue of resistance metals, ignition metal, spark plug wire, nickel sheets and wire, nickel alloys, music wire, etc. The catalogue contains tables giving electrical properties of the resistance metals listed.

Stow Mfg. Co., Binghamton, N. Y. Bulletin 400, illustrating and describing some of the portable tools made by the company, including portable drills, grinders, screw-drivers, etc., both belt- and motor-driven, as well as flexible shaft center grinders, drills, emery grinders, etc.

Foote Bros. Gear & Machine Co., 210-220 N. Carpenter St., Chicago, Ill. Catalogue illustrating and describing the Foote-Strite transmission, adaptable to practically any type of tractor. This is a new departure in the gear line of the company, and is just being placed on the market.

New Departure Mfg. Co., Bristol, Conn. Bulletin 39, "Ball Bearings in Manual Training School Lathe Work", 40, "Change-speed Gearing for Heavy-duty Metal-working Machinery"; 41, "Miscellaneous Two-bearing Mountings"; 42, "Ball-bearing Spindle for Sensitive Drill Press".

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin 506, illustrating a variety of electric hoist types, all characterized by provision for dirt exclusion, bath lubrication and permanent alignment. The hoists illustrated are built in capacities ranging from 1 to 12½ tons.

Crucible Steel Co. of America, Pittsburg, Pa. Catalogue of "Rex" high-speed steel, giving the sizes in which this quality of steel is made in rounds, squares, octagons and flats. The catalogue also contains suggestions for forging, grinding hardening and annealing "Rex" high-speed steel.

Standard Pressed Steel Co., Philadelphia, Pa. Booklet entitled "Data on Safety and Efficiency in Power Transmitting Appliances, Catalogue No. 2". This booklet contains much valuable information for millwrights and others concerned with the problems of power transmission in shops, mills and factories.

Premier Machinery Co., Milwaukee, Wis. Circular of the "Hercules" combined milling machine, internal and external keyseater and gear cutter. The illustrations show how adaptable this little machine is to a large variety of work in the machine shop and how it can be applied to repair work requiring portability.

Alfred Box & Co., Philadelphia, Pa. Bulletin of the Box wire rope hand crane, type B2R; bulletin of the Box jib crane, type AFC; bulletin 800 of electric traveling and jib cranes, illustrated with numerous examples of installations; and bulletin 1200 of monorail hoist types, illustrated with examples of installations.

Lewis T. Kline, Alpena, Mich. Catalogue of excelsior and wood-turning machinery, illustrating and describing machines for making excelsior, baling presses, wood splitters, cut-off saws, barkers, knife grinders, spur grinders, broom-handle machines, spool machines, plug machines, bolting saws, slitting saws, and wood-turning machinery in general.

Mott Sand Blast Mfg. Co., 1157 E. 138th St., New York City. Four circulars relating to machinery and accessories for sandblasting, entitled respectively: "Direct-pressure Sandblast Machine, Hose Type"; "Sandblast Tumbling Barrel with Revolving Table and Cabinet, Type G"; "Sandblast Tumbling Barrel, Type P.V.S., Double"; and "Mott Sandblast Accessories".

Wheeler Condenser & Engineering Co., Carteret, N. J. "Psychrometric Tables for Cooling Tower Work", being a small handbook for engineers which gives dry and wet bulb thermometer readings, dew-point, humidity and pounds of water vapor per thousand cubic feet and per hundred pounds of air. This is a companion book to the company's "Steam Tables for Condenser Work".

Thermalene Co., Chicago Heights, Ill. Booklet entitled "The Oxy-Thermalene Method of Welding and Cutting", describing the use of the so-called "thermalene" gas as a substitute for acetylene gas in autogenous welding and cutting of metals. The booklet illustrates and describes the apparatus used in connection with thermalene gas generation and the torches, etc., used in welding and cutting.

Cooper Flexible Transmission Co., 8th Ave. and 18th St., Brooklyn, N. Y. Catalogue illustrating and explaining the design of the Cooper universal joint, shock-absorbing shaft, and flexible shafting. The design of the Cooper universal joint is based on a principle claimed to eliminate all irregularities in speed during the revolution of the shaft irregularities which other universal joints are subjected to.

Walker M. Levett Co., 10th Ave. and 36th St., New York City. Circular of "Magnalite" pistons for internal combustion engines. Magnalite pistons weigh one-third as much as cast iron pistons of the same dimensions; thus their inertia effect is much less than that of cast-iron pistons. The claim is made that the thermal conductivity of magnalite is 11 to 1 as compared with cast iron, which has the effect of cooling the engine and promoting lubrication.

Kerr Turbine Co., Wellsville, N. Y. Bulletin 54 on "Economy" turbo-alternators and generators, covering the advantages of turbine-driven generators in both large and small units, and describing and illustrating, by halftones and line engravings, a number of installations of these turbo-alternators and generators. An interesting chart showing relative space occupied by "Economy" turbines as compared with high-speed reciprocating engines or tandem compound reciprocating engines is included.

Foxboro Co., Foxboro, Mass. Catalogue covering instruments made by the company. These instruments include tachometers; recording hygrometers; "Durand" radial planimeters; electric pyrometers; mechanical and electrical time-recorders; recording pressure and vacuum gages; siphon and mercury gages; revolution counters; thermographs; and various other precision instruments. The Foxboro instruments are manufactured by the Foxboro Co., but at the present time are sold by the Industrial Instrument Co., a subsidiary company.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Loose-leaf catalogue relating to electric controlling devices. The catalogue covers both direct and alternating current motor starters and speed regulators, self starters and elevator controllers, as well as accessories and miscellaneous resistance units, rheostats, etc. It contains a great mass of tabulated data and important information, and is also characterized by the elimination of unessential material. The size is about 4 by 7 inches, making it handy for desk use and reference.

Lea-Courtenay Co., Newark, N. J. Catalogue H 2 on centrifugal pumps, illustrating and describing the pumps manufactured by the company. The book is divided into a number of chapters covering general types of centrifugal pumps, indicating where each type is used, necessity of an efficient testing plant, inspection of parts; details of pump design and construction; single-stage pumps for low and moderate heads, single-suction, multi-stage pumps; balanced pumps; double-suction multi-stage pumps; pumps for boiler feeding; vertical multi-stage pumps; underwriters' fire pumps and portable sinking pumps.

J. E. Snyder & Son, Worcester, Mass. 1915 catalogue of upright drilling machines, illustrating and describing the full line of Snyder upright drilling and tapping machines. The catalogue comprises about fifty pages and is arranged with the illustration of a drilling machine on the left-hand page and a brief description and general dimensions on the right-hand page, making the catalogue very convenient for reference. In all, twenty-three different types and sizes are illustrated and described and, in addition, drill chucks and drill sockets and sleeves for Morse taper shank drills are listed.

American Blower Co., Detroit, Mich. Bulletin 6, describing and illustrating ABC steel plate exhaust fans, types E, L, and C. The bulletin describes in detail these fans, showing the construction by means of halftone illustrations and line engravings. The type E exhaust fan is designed especially for handling shavings, dust and refuse, or for any heavy material that will not be injured by passing through the fan. The types L and C fans are designed especially for cotton-gin work, but can also be used successfully for exhausting air or gas, and very light dust or waste material.

Brown & Sharpe Mfg. Co., Providence, R. I. Booklet entitled "Apprenticeship", describing the apprenticeship system at the works of the Brown & Sharpe Mfg. Co., with the purpose of giving information as to what constitutes the learning of the machinist's trade at the Brown & Sharpe works, and explaining the entrance requirements, the conditions of service, and the lines of advancement that may follow a successful completion of an apprenticeship. The greatest emphasis is placed on the machinist's trade, but, in addition, apprentices are trained for drafting work, patternmaking, molding, coremaking, and blacksmithing. The book is profusely illustrated with halftone illustrations showing apprentices at work at various machines in the shop. The book is a valuable contribution to the literature on apprenticeship, giving an outline of what is now being done in up-to-date manufacturing plants.

TRADE NOTES

Ingersoll Milling Machine Co., Rockford, Ill., has changed the location of its Detroit, Mich., office from 827 Ford Bldg., to 806-808 Davis Whitney Bldg.

W. S. Barston & Co., Inc., 50 Pine St., New York City, has reorganized its department of construction engineering with Arthur M. Porrey, formerly with Hildreth & Co., New York City, in charge.

American Locomotive Co., 30 Church St., New York City, announces that at the meeting of the board of directors of the company held August 11, J. O. Hobby, Jr., was appointed treasurer of the company.

Kempsmith Mfg. Co., Milwaukee, Wis., manufacturer of milling machines, is working night and day, and is now erecting an addition to the factory. The company will be in the market for considerable new equipment.

Metals Coating Co. of America, 122 S. Michigan Ave., Chicago, Ill., announces that the concern has opened an office at 100 Summer St., Boston, Mass., in charge of Herbert Jaques, Jr., who is prepared to furnish information and demonstrate the Schoop metal coating process to interested manufacturers.

Rockford Tool Co., Rockford, Ill., has just completed a new shop, the dimensions of which are 126 by 126 feet. The company is now building a new 16-inch high-duty engine lathe in addition to its regular line, and will also shortly place a new gear-cutting machine on the market.

Moltrup Steel Products Co., Beaver Falls, Pa., is erecting an addition to its plant for the production of finished crankshafts and other steel specialties. The addition is built of brick and concrete, and is 60 by 250 feet. The company also manufactures cold-drawn steel bars, machine keys and racks, and finished steel plate.

Wilmarth & Morman Co., 1180 Monroe Ave., N. W., Grand Rapids, Mich., has broken ground for a large two-story modern brick addition to its present plant that will double the present floor space. A great deal of new equipment has been installed, and it is expected that the company will soon be able to make prompt deliveries on its grinding machines.

Rockford Milling Machine Co., Rockford, Ill., has purchased the plant recently occupied by the Rockford Tool Co., in order to use this plant in connection with its present shops. A recent addition has also been made to the present plant, so that the available floor space is now more than doubled. The company intends to increase its line of milling machines.

Duff Mfg. Co., Pittsburg, Pa., manufacturer of the Barrett lifting jacks, is building an extension to its main factory building, 150 feet by 125 feet in width. The main building with the extension will be 625 feet long by 125 feet wide. A five-ton bridge transfer crane and monorail conveying system is also being installed, together with considerable additional equipment.

Fox Machine Co., 641 Front Ave., N. W., Grand Rapids, Mich., manufacturer of milling machines and multiple-spindle drills, contemplates removing from Grand Rapids to the southern part of the state. A new shop 90 by 300 feet, is being erected and a large foundry will also be constructed. The concern at the present time is working twenty-three hours a day.

Clipper Belt Lacer Co., 1020 Front Ave., Grand Rapids, Mich., is erecting a large addition to its factory which will greatly increase the capacity. Mr. Foote, president of the company, recently returned from a business trip abroad which resulted in many large orders. During the early part of August one large order was booked for 14 tons of belt lacings and another for 5 tons.

Cisco Machine Tool Co., Cincinnati, Ohio, has purchased the Von Wyck Machine Tool Co. at Elmore St. and C. H. & D. R. R., Cincinnati, and will make a number of improvements in the building and equipment. The officers are: H. C. Busch, president; James J. Stephenson, vice-president; James A. Sebastian, secretary and treasurer; G. M. Horton, general manager.

Webster & Perks Tool Co., Springfield, Ohio and the Bauroth Machine & Tool Co., Toledo, Ohio, have consolidated. The machinery and equipment of the latter has been moved to Springfield and placed in improved manufacturing quarters. The additional equipment will materially increase the facilities of the Webster & Perks Tool Co. under whose name and management the consolidated business will be continued.

Bullard Machine Tool Co., Bridgeport, Conn., has granted an eight-hour day without reduction of wages to its employes. The plant will be run twenty-four hours a day in three shifts of eight hours each. The working hours of the first shift will be from 7 A. M. to 3 P. M., the second shift starting at 3 P. M. and finishing at 11 P. M. The third shift will be a balancing shift to keep the various departments caught up and their production uniform.

Thomas Coupling Co., Warren, Pa., will move its plant and offices to Troy, Pa., where a new shop is being erected. When completed, this plant will be up-to-date in every particular. The machinery equipment will consist of new machines throughout. The company has heretofore specialized on the Thomas "Little Giant" couplings for lineshafts, but in the new and enlarged quarters the manufacture of a complete transmission line will be undertaken.

Pratt & Whitney Co., Hartford, Conn., announces that it has opened an office and show-room at 16-18 Fremont St., San Francisco, Cal. S. G. Eastman, formerly manager of the company's Chicago office, is in charge. A large stock of Pratt & Whitney machines, small tools and gages will be carried for the convenience of Pacific coast customers. The company has also been appointed agent for the entire line of the Niles-Bement-Pond Co.'s machine tools, cranes, steam hammers, etc.

Mesta Machine Co., Pittsburg, Pa., is now building a complete line of hydraulic and steam hydraulic presses for piercing, drawing and forging. Fifteen of these presses were being put through the plant in July and August. The company is also making accumulators in various sizes in connection with hydraulic systems. One of these is exceptionally large in size and capacity, having a diameter of 32 inches and a stroke of 25 feet. It will deliver water to the press at a pressure of 2500 pounds per square inch.

Western Kieley Steam Specialty Co., 116-122 W. Illinois St., Chicago, Ill., announces that a writ of injunction was issued June 23, 1915, by the Circuit Court of Cook Co., state of Illinois, perpetually enjoining James McAlear, Kieley & Mueller, Inc., and the Kieley Specialty Co. from using the name "Kieley Specialty Co.," or any other corporate, copartnership or other name or style which includes the name "Kieley" and the word "Specialty" in any combination in any manner whatsoever.

Billings & Spencer Co., Hartford, Conn., has been elected to membership in the Rice Leaders of the World Association in recognition of its established reputation for conducting business as set forth in the association emblem and the qualifications for membership. The officers of the Billings & Spencer Co. are: C. E. Billings, president and general manager; F. C. Billings, vice-president and superintendent; Louis G. Parker, treasurer; E. H. Stocker, secretary; and F. H. Stocker, assistant secretary and treasurer.

Universal Machinery Co., 1910-1920 St. Paul Ave., Milwaukee, Wis., announces that the concern has purchased the drawings, patterns, tools and equipment for the manufacture of lathes from 12 to 18 inches swing, with from 6- to 8-foot beds and over, and that a large quantity of these lathes, especially the 16-inch by 6-foot size, is now being completed. The company also announces that later it intends to manufacture a number of other classes of machine tools, including drill presses, grinders, turret lathes, and screw machines.

George Schow, Suite 717, 624 S. Michigan Ave., Chicago, Ill., has organized a foreign trade service bureau for the purpose of developing export trade to Europe. Mr. Schow, with assistants, will visit Russia, Norway, Sweden, Denmark, England and France to establish and organize a chain of sales agencies for leading American manufacturers. He has spent many years in the foreign field, having built several manufacturing plants in Europe and equipped them with American machinery and tools. He represented the Fox Machine Co., Grand Rapids, Mich., for the past ten years. A limited number of lines of machine tools will be handled, none of which will conflict.

CONTENTS

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Make It Definite

Recently the writer rode by a clothing store which was conducting a big closing-out sale with the aid of signs which covered the whole front. One of the signs, the biggest of all, said this:—

ESTABLISHED 1892

Evidently the proprietor considered this fact a very important one to put before the public, and it was, because there are many mushroom concerns operating fake sales in big cities. His was a genuine sale of a real business—one that was established in 1892. But how long ago that was the writer did not stop to figure out. How many passersby would make the calculation, and how many would be impressed with the figures 1892? Very few, we believe. The sign should have read:—

ESTABLISHED 23 YEARS AGO

That would have told the whole story. Advertisement writers sometimes fail to get their points home definitely and effectively, because the passing reader must do some guessing, figuring or thinking himself, in order to grasp their significance. Such advertisements make only a weak impression.

If weight in a machine is important, it is better to say it weighs 4200 pounds than to say it is heavy. A paper weight is very heavy compared with a feather. If precision is a valuable point it is better to specify the actual degree of precision in thousandths of an inch than to merely claim accuracy. Words are common property. If power is a strong point, don't expect the reader to stop and wonder how powerful the machine is—he may just pass on. Tell him definitely and specifically, or better still, show him a picture of the machine doing a job demanding unusual power. That is the best method so far devised in mechanical advertising to demonstrate with convincing power the talking points of a machine. Show it doing practical work, and give the figures.

Two kinds of readers see every advertisement in MACHINERY—the casual and the specially interested. The more definite and specific the advertisement is, the better in both cases. The man specially interested is looking for real information. And the needs of the casual reader often send him back a day, a week or perhaps a month later, to re-examine the specific points noticed in passing. And thereby hangs a sale.

Oxy-Acetylene Welding and Cutting Equipment*

by

S. W. Miller †‡

WELDING is understood by the average person to mean the uniting of two pieces of steel or iron by heating to the temperature at which they become softened, without melting them, placing them together, and hammering, or in some way bringing them into intimate contact. As is well known, this cannot be done in the case of the common metals other than wrought iron or steel. It will however be readily seen, even by those unfamiliar with oxy-acetylene welding, that if two pieces of metal can be melted together the union will be sound and the joint invisible, even in the case of a casting. The fact that this could be done in the case of cast metals such as cast iron, cast steel, brass, etc., has been known for years, and the use of this method—termed "burning in" in foundries—is of frequent application. However, there is no assurance that a sound structure will be produced, because there is no possibility of observing what is going on at the junction of the old and new metals. The field of application is somewhat limited, and the results frequently unsatisfactory, owing to the conditions under which the work is done.

Ten years ago the oxy-acetylene method of welding and cutting metals was hardly more than a laboratory process, but in the course of these few years it has become one of the most important methods in the metal-working industries. It has made possible the making of repairs in broken machine parts that previously had to be replaced by an entirely new casting or forging. Not only has the process proved of the utmost importance in repair work, but its application has also proved of the greatest value in the manufacture of many articles. Much has been published relating to this process, but the articles have generally been descriptive of odd jobs. It is believed that the series of articles in Machinery beginning in this number will constitute one of the most complete records of the principles and practice of the art of oxy-acetylene welding that has so far appeared in any publication. The wide experience of the author in the practical application of the process, and the success he has attained in his business, vouches for the reliability of the extensive treatise here published.

If, however, some process were devised by which these difficulties could be overcome, that is, by which the action of the melted metal could be observed and the expansion and contraction could be taken care of, and by which it could be insured that sound unions would be made under all conditions, it is evident that a very useful addition to the mechanical arts would be produced, and one which would be of wide application. Such is the oxy-acetylene process, or, as it is frequently called, "autogenous welding," the word "autogenous" meaning "self-produced." The use of the term "autogenous" is rather unfortunate. As stated, it means self-produced, which is certainly not true in the case of a weld made by the oxy-acetylene process. The word "autogenous" is used in biology and physical geography in its correct sense. The idea that should be conveyed by any term describing this kind of a weld is that it is made with the same kind of material as that of which the piece is composed. The word "autogenous" does not convey this meaning.

Another idea that should be conveyed is that the process involves the melting of the metal during the making of the weld. It might be possible for one skilled in the dead languages to devise some term that would cover these points, but it would undoubtedly be a cumbersome word or combination of words, and therefore as unsatisfactory as the word "autogenous". Probably there is no word which conveys all of the ideas involved, but "homogeneous" would better explain the uniformity of the character of the weld than "autogenous". This is, however, a long word and not really descriptive of the process.

As stated, one of the essential features of the process is the melting of the metal, and as it is not true in all cases that the process uses the same kind of metal for joining as is in the original piece, it would seem that the term "fusion weld", which is short, descriptive and distinctive, should be entirely satisfactory. The author will therefore use it in these articles, employing also at times the term "homogeneous" to describe, when necessary, the uniform character of the weld and piece. In certain cases other gases than oxygen and acetylene are used, but it is not necessary to consider them here, as by far the most important work in fusion welding is done by the use of oxygen and acetylene.

* For previous articles referring to oxy-acetylene welding and kindred subjects see MACHINERY, August, 1915, "Fluxes for Oxy-Acetylene Welding"; June, 1915, "Fluxes for Oxy-Acetylene Welding"; October, 1912, "Pre-heating Metals to be Welded by Oxy-Acetylene Process", January 1912, "The Manufacture of Tubing by Autogenous Welding", and other articles there referred to.

† Address: Rochester Welding Works, 406 Orchard St., Rochester, N. Y.

‡ S. W. Miller was born in New York City and graduated from Stevens Institute with the degree of mechanical engineer. He served a special apprenticeship in the shops of the Pennsylvania Lines West of Pittsburg, and among other positions has held that of master mechanic of the Pennsylvania Lines, and superintendent of the American Locomotive Co. He is now the proprietor of the Rochester Welding Works, Rochester, N. Y., which he has conducted for five years past. His specialty is oxy-acetylene welding and research work connected with this branch of mechanical development.

Equipment for Welding

The welding equipment necessary will depend on the kind and amount of work to be done. It will include the necessary torches and hose, oxygen and acetylene generators or containers, pressure gages and reducing valves, dark glasses, etc. Only the best apparatus should be purchased, and as in many other cases, it is advisable to know that the manufacturer is sound financially and is going to continue in the business. The patent situation with regard to welding equipment, and even in regard to certain processes, is somewhat confused at the present time, and it is well to be sure that after it is cleared up repair parts can be obtained. The manufacturers of the best apparatus have more experience and are able to give assistance and information to the beginner which is not obtainable elsewhere. Poor apparatus is expensive to operate and therefore costly, even when the purchase price may appear low.

The Welding Torch

The first practical welding torch was devised by Fouché and Picard in France in 1901, and the first industrial application was made by them in 1903, after many experiments to avoid the danger from explosion. It was also found necessary to take care of "back-firing". If a tube of comparatively large diameter is filled with a gas and ignited at one end, the flame will travel to the other end at a certain speed, depending chiefly on the nature of the gas, but also on some other considerations, such as the size of the pipe. The flame from ordinary city gas or natural gas will not travel back through pipes of the size ordinarily used in carrying it. It has been found, however, that it is necessary to have a very small pipe to prevent this action in the case of acetylene, and also that the speed of travel of the flame is very high in the case of this gas. The dangers resulting from not taking proper precautions to prevent such flame-travel are well illustrated in the terrific mine explosions which have occurred and which have been duplicated in experiments on full-sized tunnels in which the speed of travel of the flame of burning mine gases has been accurately measured.

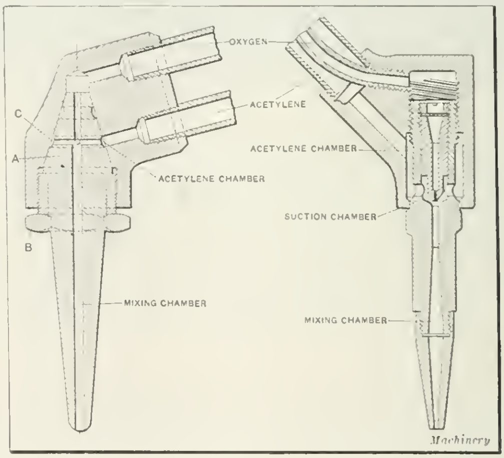

Fig. 1. Tip of So-called "Positive-pressure" Torch

Fig. 2. Tip of Low-pressure Torch

It is evident, however, that if the gas issues from the end of the pipe with a velocity greater than that with which the flame travels backward in the pipe, it will burn without any danger. In the early torches with comparatively large acetylene openings, it was necessary to provide a chamber in the torch filled with asbestos and provided with wire gauze partitions to prevent this back-firing; but it was later found possible to do away with this precaution if the acetylene holes in the head of the torch were made sufficiently small.

There are a large number of torches on the market, some of which are good and some of which are bad. One of the most essential features of a torch is the use of as little oxygen as possible in proportion to the acetylene used; early torches were very defective in this respect. The result of this was unsatisfactory welds, particularly in steel or any metal which is easily oxidized, such as aluminum. Modern torches give much better results, and it is believed that still further progress will be made in the future. The actual amount of oxygen used should be the same as that of acetylene, and this is quite closely approached at the present time in some torches.

It has been stated that the intensity of the flame from an oxy-acetylene torch is the highest that can be produced by the burning of gases. It is impossible to measure the temperature directly, but from theoretical considerations it has been determined that it is about 6300 degrees F. When it is considered that the melting point of cast iron is about 2100 degrees F., that of soft steel about 2600 degrees F., and of wrought iron about 2700 degrees F., it will be seen that there is no difficulty whatever in melting any of the metals.

Good welding can be done with any good torch; as stated, the best is the one which uses the least oxygen in proportion to acetylene, because it is less expensive in operation and tends to give a more neutral flame. The number and sizes of the torches depend on the character of work to be done, but there should always be a full set of tips provided. If this is not done experience proves that a time will come unexpectedly when a tip not on hand will be needed. Hose should be of the best quality. It is subject to quite heavy strains, and as the lighter the torch is, the easier it is to handle, the best quality is necessary to avoid excessive wear.

The oxy-acetylene welding torches which are in use at the present time may be divided into two general types, according to the pressure under which the acetylene is supplied. These are known as the low-pressure torch and the medium or "positive" pressure torch. The term medium-pressure is employed to distinguish torches of this type from the high-pressure torches which were used in France at the time that the oxy-acetylene welding and cutting industry was in the early stages of its development; this name also distinguishes the medium-pressure torch from the so-called low-pressure torch in which the acetylene is delivered at slightly above atmospheric pressure, while the oxygen is under a higher pressure than is the case with the medium-pressure type of torch. As the pressure under which the gas is delivered at the outlet from the tip or burner is necessarily that of the gas which is at the highest pressure, the low-pressure torch may deliver the mixed gas at a higher pressure than that under which the gases are delivered from the medium-pressure torch. The low-pressure torch works on the injector principle, the oxygen being under high pressure so that it flows rapidly through the duct in the head of the torch and draws in the acetylene. As the two gases flow on through the duct or mixing chamber in the head or burner tip, they are mixed together ready for combustion to take place as they emerge from the orifice at the end of the tip.

In the medium- or positive-pressure type of torch, both the oxygen and acetylene are under pressure, so that the flow of the acetylene is controlled without employing the injector principle. In this type of torch the oxygen and acetylene are carried to the head through two tubes which deliver the gas into a mixing chamber; and the mixed gas then flows through this mixing chamber or duct to the orifice at the tip of the burner. It will be noted that in both types of torches shown the oxygen and acetylene travel through a duct of considerable length, so that a complete mixture is obtained by the time the orifice at the tip is reached. Figs. 1 and 2 illustrate medium- and low-pressure torches.

Figs. 1 and 3 show the design of welding torch which has been adopted as a standard construction by the Davis-Bournonville Co., New York City. This torch is made in different sizes to meet the requirements of various classes of work. One of the basic principles of this type of torch—which was covered in the original French patent and also by patents in the United States—provides for using different sizes of interchangeable burner tips in a given size of torch, in order to adapt it for handling various kinds of work. The gases enter the tip at separate points, and the pressure of each gas is

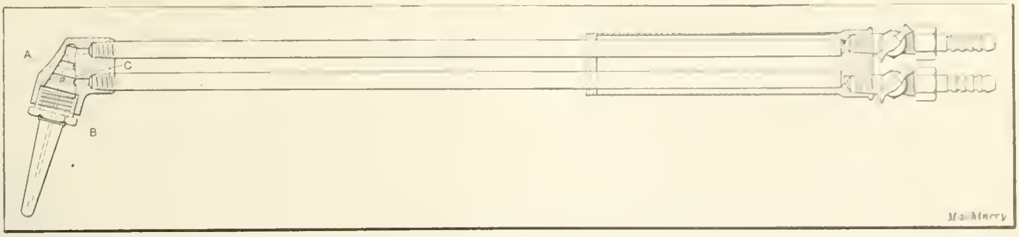

Fig. 3. Standard Type Positive-pressure Welding Torch as made by the Davis-Bournonville Co.

regulated to obtain exactly the required mixture. Each tip provides a size of flame suitable for various classes of work. In this connection it is interesting to note that a patented construction has been employed for fitting the burner tip into the head of the torch. Instead of using a threaded joint, it will be noted that the tip is tapered at *A* to fit a tapered socket in the head of the torch. This does away with trouble from damaged threads which resulted from the earlier construction in which the tip was screwed into the head; and leakage caused by expansion or contraction of the different parts of the torch due to variations in the temperature has been done away with. It will, of course, be evident that the tip is held in place in the head of the torch by the nut *B*, and that the oxygen enters the tip through the axial duct, while the acetylene enters the groove *C* which leads the gas to the four ports or transverse ducts in the tip.

Each of the two sizes in which this torch is made is provided with five different sizes of tips. The five smaller sizes provide for welding metal from 1/32 up to 1/4 inch in thickness, while the five larger sizes are employed for heavy welding operations on metal from 1/4 inch in thickness and up. When using each size of tip, a definite specified pressure of the oxygen and acetylene is secured through the use of pressure regulators. The pressure of the oxygen and the size of the axial duct in the tip bear such a relation to the pressure of the acetylene and the size of the ports or transverse ducts, that the ratio between the consumption of oxygen and acetylene is 1.14 to 1, which gives a neutral flame.

Fig. 2 shows a cross-section of the welding head of the Oxweld low-pressure or injector type of torch, as made by the Oxweld Acetylene Co., Chicago. The notation in the illustration shows the construction clearly. Fig. 4 shows a type of torch which differs in its arrangement to a considerable extent from the other two types shown. This is made by the Prest-O-Lite Co., Indianapolis, Ind. This torch is used for compressed or medium-pressure acetylene only, and therefore no injector device is necessary. The gases mix near the handle, and flow together along the full length of the stem. The handle of the torch is fitted with "anti-fire-back" chambers for both gases, filled with material through which it is impossible for the flame to pass.

Cutting Torches

In cutting iron and steel with the oxy-acetylene torch, the cut is made by the burning away of the metal along the line on which the cut is to be made. In order to understand the operation of the cutting torch, the reader must first grasp the idea that the burning of any matter—regardless of whether it is coal, oil, wood, or metal—is due to the chemical combination of the oxygen with the material which is being burned. In the case of iron and steel, this burning action can only take place at very high temperatures and for this reason the metal is heated by means of the oxy-acetylene flame, which raises its temperature to a point where the metal will combine with the oxygen; but ordinary air consists of one part of oxygen to four parts of nitrogen, and as a result the cutting action would be quite slow if additional oxygen were not supplied. In the early forms of cutting torches, this was done by attaching a separate tip at the side of the welding torch, which was connected to a third tube that carried an auxiliary supply of oxygen and discharged it against the heated metal. The flow of oxygen through this auxiliary tip was controlled by means of a valve which was held open by depressing a thumb-lever.

To avoid the use of this construction, and to provide a cutting torch on which only two hose connections are required, the Davis-Bournonville Co. is now manufacturing a torch of the form shown in Fig. 5. In this torch there are two rubber tubes which connect the torch with the supply of oxygen and acetylene. The torch itself is provided with three metal tubes *A*, *B* and *C*, and the tip is drilled with three longitudinal ducts *D*, *E* and *F*. Each of the ducts *D* and *E* delivers a mixed supply of oxygen and acetylene which burns at the tip of the burner, serving to heat the metal to the oxidizing temperature. So far as the method of effecting the mixture of the oxygen and acetylene is concerned, each of the ducts *D* and *E* is analogous to the ducts of the welding tip which has already been described. The central duct *F* delivers a supply of pure oxygen to the metal when the thumb-lever *G* is thrown over to open the valve in tube *A* to the oxygen supply. This pure oxygen strikes the metal which has been heated to a high temperature by the oxy-acetylene flame and causes a rapid oxidation or burning of the metal to take place. In this way the metal is burned away along the line of the cut, but with a narrow saw-like kerf which, when the cutting is skillfully done, does not give the metal the appearance of having been burned or melted. The torch is made with three sizes of interchangeable tips for cutting different thicknesses of metal. The smallest tip cuts metal from 1/4 to 3/4 inch in thickness, the medium tip from 1 to 3 inches in thickness, and the largest size from 3 inches in thickness up. As in the case of the welding tips, each size of cutting tip uses the oxygen and acetylene under specified pressure.

Fig. 6 shows a group of the different styles of welding and cutting torches manufactured by the Davis-Bournonville Co. A large size of welding torch is shown at *A*, this being a standard torch for performing medium and heavy welding operations in making boiler repairs, and for general shop

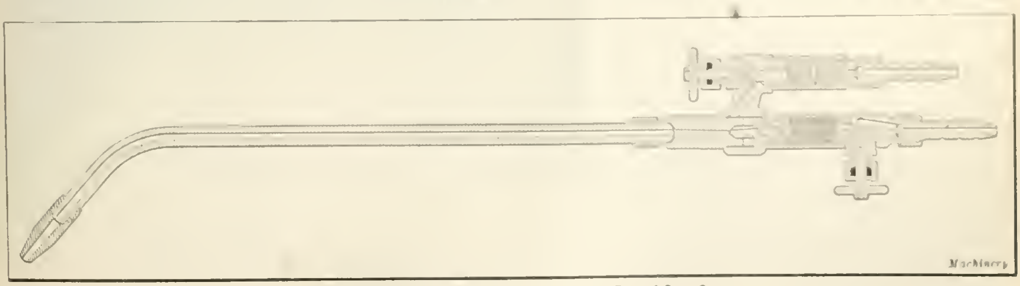

Fig. 4. Type of Welding Torch made by the Prest-O-Lite Co.

work. The torch is fitted with a set of the five large sized welding tips, and is adapted for welding metal from 5/16 inch in thickness up. It is 20 inches long and weighs 2 pounds. A special torch of this size is made in a 3-foot length for very heavy work where it is desirable to enable the operator to get as far away from the work as possible, owing to discomfort experienced from the intense temperature of the metal. The standard two-hose cutting torch is shown at *B*. This torch is 20 inches long and weighs 40 ounces. What is known as a "manufacturer's" torch is shown at *C*. This torch meets the requirements for light and medium sheet metal welding; it is especially adapted for manufacturing operations on boilers, steel barrels, iron and steel tanks, cylinders, etc. A small size of the standard welding torch is shown at *D*, this torch being convenient for use on light and medium sheet metal welding and on light repair work. Its length is 14 inches and weight 18 ounces. This torch is provided with a set of the five small sized tips, and is adapted for welding metal from 1/32 to 5/16 inch in thickness. A torch for circular hand cutting is shown at *E*. This torch is of the same general type as the standard cutting torch, but is fitted with a compass attachment to adapt it for cutting circular holes. Torches for use on cutting and welding machines are shown at *F* and *G*, and a torch with a water-cooled head and tips at *H*. This is for use on heavy welding where there is a tendency for the head and tip of the torch to become overheated from the intense heat radiated by the metal that is being operated upon. This is especially true in cases where the head of the torch is surrounded by the heated metal, and to overcome this difficulty a supply of cooling water is circulated through the head and tip by means of two extra hose connections provided for the purpose. At *I* is shown an oxy-hydrogen cutting torch in which hydrogen gas is burned in place of acetylene.

In Fig. 7 is shown the Oxweld cutting torch, which differs from the welding torch made by the same concern mainly in that an additional oxygen duct is provided.

Regulating Valves

Regulating valves should be kept in good condition. Unless this is done, so that the reduced pressure remains constant under all conditions, the action of the torch will be irregular and unsatisfactory. In the course of time the diaphragms become buckled, and have to be renewed. This and dirt in the small passages are the only difficulties in a well designed valve. Gages and regulating valves should be suitable for the work, and of substantial design. The gage capacity should be about one and one-half times the maximum pressure used. The gages for welding torch pressures should be graduated in single pounds, and need not have over 50 pounds capacity. For cutting torches the gages should be graduated to about 250 pounds. Good gages give practically no trouble.

Fig. 8 shows a section of the Oxweld Acetylene Co.'s oxygen welding regulator which reduces the oxygen tank pressure, about 1800 pounds, to that necessary for welding, as the latter pressure does not exceed from 10 to 30 pounds. Its action is as follows: The oxygen enters from the tank through passage *E* to valve *F*, the seat for which is held away from the valve by the spring *K* acting through the diaphragm *C*, which can be adjusted by turning handle *H*, to obtain any desired pressure. The oxygen then passes into chamber *D*, and when there is sufficient pressure, the diaphragm is forced to the left, allowing the small spring *M* to pull the valve seat against the valve and shut off the supply of oxygen. As soon as the pressure falls, the action is reversed, and the supply of oxygen is renewed. The oxygen passes from the chamber *D*, through a connection not shown, to the hose. The regulator for cutting is similar in design to that for welding, but as the cutting pressures may run up to 100 pounds, it is made heavier, and provides for a larger flow of gas. The differences in conditions make it necessary to use different regulators for welding and cutting, and good results will not be obtained unless the proper regulator is used.

Oxygen

Oxygen is a gas which constitutes about 20 per cent of the air in the atmosphere, the other 80 per cent being nitrogen, a gas which does not support combustion. Oxygen, however, is the active agent in maintaining life and combustion; its properties have been known since the end of the eighteenth century. Oxygen can be produced in several ways at such a price as to make it commercially useful. At the present time the largest proportion of it is made by the liquid air process invented by Dr. Linde in 1897. Almost every one remembers the demonstrations a few years ago of liquid air, and of the many curious and interesting things that were done by its use. Most of these things, however, were mere laboratory experiments, and its most important application, that of producing oxygen for commercial use, was not thought of at that time. The possibility of producing oxygen in this way has been one of the chief factors in promoting the use of oxy-acetylene welding, as it is has reduced the cost of the oxygen. The process simply consists in liquefying air and allowing it to again vaporize. The boiling points of oxygen and nitrogen are considerably different; hence, the gas desired may be collected and the other allowed to evaporate.

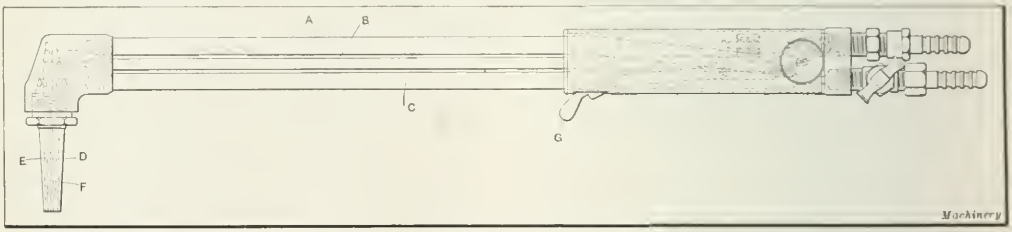

Fig. 5. Davis-Bournonville Cutting Torch

The oxygen, after purification, is compressed into cylinders or tanks, and can then be shipped wherever it is desired for use. The principal impurity in oxygen thus made is nitrogen, a percentage of which is likely to be present, and, which even when small, has an adverse effect on a weld, and is particularly objectionable when using a cutting torch.

The next most important process for producing oxygen is the electrolytic. The decomposition of water by electric current into its two elements, oxygen and nitrogen, has been practiced for many years; but it was not until the cost of electric current was reduced to a low point that it was possible to use this process commercially. It was also found by experiment and test that the production of an efficient and safe electrolytic cell was not an easy matter. It is, however, at the present time a thoroughly practical process, and one which is gaining ground daily. It is exceedingly flexible, and while the cost of cells is prohibitive for a small plant, yet, where considerable oxygen is used with regularity and the expense can be afforded, it is much used, as it produces the purest commercial oxygen. The only impurity in it of any importance is a small percentage of hydrogen, which does not injure the weld, nor is it of disadvantage in cutting, as it burns, producing heat.

There are a number of other processes for producing oxygen, the only important one being by heating chlorate of potash in a retort, passing the gas through a washing apparatus and collecting it in a gasometer. It can then be compressed to the required pressure and used as needed. Oxygen should never be generated from chlorate of potash under a pressure of more than a few ounces, on account of the danger of explosion. Oxygen, particularly when moist, as after passing

through a washer, attacks the piping, etc., resulting in a weakening of the pipes, which cannot be generally detected in time to prevent serious results. Oxygen is also liable to cause an explosion when it is heated and comes into contact with any carbonaceous material, such as splinters of wood, in the retort. Serious accidents have occurred from this cause. The method, however, is perfectly safe if care is taken and apparatus is procured from reliable manufacturers. The generation of oxygen from chlorate of potash under pressure is considered much more hazardous.

The gas produced by the chlorate-of-potash process is quite expensive, and contains a certain amount of chlorine which is detrimental to the strength of the welds and, therefore, unsatisfactory. This chlorine, however, can be removed entirely if proper apparatus is used, and under certain circumstances, as where the cost of shipping tanks back and forth is very high, the use of chlorate of potash for generating oxygen may be advisable. At the present time, the European war has greatly increased the cost of chlorate of potash, and this should be considered in making estimates.

As commercially used in the oxy-acetylene welding industry, oxygen may be made or bought. The latter is the cheaper method if the location is near a large plant making oxygen as a commercial product, as it saves the installing of a somewhat expensive apparatus. If it is necessary to make oxygen, either on account of cost or irregularity in delivery, the best process on a small scale is the heating of chlorate of potash in closed retorts, the resulting gas being passed through washers and collected in a gasometer, as described, from which it is pumped into tanks by a small compressor, generally belt driven. The usual maximum pressure in the tanks is about 300 pounds, and they generally have a capacity of 100 cubic feet of oxygen measured at atmospheric pressure. These tanks are convenient for shop use, but for outside work they are somewhat heavy and bulky, and can be replaced with advantage by smaller tanks of the same capacity, but having pressure of about 1800 pounds per square inch. These tanks are not sold, but are furnished, filled with oxygen by the oxygen companies on reasonable terms, and when empty may be returned for refilling. Oxygen can be obtained in this way much more cheaply and conveniently under ordinary conditions than by making it. It should be noted that all tanks shipped must comply in all respects with the requirements of the Federal Bureau of Explosives.

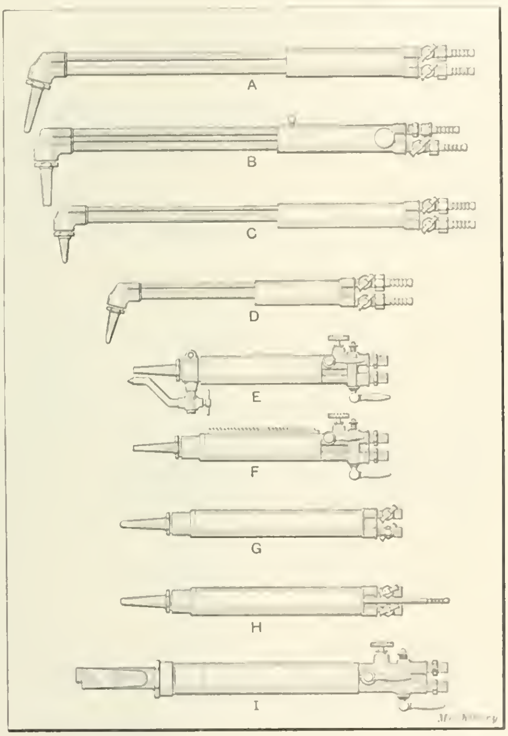

Fig. 6. Different Types of Cutting and Welding Torches

Potassium-Chlorate Method of Oxygen Generation

A diagrammatic view of the apparatus used for making oxygen by the potassium-chlorate method is shown in Fig. 9. The potassium chlorate is sealed in a retort *A* and heated by gas burners *B*. The heating causes the potassium chlorate to give off oxygen, but this reaction would proceed too rapidly if the charge placed in the retort consisted of pure potassium chlorate. It has been found, however, that by mixing thirteen pounds of manganese dioxide with 100 pounds of potassium chlorate the chemical reaction will proceed more slowly. The manganese dioxide plays no part in the chemical reaction, but is merely used as a retarding agent. Ten pounds of the mixture is put in the retort at a time. The gas from the retort is delivered through a series of three washers *C*, which serve to remove impurities, after which it passes on and is collected in the gasometer *D*. From the gasometer the oxygen is piped to the air compressor *E*, which compresses it into cylinders at the required pressure ready for use. The purity of the oxygen obtained by this method is slightly over 97 per cent.

Manufacture of Oxygen by the Liquid Air Process

In the manufacture of oxygen by the liquid air process, the oxygen is obtained by making a separation of the oxygen and nitrogen, which are the chief constituents of air. This is done by first bringing the air to the liquid condition by the combined action of high pressure and low temperature, and then separating the oxygen from the nitrogen by taking advantage of the difference in the boiling points of these two constituents of the air when in the liquid condition. This method allows oxygen to be obtained at a relatively low cost, but the plant required is only suitable for working on a large scale. Consequently, the method is suitable for the use of manufacturers of oxygen rather than for the users of welding and cutting torches who desire to make only enough oxygen for their own use. It is for this reason that many users of welding and cutting torches have found it more advantageous to buy their oxygen in cylinders ready for use than to make their own supply in a potassium chlorate or an electrolytic plant. To meet the demand from this class of consumers, the Linde Air Products Co. has established generating plants in thirty-seven of the most important industrial centers throughout the United States. These plants supply oxygen to the consumer, which is contained in pressure cylinders ready for use; and as a result of these numerous plants, many consumers get the advantage of buying their oxygen without having to pay freight on the filled cylinders or on the empty ones which must be returned to the generating plants. In many cities where there is not enough manufacturing to warrant the maintenance of generating plants, warehouses have been established in which a supply of filled oxygen cylinders is carried so that orders can be promptly filled, but in these cases the price is necessarily higher, as freight charges must be included.

It has already been stated that the method by which oxygen is obtained from the mixture of nitrogen and oxygen in the air, consists of first bringing the air to the liquid condition by the combined application of high pressure and low temperature, and then separating the oxygen and nitrogen by allowing the nitrogen to boil off from the mixed liquid. Fig. 10 shows a diagrammatic view of the plant employed for this purpose. This diagram gives a comprehensive idea of the principle involved and the general character of the equipment which is used. The diagram is presented simply as an adjunct to the following description, and many details have been omitted. It is well known that atmospheric air contains appreciable quantities of carbon dioxide gas, and the first step in the manufacture of oxygen by the liquid air method is to remove the carbon dioxide. This is done by drawing the air through a pit containing lime, which absorbs

the carbon dioxide by a chemical reaction resulting in the formation of a compound known as calcium carbide. After leaving the lime pit, the air goes to a five-stage compressor in which the pressure is raised to 3000 pounds per square inch, and means are provided for cooling the air between each stage of compression so that it leaves the compressor at about room temperature. After leaving the compressor the air is delivered through pipe *A* to the "fore-cooler", in which the first reduction of temperature is effected. This fore-cooler is equipped with three sets of coils. The first coil contains carbon dioxide supplied from an external refrigerating system, and the other two coils contain the oxygen and nitrogen gas which have already been separated from the liquid air and are at very low temperatures.

As a result of its passage through the fore-cooler, the temperature of the air has been reduced to about zero degrees C. After passing through the fore-cooler, the air enters pipe *B* which carries it to a third unit of the plant, known as an "interchanger." This pipe *B* leads to a coil *C* which is submerged in the liquid air in the interchanger, and the purpose of passing the air through this coil will be subsequently explained. After leaving the coil *C*, the air, which it will be remembered is at a pressure of 3000 pounds per square inch, is allowed to pass through an expansion valve *D*, where the pressure is suddenly released. This results in a rapid expansion of the air, that, in turn, causes a further reduction of temperature, with the result that the air is brought to the liquid condition by this application of the Thomson-Joule principle. The liquid air passes through the vertical pipe to the top of the interchanger where it is discharged through the atomizer *E*, which is located at the top of a tower filled with perforated baffle plates *F*. The liquid air passes down over these baffle plates and finally reaches the container in which the coil *C* is submerged.

We are now in a position to go back to the reference which was made to the purpose of the coil *C*. It will be recalled that the air left the fore-cooler at a temperature of approximately zero degrees, and although this is a relatively low temperature, it is quite high when compared with the boiling points of liquid nitrogen and oxygen, which are 194 and 184 degrees C below zero, respectively. The result is that the passage of the air through coil *C* causes the liquid in the container to boil in the same way that a coil containing high-pressure steam would cause water to boil. But as the boiling point of nitrogen gas is 10 degrees higher than that of oxygen, the nitrogen must be removed from the liquid before the oxygen will start to boil. The result is that the nitrogen gas passes up through the baffle plates *F* in the tower, and in so doing heats the liquid air sufficiently to remove a large part of the nitrogen before the liquid actually reaches the container. The boiling of the nitrogen sets up a pressure in the interchanger which is sufficient to force the liquid oxygen up through the pipe *G* into the inner tube of the double coil *H* which surrounds the tower in which the baffle plates *F* are located; and the nitrogen which has been removed from the mixture passes down through the outer tube of the coil *H* which surrounds the tube carrying the oxygen. The result is that the oxygen gradually rises through the inner tube of the coil, and while doing so changes from the liquid to the gaseous condition.

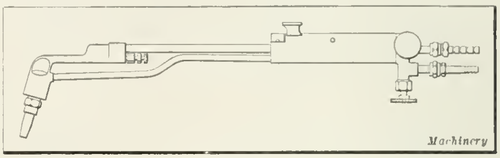

Fig. 7. Oxweld Cutting Torch

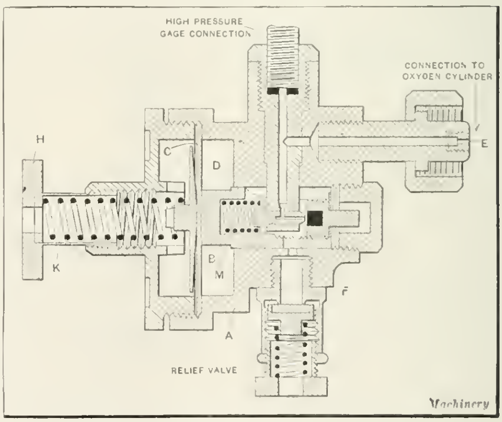

Fig. 8. Diagrammatic Section of Oxygen Welding Regulator made by the Oxweld Acetylene Co.

In order to keep the temperature of the interchanger down, the coils and other portions of the apparatus are carefully insulated by packing the space in the outer case with lamb's wool, which effectually prevents the absorption of heat from the outside.

After passing through the coil *H* in the interchanger, the pipes containing the oxygen and nitrogen—which are still at a very low temperature—are carried over to the fore-cooler where they enter two coils. It will be recalled that in the preceding description of the fore-cooler, mention was made of these coils through which the low-temperature oxygen and nitrogen were passed. The purpose is to utilize the low temperature of these gases to assist the carbon dioxide coil in reducing the temperature of the air as it passes through the fore-cooler on its way to the interchanger. After passing through the coil in the fore-cooler, the oxygen and nitrogen pass out through pipes and the oxygen is ready to be collected in compression cylinders. At the present time the only use for the pure nitrogen gas which is made by this method is in incandescent electric light bulbs. Nitrogen is very suitable for this purpose because it is chemically inert, and so does not have any effect upon the incandescent filament. Research work is also done with the view of developing a method of "fixing" the nitrogen, *i. e.*, of developing a method of chemically combining the nitrogen with some other element or elements so that it may be used as a fertilizer, and in various chemical industries. The Linde Air Products Co. is prepared to guarantee a purity of 98.5 per cent for its oxygen, and as a matter of fact, the purity is in the neighborhood of 99 per cent. The 1 per cent of impurity is nitrogen which is chemically inert, so that it has little detrimental effect upon the steel or other metal which is being welded.

The Electrolytic Method of Generating Oxygen

For those shops which use oxygen in sufficient quantities to warrant the installation of a plant for generating the gas by the electrolysis of water, there is probably no more satisfactory method. It is well known that water is composed of two parts of hydrogen chemically united to one part of oxygen, and that when an electric current is passed through water—with the necessary amount of sodium hydroxide, potassium hydroxide, or some other chemical dissolved in it to make the solution a conductor of electricity—the chemical bond between the hydrogen and oxygen will be broken down. The result is that hydrogen gas is given off at the cathode or negative pole, and that oxygen is liberated at the anode or positive pole of the electrolytic cell.

In the manufacture of oxygen by this method, the electrolyzer in which the dissociation of the hydrogen and oxygen takes place is so arranged that the two gases are kept separate from each other and carried off through individual pipes. Fig. 11 shows the arrangement of the type of electrolytic cell made by the Davis-Bournonville Co. The reservoir in which the potassium hydroxide solution is contained is divided by a metal plate *A*; and an anode *B*, on which the oxygen is formed, is suspended in the solution on each side of the partition. The cell itself is made of metal, and the container and metal partition form the cathode or negative pole from which hydrogen is evolved. To provide for keeping the oxygen and hydrogen separate, an asbestos cur-

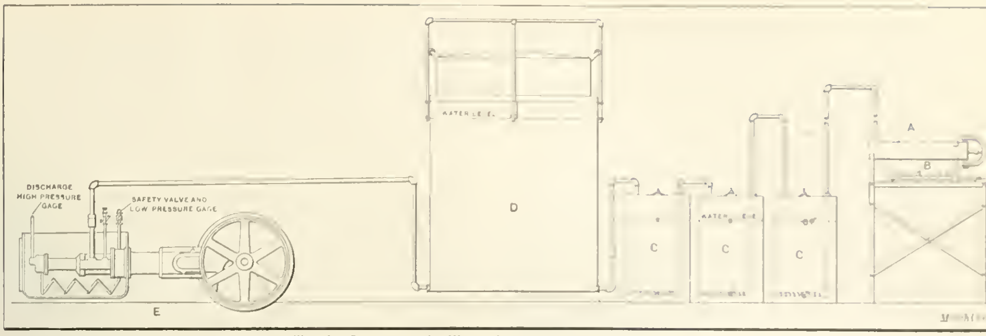

Fig. 9. Diagrammatic View of Potassium-chlorate Oxygen Plant

tain surrounds each of the anodes B; this curtain extends almost to the top of the cell and keeps the oxygen separate from the hydrogen. The oxygen gas is carried off through the two pipes D which are connected with the off-take pipe E, that carries the oxygen from all of the cells to the gas holder in which it is collected. Similarly, the hydrogen is carried off from the cell through pipe F, which is connected with pipe G that carries the hydrogen from all of the cells.

When the electric current is passed through the cell, the entire volume of water is placed in a state of charge, which results in the liberation of oxygen at the anode and hydrogen at the cathode. There is no tendency for these gases to be liberated at any point except at their respective terminals in the cell, and so the asbestos separator C will keep the two gases from mixing. It is important, however, for the pressure of the oxygen and hydrogen to be kept the same, in order to avoid the tendency for the gas at higher pressure to be forced through the asbestos curtain. This equalization of the pressure is provided for by having the two pipes E and G pass the gas which they carry through two water seals. These are arranged so that the pressure head of water is the same in each seal, and, as a result, the back pressure exerted on the oxygen and hydrogen leaving the cells is maintained exactly the same. Some factories make a practice of collecting the hydrogen gas which is generated, for use in oxy-hydric cutting torches; and, in certain cases, the hydrogen has been employed for filling the bulbs of incandescent electric lights. In many shops, however, it is not found worth while to attempt to utilize the hydrogen, and in such cases this gas is allowed to pass off into the atmosphere.

Fig. 12 shows the arrangement of a complete plant for the generation of oxygen and hydrogen by the electrolytic method, in which provision is made for collecting both the oxygen and hydrogen. In this illustration, the motor generator which supplies current to the electrolytic cells is shown at A. The cells are shown at B; the gas holders for the oxygen and hydrogen, at C and D, respectively; the compressors for compressing the oxygen and hydrogen, at E and F; and the pressure tanks to which the compressors deliver the oxygen and hydrogen, at G and H. It will also be noted that provision is made for connecting portable cylinders I and J direct to the compressors so that these cylinders may be filled with oxygen and hydrogen

In presenting a description of the operation of the plant, it will simplify matters to refer only to the equipment used for the generation and compression of the oxygen The equipment shown for handling the hydrogen gas works on exactly the same principle, so that one description will apply in both cases. Upon leaving the electrolytic cells B, the oxygen is passed along to the gas holder C, which is of the standard type in which an inverted bell is suspended over water by means of a counterweight. As the oxygen enters the gas holder the bell rises, and when it has reached a predetermined limit—or when the gas holder is filled to its capacity—an automatic switch is thrown which starts the electric motor that drives the oxygen compressor E. This results in pumping oxygen out of the gas holder and compressing it in the oxygen pressure tanks G. These tanks are usually arranged for a maximum pressure of 300 pounds per square inch, and when this has been obtained a pressure regulator of the Bourdon spring type, which is located on the switchboard K, throws a relay that, in turn, trips the compressor motor switch and stops the compressor.

While the compressor is in action it will be evident that oxygen is being withdrawn from the gas holder C, with the result that the bell descends; and when the bell has reached the lower limit of its travel—so that practically all of the oxygen has been pumped out of the holder—an independent electric switch will be thrown to stop the compressor motor. When the compressor is stopped in this way, the motor gen-

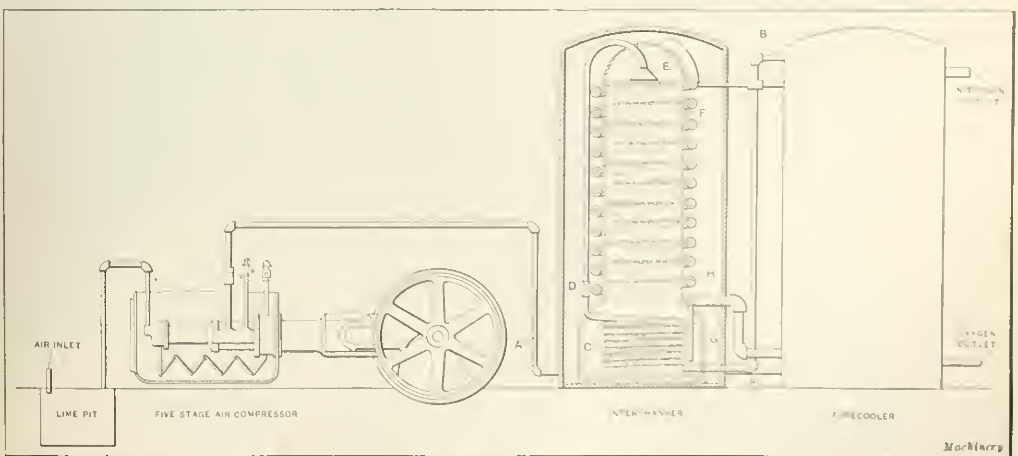

Fig. 10. Diagrammatic View of a Liquid-air Oxygen Plant

erator A continues to run so that the supply of oxygen from the electrolytic cells B is continued until the gas holder C is filled to its capacity. When this result is obtained the normal sequence of events would be for the switch which governs the compressor motor to be thrown over, in order to start the compressor. It may happen, however, that the pressure in the oxygen tanks G is at the maximum of 300 pounds per square inch; when such is the case means are provided to make it impossible for the switch to be thrown to start the compressor motor. Under such conditions, an automatic switch is thrown, which stops the motor generator and cuts off the generation of oxygen in the electrolytic cells. As soon as the oxygen in the pressure tanks has been partially consumed, thus lowering the pressure, the compressor motor automatically starts to deliver more oxygen to the pressure tanks, with the result that the gas holder starts to descend. This, in turn, closes the switch controlling the motor-generator set, which restarts the motor-generator and causes the electrolytic cells to begin to generate more oxygen. The 500-ampere cell requires 1¼ gallon of water to be added each twenty-four hours, and the 1000-ampere cell requires 2½ gallons of water per twenty-four hours; otherwise the only attention necessary is the maintenance of the different units of the plant in running order, and this takes very little time. The purity of the oxygen generated by this process is in excess of 99 per cent.

Acetylene

Acetylene has been known for a great number of years, having been discovered in 1836, but until 1892 its production was merely a laboratory experiment. In that year calcium carbide was accidentally manufactured in an electric furnace at the works of the Willson Aluminum Co., in North Carolina. It was considered of no value and was thrown into the river. It was then accidentally discovered that the gas arising from it when thrown into water, would ignite, and a further investigation proved that this was acetylene. Its commercial exploitation began shortly afterward in its use for isolated lighting plants, as in a suitable burner it produces an intensely white and very pleasing flame; and as the generation is comparatively easy and safe, it has attained a wide popularity.

Acetylene is composed entirely of carbon and hydrogen, both of which elements, when combined with oxygen, burn, producing heat. Acetylene has the property of having more heat units per cubic foot than any other gas; it contains in this volume 1630 heat units, or nearly five times as many heat units as hydrogen. Consequently, if it were completely burned, it would produce the maximum temperature possible in a gas flame. This was appreciated by a number of experimenters, but they found great danger from its explosive properties. For instance, if mixed with air and compressed to about 30 pounds gage pressure, it explodes. Even if not mixed with air it cannot be compressed above this pressure and subjected to heat, shock or other disturbances without being decomposed into its elements; and then a violent explosion results. This is one reason why acetylene generators must be properly designed and taken care of; also, to prevent overheating, a large excess of water should be used, as one pound of carbide will raise the temperature of one gallon of water 90 degrees F.

It has been found, however, that certain liquids have the peculiar property of absorbing many volumes of acetylene. The most satisfactory liquid for this purpose is acetone, and this is used in all compressed acetylene tanks at the present time. It is also found advantageous and safer to fill these cylinders completely full of asbestos or other porous material, so that there will be no chance of dead spaces which might otherwise become filled with air and make the cylinders more or less unsafe. In this porous material is contained the acetone, and in the acetone is dissolved the acetylene. It is perfectly safe to compress acetylene into such tanks, and they have been subjected to the most violent shocks, such as firing a rifle bullet through them, dropping large weights on them, and even putting them into hot fires, without explosion. Acetylene may also be produced in a generator suitable for the purpose by bringing in contact water and calcium carbide. This produces gas more cheaply than that furnished in tanks, and if the generator is of the proper design, it will be found entirely satisfactory for most welding.

Generating Acetylene Gas

When calcium carbide is brought into contact with water, acetylene is given off and slaked lime left as a residue. There are three kinds of generators, the essential differences being the methods of uniting the carbide and the water. These methods are:

1. Dropping the carbide into a large body of water.
2. Allowing the water to rise slowly against the carbide.
3. Dropping the water on the carbide.

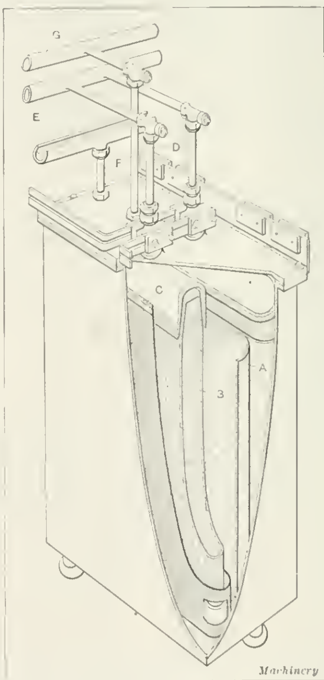

Fig. 11. One of the Cells used in Electrolytic Oxygen Manufacture

The first is by far the safest method; it keeps the pressure uniform, gives cooler and purer gas, and is in every way to be preferred. In any case, the directions furnished by the makers of the generator should be strictly followed, or an explosion may result. The safety valve should be tested daily to be sure that it is working properly; the regulator should be kept in condition so that the working pressure will be kept within proper limits; leaks of all kinds should be carefully avoided; and the feeding mechanism should be stopped, and the cut-out valve in the supply pipe shut off every night or when the generator is out of service for any length of time. Keep flames or lights of any kind away. An excess of precaution is advisable in handling acetylene, and the matter of insurance should receive special attention, as improper location or installation may invalidate any insurance in force. If the generator is worked too hard it will become hot, and in this condition is dangerous. The maker can say how many torches of a given size should be connected and working at one time. If a generator becomes hot for any reason, stop the use and generation of gas until it is cooled down, no matter how long it takes.

A generator with carbide in it should never be moved around; it it liable to be upset, and the water, coming suddenly in contact with a large quantity of the carbide, will raise the pressure to the explosive point, which is about 30 pounds per square inch when acetylene has any air mixed with it. Fatal accidents have occurred from this. Freezing must be guarded against, but if thawing out is necessary, hot water applied externally is the only safe method to use. Where flash-back chambers are provided, keep them in proper condition, filling them with water every time carbide is put in. If any part of the generator is not understood by the user, consult the manufacturers; they will give full instructions and advice.

The end of the discharge pipe for the residue should be where it can be seen, so that if there is a loss of water due to a leaky valve, it can be noticed. If water is gradually lost, it may in time entirely drain out, and the generator will run hot. It will not give a sufficient or uniform supply

of gas and will be in a dangerous condition. Do not open the hand-hole, or any opening in the body of the generator, under such conditions, as it is liable to produce an explosion. Let the generator cool down until it reaches the room temperature. The proper method of handling depends on the type of generator, and if one is not sure what to do, he should consult the manufacturer. Explosions will never occur if the generator is watched and handled in the proper way.

There are two general types of acetylene generators used in the United States, which are called high- or medium- and low-pressure, respectively. The first uses acetylene under a pressure as high as 6 pounds per square inch at the torch, while the other uses a pressure of only about as many ounces. The torches for these two systems are entirely different in construction, and must be handled differently in operation. Care must be taken to follow the instructions of the manufacturers in regard to their operation in every case, or satisfactory results will not be obtained.

Impurities in Calcium Carbide

Calcium carbide, being made of coal or coke and lime by heating them together in an electric furnace, naturally contains some of the impurities in these substances. Neither coal nor coke is free from sulphur, nor is lime entirely free from phosphorus; therefore, acetylene made in a generator will contain more or less sulphuretted hydrogen and phosphoretted hydrogen, the amount depending on the purity of the original materials. These impurities, and the exceedingly fine dust that is sometimes carried over with the gas, give to the welding flame a somewhat yellow color which is not noticed when dissolved acetylene is used, the flame then having a slight violet tinge.

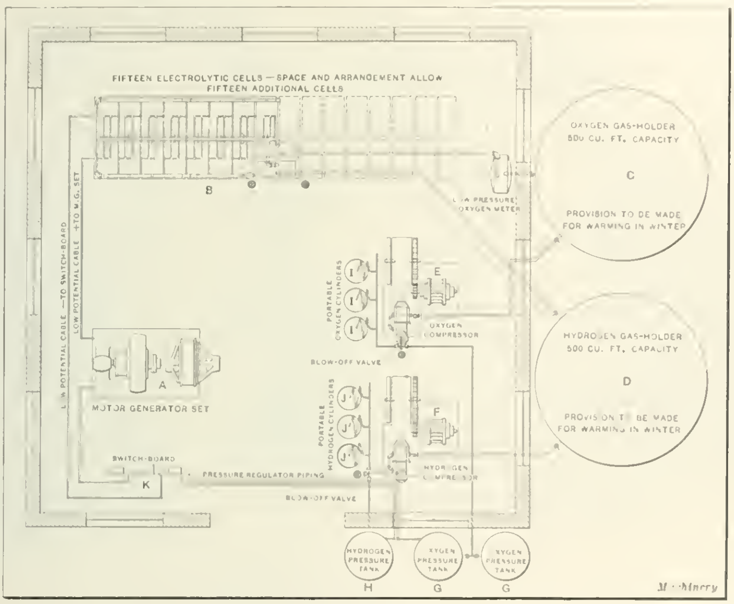

Fig. 12. Plan of Electrolytic Oxygen Plant

The presence of these sulphur and phosphorus compounds can be shown by a very simple test. Moisten a piece of white blotting paper with a 10 per cent solution of nitrate of silver and turn a jet of acetylene on it. If these gases are present, the moistened spot will turn black, and a rough idea may be obtained of the amount of the impurities by the rapidity with which the action takes place. Inasmuch as both sulphur and phosphorus, when present in more than very slight amounts, are injurious to iron and steel, it is necessary to provide for the removal of these gases from acetylene, if important welds are to be made. The importance of purifying generator acetylene is not realized in this country, although both in England and on the Continent purifiers are in quite general use. They are of comparatively simple construction, and it is believed that it is only a question of time until their use will be general in this country.

Sulphur and phosphorus compounds are not so injurious to other metals as to iron or steel, and as the quantities are small when good carbide is used, ordinary work is not seriously damaged. The dust carried over the gas consists very largely of lime, which has an exceedingly injurious effect on any steel or iron weld.

A yellow deposit on the lime residue indicates that the generator has been working at too high a temperature, and in fact, a dangerous one. It is not often that this is found.

Generators for Acetylene Gas

Fig. 13 shows the form of generator developed by the Davis-Bournonville Co. for use with its positive-pressure (often erroneously referred to as high-pressure) torches. In this generator the carbide is introduced into the hopper *A* through two filling holes at the top of the generator. As acetylene is an extremely inflammable gas, it must be handled with considerable care. The operation of acetylene generators has been made the subject of careful study in the laboratories of the fire underwriters. At present, the rules of the insurance companies require a generator to be operated under such conditions that the gas will be produced at the rate of 1 cubic foot per pound of carbide per hour. As a result, means must be provided for dropping the calcium-carbide from the hopper *A* into the water in the generator at a prescribed rate. This is accomplished by means of a clock motor which is driven by the counterweight *B*. This motor causes the rotation of a disk at the bottom of the hopper, and as the disk revolves the carbide is swept off by an inclined plate or vane.

With acetylene gas under pressure of more than two atmospheres — approximately 30 pounds per inch — there is danger of endothermic explosion; and to provide an adequate margin of safety, the pressure of the gas in the generator is not allowed to exceed 15 pounds per square inch. When the pressure reaches 15 pounds per square inch, the first one of these two diaphragms is distended, with the result that a locking device stops the clock motor and hence cuts off the supply of calcium-carbide. As a safety device, a second flexible diaphragm is provided which operates at a pressure slightly above 15 pounds per square inch. In case the first diaphragm should fail to work, the second one would rise and engage a locking clutch which stops the motor. In addition, a safety valve is provided at *C* which will blow off in the event of the pressure's rising above the required point. This safety valve is connected to a pipe which extends up above the roof of the generating house so that the acetylene may be discharged into the atmosphere. In this way all danger of explosion is eliminated.

Lump carbide, designated as the $1\frac{1}{4}$ by $\frac{3}{8}$ inch size, is used in the generator. When this carbide is dropped from the hopper, it sinks to the bottom of the water in the generator, and as a result the acetylene gas which is liberated must rise through the full depth of water. Two advantages are secured in this way: first, the acetylene receives a preliminary

washing in the generator; and second, the heat produced by the chemical reaction of the carbide with the water is absorbed by the water so that the gas is passed on at a relatively low temperature. Upon leaving the generator, the gas passes into the pipe *D* which carries it to the bottom of the flash-back chamber *E*. This chamber is full of water and serves the double purpose of giving the gas a second washing and forming a water seal between the service pipe and the acetylene in the generator. After passing through the flash-back chamber the gas enters the filter *F* which is filled with mineral wool that serves to remove suspended impurities, and upon leaving this chamber the gas enters the service pipe *G*, from which connection is made direct to the torches. It is not within the scope of this article to give instructions regarding the operation of the acetylene generator, but the manufacturers issue a booklet in which complete information is given in regard to this branch of the welding and cutting industry. The generators are made in five sizes, with capacities for charges of 25, 50, 100, 200, and 300 pounds, respectively. One pound of carbide will produce 4½ cubic feet of acetylene, so that the different sizes of generators will produce 112, 225, 450, 900, and 1350 cubic feet of acetylene from a single charge. These generators are intended for use in shops where the acetylene is used direct from the generator, but the Davis-Bournonville Co. also makes a generator known as the "Navy" type, which is designed for use in connection with a compression plant for collecting the acetylene in cylinders for portable use, and acetylene can also be taken direct from the generator under pressure for use in the cutting and welding torches. In this type of plant, provision is made for drying the acetylene and removing the air from it preparatory to compression.

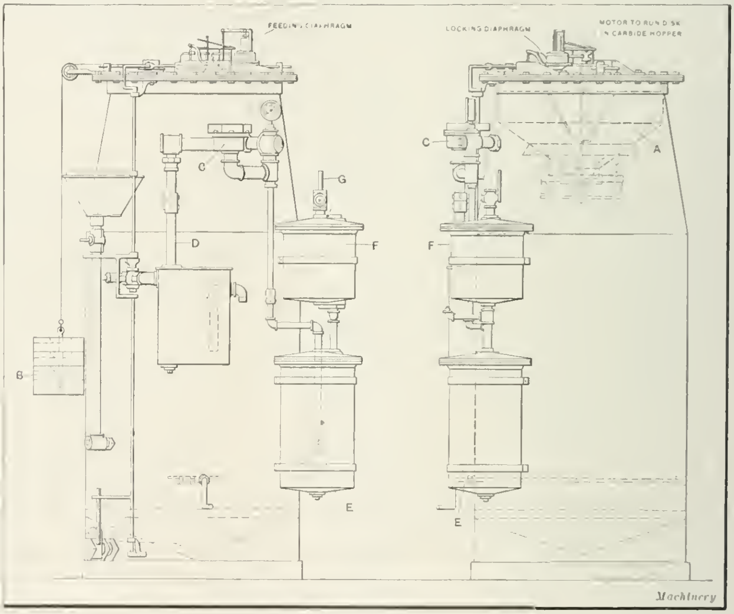

Fig. 13. Davis-Bournonville Acetylene Generator

The generators which have just been described are made for installation in a fixed position, but for some classes of work it is desirable to be able to move the source of acetylene about from place to place. To meet this requirement, the Davis-Bournonville Co. makes two styles of portable outfits which are shown in Figs. 14 and 15. In one of these, a two-wheeled truck is employed, on which are mounted an oxygen cylinder and a cylinder containing the acetylene gas. In the other style of portable outfit, an acetylene generator and a battery of oxygen cylinders are mounted on a four-wheeled truck. This equipment is made with either the 25-pound or 50-pound acetylene generator, and with a corresponding number of oxygen cylinders, according to the requirements of the plant in which it is to be used. It is often found convenient to use one of these portable outfits to avoid the necessity of moving heavy work, or for working in different places in large factories, where it is easier to take the torch to the work than to bring the work to the torch.

Fig. 16 shows the generator furnished by the Oxweld Acetylene Co. This is a low-pressure generator, used in connection with the company's low-pressure torch. The illustration, with the arrows indicating the flow of the gas, shows clearly the action of the generator. The apparatus to the left is the generator proper, while that to the right is the gasometer, used for storing the gas at low pressure.

Piping

Acetylene piping should be carefully designed, especially in regard to size. Frequently trouble is caused, particularly in the case of low-pressure systems, by having the pipe too small. The manufacturers of the equipment will give advice in this connection. Acetylene piping can be put together with ordinary screw joints and pipe grease; or other lubricants, such as red or white lead, may be used. It is better, however, to weld the pipe and insure in this way against leakage.

In the case of oxygen piping, no grease or oil whatever should be used, if it is put together with screw joints, as a lubricant should not be depended on to make a pipe joint in any case, but only to allow the threads to be easily screwed into place, the joint depending on the threads. Soap answers the purpose for oxygen pipe very well. It is, however, advisable, as in the case of acetylene piping, to weld the joints. Piping for both oxygen and acetylene should be galvanized. The ends of all pipes should be reamed out to make the pipe of uniform size throughout. Where piping is welded, no fittings should be used. Valves should be of the best quality and of sufficiently large area, particularly with a low-pressure system, to avoid reducing the pressure. After the piping is all erected, it should be tested to at least 100 pounds pressure per square inch, and leaks, if any, stopped. The best method of testing is with soap suds, brushed not only on the joints, but all over the pipe, as there are sometimes pin holes or slight defects in the body of the pipe.

Acetylene and Oxygen Tanks

Portable acetylene tanks are provided by the makers of acetylene gas, from whom they may be obtained on reasonable terms. The cost of the gas is about 2½ times that made in a generator, but this expense is warranted in some cases even for shop work, on account of the tanks costing less than the generator. Each case has to be considered separately. The larger the shop, the greater the advantage in the use of a generator. The charging pressure of these tanks is about 225 pounds per square inch, but this varies so much with the temperature that the pressure alone is no indication of the amount of gas in the tank. It is sometimes found that after working an hour or so, the pressure is equal to or greater than that at the start, due to the tank being warmer. Tanks should be kept in a cool place and the outlet capped to be sure that there is no chance for a leak.

Compressed acetylene should never be used at a greater rate per hour than one-seventh of the capacity of the tank. For instance, if a tank holds 300 cubic feet, 45 cubic feet per

hour is about the maximum rate at which the acetylene should be drawn. If it is necessary to use a torch large enough to exceed this rate, two or more tanks should be coupled together with manifolds which can be procured from the manufacturers of the tanks, or made in any good machine shop. A greater rate of discharge than that stated above results in some of the acetone being drawn out, which is liable to cause bad welds.

The Federal law requires that in shipping a tank containing oxygen, or a full acetylene tank, a label be pasted on it, colored green or red, respectively, and worded according to the instructions on the subject issued by the Bureau of Explosives, 30 Vesey St., New York City, from which copies may be obtained. Empty oxygen tanks need no label, but the bill of lading or express receipt should specify that the tanks are empty, in order to obtain the advantage of the lower freight rate. Empty acetylene tanks must have the red label removed before shipment and can only be shipped by freight. Any tank found to be defective should be tagged, and the manufacturers notified by letter. It occasionally happens that a valve cannot be shut. Such a matter should be reported to the manufacturers, and if the valve is found defective, they will make an adjustment for the amount of gas lost. All tanks, both oxygen and acetylene, are provided with safety disks or plugs. These are intended to prevent excessive pressure caused by heat or otherwise, by allowing the gas to escape gradually and thus prevent an explosion. In some cases these safety devices are so arranged that they are sealed to prevent tampering with them. If this seal is broken no adjustment will be made. Therefore, if anything goes wrong with the valve or disk, do not attempt to repair it, but return it in exactly the condition in which it was found. Of course, if an acetylene tank should leak, it should be placed out of doors to avoid danger of explosion. The percentage of such difficulties is exceedingly small.

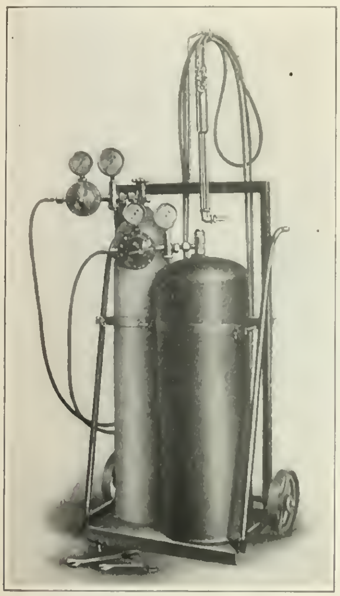

Fig. 14. Portable Compressed Acetylene and Oxygen Tanks

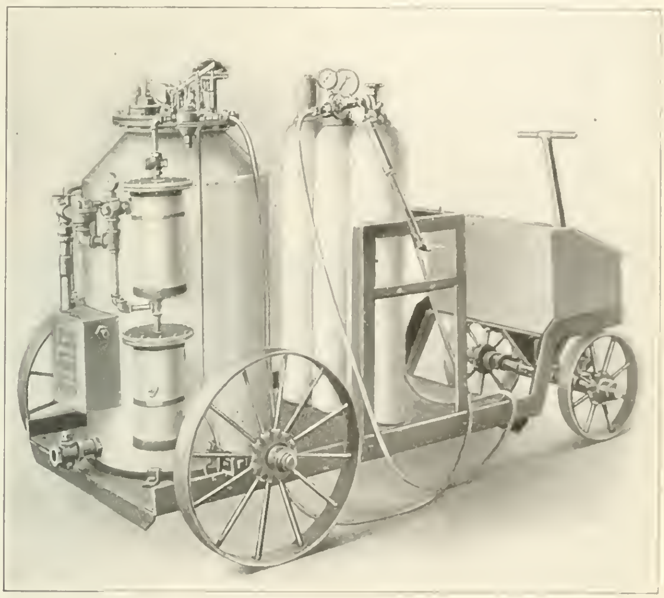

Fig. 15. Portable Outfit comprising Acetylene Generator and Oxygen Tanks

Fire Risk

Chlorate of potash and carbide are both dangerous from a fire standpoint, and should be kept outside of the shop, preferably in a shed separated entirely from the building. Most, if not all, cities regulate the storage of these chemicals. If possible, a shop location should be selected away from a bad fire risk, such as a lumber yard, planing mill, cabinet shop, oil store, etc., as these automatically increase the insurance rate no matter how well the welding shop is protected. The installing of automatic sprinklers should receive careful consideration, particularly with a low roofed building, as the heat from heavy welding fires is great. Overhead wooden truss members and joists should have the accumulation of dust cleaned off at frequent intervals, as it is liable to catch fire from charcoal sparks. A coat of whitewash, using the acetylene generator residue, is a good thing to keep sparks from catching, as well as being of considerable assistance in lighting the shop. Charcoal fires should be kept covered with asbestos paper to hold sparks down. It should be remembered that even if the fire insurance were paid the day after the fire, there would be a great loss from not being able to do business and that, therefore, all precautions should be taken. Insurance should be considered as a protection against the mistakes of others, and not as a license to be careless. If every-one would act as if no insurance could be collected for damage caused by his own carelessness, there would be fewer fires, and insurance rates would not be as high as they are.

Eye Protection

Dark glasses should always be worn while welding, as one's eyes are liable to be injured, particularly by the intense glare from the flux used in welding cast iron. For cast iron, very dark glasses, with a greenish tinge, are most suitable. For other metals, lighter colored glasses are better, as they permit a clearer vision of what is being done. In any case, glasses are dark enough, if immediately after welding it is possible to see clearly, without being bothered with white spots in front of the eyes after taking off the glasses.

Machine Tool Equipment for Welding Shops

The machine tool equipment to be provided will depend upon circumstances. For a shop where welding alone is done, the following should be provided: 24-inch upright drill; floor stand; two-spindle emery wheel for 10-inch wheels, flexible shaft grinder with 6-inch wheel. These tools can be driven by a small electric motor, if current is available. Any other motive power can be used, although a gasoline engine should be carefully installed to avoid fire risk. The author permits no gasoline in his shops under any pretext whatever.

For a large shop, or where a good machine shop is not available, it may be necessary to install more machinery. The following additional tools will cover practically everything necessary: Lathe, 20-inch swing, 4 feet between centers; lathe, 30-inch swing, 8 feet between centers; planer, 36-inch by 36-inch by 6 feet; pillar shaper, 12-inch stroke; horizontal boring mill, 4 feet between heads; 3-foot plain radial drill.

These tools must be accurate, but as there is no question

of production in quantity involved, they may be of light and simple construction; for instance, it is not necessary to have quick change-gears on the lathes. All such expense should be avoided. Very careful thought should be given to the machine tool equipment. It is expensive, and unless enough work is done, it will not pay to install it, but it will be cheaper to do the work with hand tools, or even send it to a shop at some distance.

The real cost of operating a machine is frequently underestimated. Interest, depreciation, repairs, insurance and taxes have to be paid, even if not charged in the operating expenses. Taking the sum of these items at 15 per cent per year on the cost of a machine, and assuming the installed cost at $2000, there will be a monthly expense of $25 against the machine. If it is operated 200 hours per month, the hourly expense will be 12½ cents; if it is used only 20 hours per month, the hourly expense will be $1.25. It is evident that no ordinary charge for work, say 60 or 75 cents per hour, will cover the latter expense, which is exclusive of labor, power and supplies. Each case is a law in itself, and all that is urged is that careful and intelligent consideration be given, to avoid financial loss.

Other Equipment

It is generally necessary to heat pieces before welding to obtain a sound weld as well as to economize in the gases. For this purpose, plain blacksmith forges are the most convenient for small work. Their tuyeres should be level with the bottom of the pan, which should be of cast iron. The pan should measure about 23 by 36 inches inside and about 4 inches deep, which will allow the bottom to be lined with 1-inch thick firebrick, laid in fire-clay, and still leave the sides high enough to keep the fire off the floor. The simplest fan drive is good enough, as it is never used except in starting the fire. It is well to have plenty of forges, as a good welder on moderate-sized work can keep two or three busy without any difficulty.

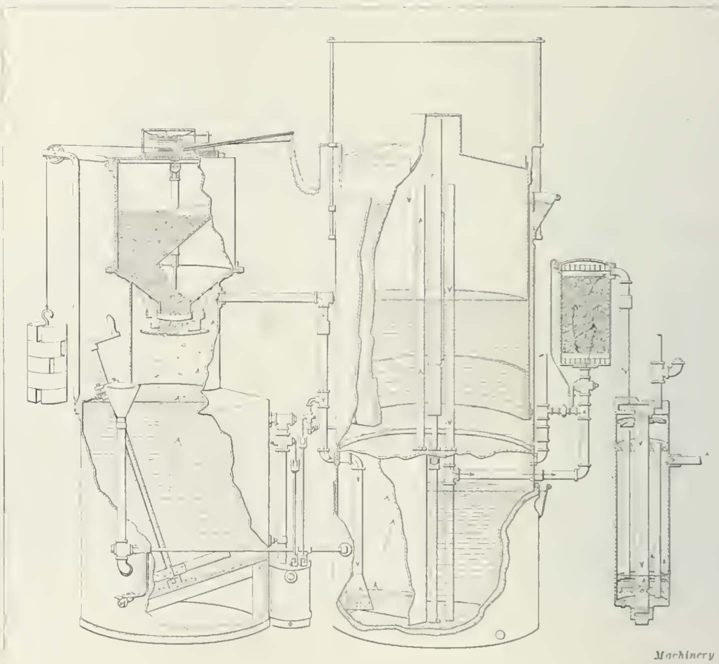

Fig. 16. Oxweld Low-pressure Acetylene Generator

For heavy work a concrete or brick floor is necessary; this, if of concrete, should be at least 6 inches thick, laid on a solid foundation of cinders that should be free from coal and well rammed; and proper provision should be made for drainage. The concrete may be a rather lean mixture, but should have a top dressing ½ inch thick of a rich cement mortar. The floor should be about 10 feet by 15 feet or 12 feet by 12 feet, preferably the former, as it is more convenient for a number of fires. Over the floor should be some kind of hoist of a capacity of about 3 tons, which will handle almost any work that can be brought into the shop. The kind of hoist depends upon the circumstances, such as the construction of the building, space around the floor, etc. A jib crane is very convenient, but expensive. If the roof trusses are strong enough, an I-beam extending between them and carrying a trolley and chain hoist is ample and cheap. If the floor of the building is of concrete, be sure that it is heavy enough to stand considerable heat. Of course a fire should never be built directly on the concrete. A layer of firebrick can be placed under the entire area to be covered by the fire, and the piece laid on this raised enough to get the fire in place; or plates of cast iron or steel can be laid on bricks to give air space underneath and the fire built on the plates. Cast-iron plates 1 by 3 feet are best. They should have 1-inch holes cored in them about 6 inches apart for draft, and when setting up, they should be left slightly apart for the same reason. Angle-plates of the same general design may be used for walls instead of bricks, and in some cases are very convenient. They should not have any holes in them. They radiate more heat than bricks, but do not fall over so easily. Some of them should be 18 inches long for small fires.

Firebrick will also be needed for holding the fires in place on the forges, and for use on the floor. Hard-burned brick, while not so good for the regular purpose for which firebrick is used, is better for this purpose, as it does not break or chip so easily in handling.

Examples of Equipment

Fig. 17 shows a cast-iron table 30 inches wide and 60 inches long. It is planed on the top, bottom and all edges, and has a support made of old ¾-inch pipe welded together. It is 26 inches high from the floor, which is found to be most convenient, as small work can be done by the welder while sitting, and for large work, such as rear axles, rear axle housings, cylinders, etc., which have to be tested, and which are frequently set up high on blocking, is not too high for convenience. Another view of the table is shown in Fig. 18, which also shows an angle-plate that is very convenient. It will be noticed that the rib *D*, which is ¾ inch thick, extends on two sides of the table, while the other two sides are provided with a flange *B*. As stated, all of these edges are planed. This permits of clamping pieces vertically or horizontally, as the case may be, and has been found to be an exceedingly convenient arrangement.

Fig. 17 also shows what was originally designed as a jig for welding crankshafts, although it has been found that it is a valuable appliance for many other purposes, particularly in welding bars, tubing, etc., that must be kept straight. It is shown at *C*. The V-blocks are provided with tongues which slide in the groove *D*; the slots *E* and *F* are at unequal distances from the groove. This is done to insure proper setting of the V-blocks. The base is planed on top and bottom, and after the bases of the V-blocks were machined, they were bolted in place and the V's in the top of them planed at the same time to insure absolute alignment. The V-block caps have the holes for the studs drilled ⅛ inch large, so that there will be no difficulty in clamping when screwed down

Fig. 17. Welding Table, Welding Jig, and V-blocks

Fig. 18. Another View of Welding Table and Angle Plate

on a round piece. The base of this jig is 10 inches wide and 36 inches long. The V-blocks are of different thicknesses, the wide ones being 2½ inches and the narrow ones 1½ inch. This permits of getting into corners, which is sometimes desirable. There are also shown a plate of graphite at *A* and a set of ordinary V-blocks at *B*, which are better shown in Fig. 19. Two sets of these are useful for holding shafts and similar pieces that must be kept straight in welding, and will be found of advantage for many other purposes. The six V-blocks should be made from one casting, first planed and then cut off to the required thickness. Each one of a pair should be planed to the same thickness, and the 1- and 1½-inch sizes together should have the same thickness as the 2½-inch size. The grooves should be planed in the casting before cutting off, to enable the blocks to be placed in the same line as when originally planed, it being difficult otherwise to plane the V's exactly symmetrical. The various devices shown in these two illustrations make it possible to take care of almost any shape that must be kept square or in line.

Fig. 19. Set of Cast-iron V-blocks of Different Thicknesses

A kerosene-oil burner can, in many cases, be used for heating large articles in which contraction strains will not cause any trouble, and is useful to have in a welding shop.

The general tendency in a shop of any kind is to allow bars, mandrels or similar material to lie around in corners or under the bench where they are difficult to reach, and frequently damaged. A rack for such parts, shown in Fig. 20, is safer, and improves the appearance of the shop. This rack is about 5 feet long and 3 feet high, and is made out of old ¾-inch pipe welded together. On the right-hand end is shown a device which in its different forms is frequently of service in preventing the melting of babbitt bearings. It cannot be used in all cases, but where there is much work of one kind to be done, it pays to use it. This particular device consists of cold-drawn steel tubing about 1/8 inch thick and of proper outside diameter to fit the bearings of the Ford automobile cylinder block. When it is necessary to do any welding on one of these cylinders, this piece is clamped into the bearings just tight enough so that it will not turn readily, and filled with water. The ends shown hanging down stand up straight. Any change in the position of the cylinder in the fire can be taken care of by keeping the legs upright. It is necessary to watch the water carefully so that it does not evaporate.

Fig. 21 shows the use of the cooling apparatus for preserving the babbitt bearings in the upper half of a Ford crank-case. The illustration shows the device held in place by wires. This was found at the first trial to be unsatisfactory, as it did not hold the pipe in contact with the bearings closely enough, and at the present time bolts and 1/4-inch pieces of steel are used to overcome the trouble.

Miscellaneous Equipment

A substantial work bench with one or two vises should be provided. If two vises are provided, one vise should have jaws 5 inches wide, for general use; the other may be a second-hand one, to be used for holding pieces while welding, when they cannot be easily blocked up so that the welder can reach all parts of the weld. The good vise should never be used for welding, as the heat will in the course of time draw the temper of the jaws. Of course the total number of vises

Fig. 20. Rack for Mandrels, Blocking and Other Tools

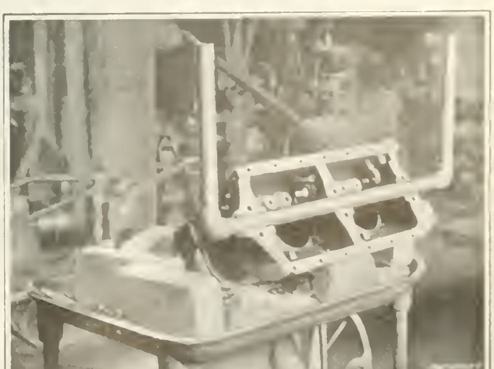

Fig. 21. Pipe Mandrel used to prevent Melting of Babbitt Bearings

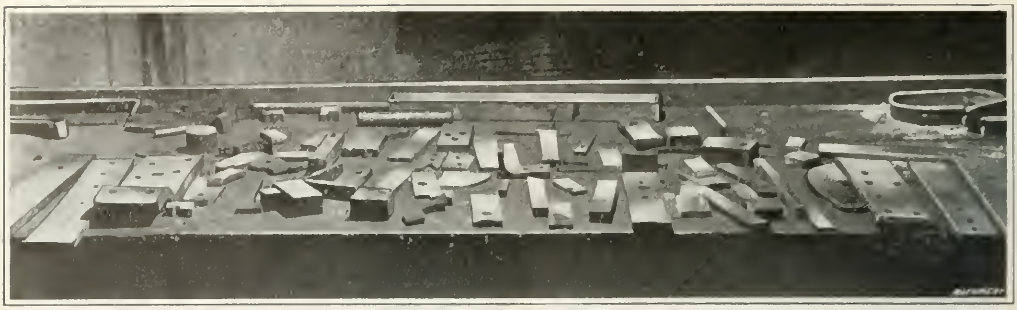

Fig. 22. Miscellaneous Clamps and Blocking required in Welding

and size and number of benches will depend on the number of welders employed. For four men, one old vise and two good ones will be enough; the bench may have a length of about 25 feet, or three small benches may be used. Several pairs of "pick-up" tongs for handling bricks and other hot objects, and gas pliers 10-inch and 13-inch sizes for use around the forges are necessary; their screwdriver ends should be ground off or bent over to make them safe when lifting with the end toward the face. The sharp end has caused bad injuries. As soon as the jaws become slippery, the pliers, should, of course, be thrown away.

In many cases, especially where the pieces are of cast iron, and heavy, or where lugs or projections have to be built higher than the adjacent surfaces, time will be saved by building a dam of some refractory material of the proper shape, and melting the metal into it. The best material for this in the case of cast iron or steel is a graphite mixture, such as is used in crucibles. This can be obtained in blocks of any size and shape, by ordering it specially; but rectangular blocks from ½ inch thickness up, and round rods of various diameters, for use in keeping holes from filling up, are stock sizes, and can be obtained on short notice from crucible manufacturers. An assorted stock will be of great aid in quick work. In using this material, it will be found advisable to have it in position while preheating. It is more or less porous, and when covered over during the welding, the heated air coming from the pores will cause pin holes, as it has no other way to escape than through the weld. Preheating the graphite expels some of the air and leaves less to cause trouble; but if a smooth, thoroughly sound weld is required, it will be necessary to turn the piece over, remove the graphite, and melt the metal until the blowholes are eliminated.

An assortment of C-clamps, with from 3- to 10-inch opening, is needed for clamping work together or to the table; also two

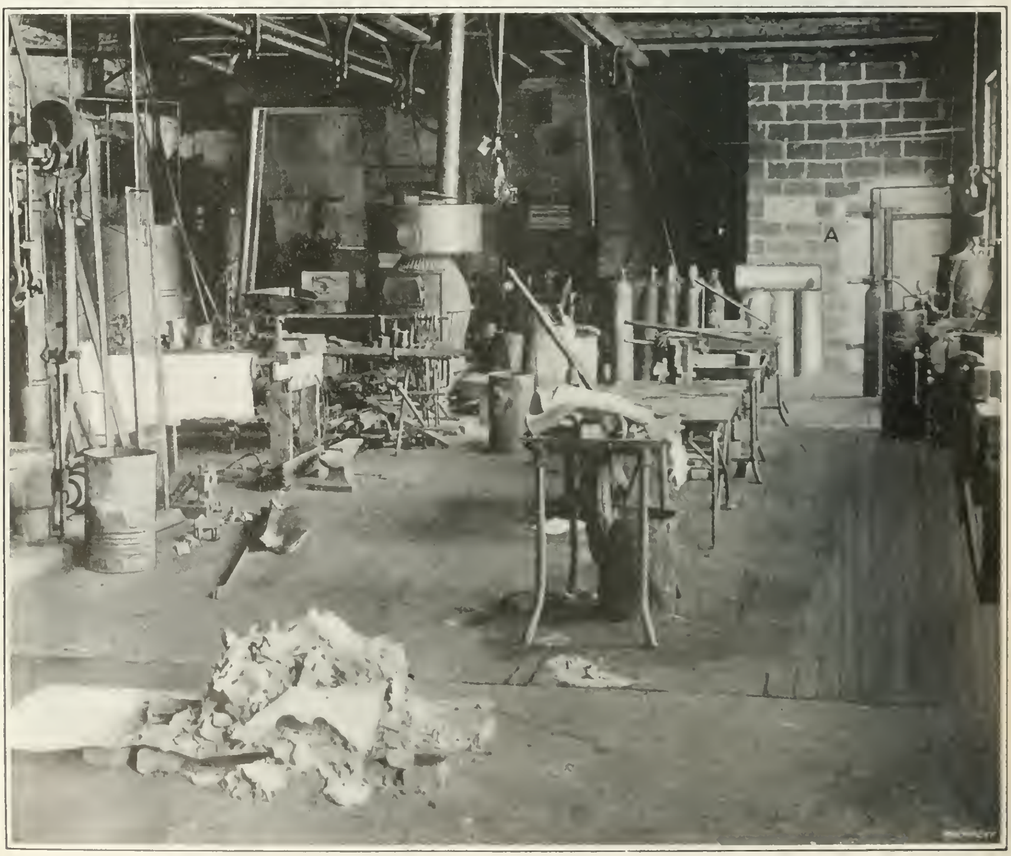

Fig. 23. View of Welding Shop

bar clamps taking in about 30 or 36 inches, such as are used by carpenters; these are handy for long work. Of course the regular metal-working hand tools will be needed, such as hammers, chisels, files, hack-saws, calipers, squares, straightedges, surface gages, etc. A number of cold-rolled steel bars, about 30 inches long, and of various diameters, are of great assistance in lining up automobile crank-cases and other parts. They may be obtained as they are needed.

A collection of pieces of scrap of various sizes and thicknesses for liners, as shown in Fig. 22, is necessary for lining up. The thicknesses will range from a piece of tin to 2 inches. The thicker ones should be of cast iron, to avoid injury by heat. It is also of advantage to have some of the thicker pieces in pairs and planed to the same thickness. These pieces should not be exposed to great heat, to avoid warping them. They are of special advantage in blocking up pieces with finished surfaces.

Fig. 24. Preheating Floor for Building Fires

Asbestos building paper is used to protect the welder from the heat; to confine the heat to the piece being heated; to keep drafts off a casting that has been welded, which without such protection would tend to crack; and after it has been broken up so small as to be useless for these purposes, it is valuable for packing cylinders, etc., to allow them to cool uniformly. This material comes in rolls of about 100 pounds and in thicknesses varying from 6 to 12 pounds per 100 square feet. The 8-pound material is heavy enough for general use.

Plaster-of-Paris Patterns

Some knowledge of patternmaking is very helpful, especially where pieces of some size are missing. It is expensive to fill up such places with the torch. If a pattern can be made to fit, its use will make a cheaper and better looking job, particularly if the surface is irregular. Even if the pieces are not missing, but are many in number and small, so that the total length of welds would exceed the length of the weld required if a single casting were used for the repair, it generally pays to make one. Plaster-of-paris is the most convenient material to use for patterns for this purpose. Wooden patterns are very expensive, and unless they are simple, and a number of castings are to be made, are out of the question.

It requires some experience to handle plaster-of-paris successfully, and it is impossible to lay down rules for its use that will fit all cases. Therefore, the following suggestions will not always apply, and good judgment and ingenuity will have to be used:

Do not mix the plaster too dry, or it will set too soon.

Do not mix too much at once, but have several batches ready to mix one after another, if a large quantity is needed.

Prepare the piece by chipping or in other ways, so that the pattern will come out easily.

Make the shape of the pattern as simple as possible, by cutting out irregularities around the sides. The sum of two sides of a triangle is always greater than the third side, and cutting off angles, of course, means a saving in welding.

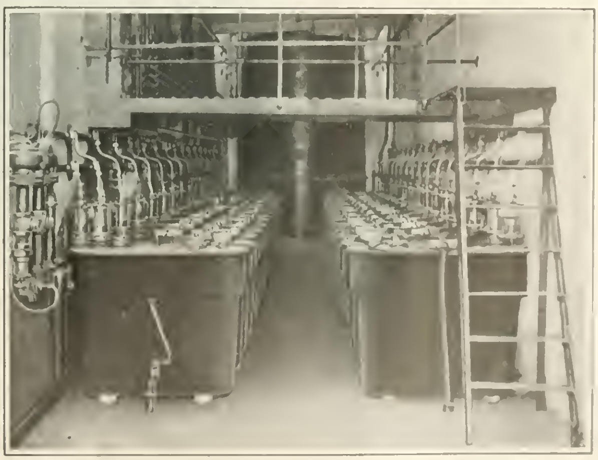

Fig. 25. International Oxygen Co.'s Apparatus for making Oxygen

Bevel the edge of a cast-iron piece before pouring the plaster-of-paris, and bevel the edge of the pattern before taking it out; it comes out more easily and saves preparing the casting.

Do not bevel too much, but leave enough so that it can be fitted tightly in place. This helps in less contraction of the weld. The fit need not be perfect, but the better it is the better the job will be.

In the case of aluminum, fit well, but do not bevel unless over 3/8 inch thick, and then leave about 1/4 inch bearing, as aluminum crushes easily when hot, and there should be bearing enough to force expansion without crushing, if possible.

Have the molder rap the pattern well; the shrinkage of cast iron in casting is 1/8 inch per foot, and of aluminum 7/32 inch per foot. In the case of large patterns it will be necessary to add the needed amount to the proper edges and surfaces to allow for the shrinkage, and enough more to permit of any finishing that may be necessary.

General Shop Arrangement

Fig 23 shows one of the author's shops. The arrangement is not ideal, because there are windows only on one side of the shop which leaves considerable floor space that cannot be utilized. The arrangement of the forges and welding table should be noticed, particularly with reference to the work bench. In arranging a welding shop, the welding table and forges should be located near a good light, preferably daylight, so that the lining-up of work can be done quickly and accurately.

Old carbide cans are used under the forges to catch the ashes from the charcoal fires. These cans are kept partly full of water all the time. Before closing at night, the wooden floor around the forges is well soaked with water.

The acetylene generator room *A* is built in accordance with the underwriters' requirements and has a standard fire-door. No light, except daylight, is permitted in the room, nor is there any opening except one window and the door into the shop. It would be preferable to have the door opening from the outside of the building into this room, but in this case it could not be so arranged. The work on the concrete floor shown in the foreground is reached by the use of long hose extending from the regulating valves on the wall.

Fig. 24 shows the concrete floor on which the heavy welding is done. In certain cases, as for instances, when a large number of cylinders are to be repaired, and the forges are in use for other work, special fires, as at *B*, are built on it. Of course such fires are not built directly on the floor, but on sheet-iron or cast iron plates which rest on bricks. There are four cylinders of various sizes in the fire *B*. At *D* is a home-made furnace lined with firebrick 1 inch thick on the bottom and sides which is used for preheating. Its dimensions are 25 by 21 by 10 inches, and the top angle-iron is 34 inches from the floor. A better size is 42 by 21 by 12 inches deep. A furnace of these dimensions would be large enough to handle the largest "six-in-block" cylinder made.

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OXY-ACETYLENE WELDING AND CUTTING

In this number begins a series of articles on oxy-acetylene welding and cutting which will cover the subject thoroughly and be of great value to those engaged in this kind of work. The author of the articles, who has conducted a successful oxy-acetylene welding repair shop for over five years, has endeavored to describe the principles in general use on repair work. Photographs are invaluable aids to description, and a large number showing actual operations will be included—all of work done successfully in the author's own shops.

It should be understood that even a man who is fairly expert with the welding torch may find it difficult to prepare or preheat a repair job which is different from any with which he is familiar. Even with wide experience, it is not always possible to say off-hand how a piece of work can be best handled, and often the desired results cannot be obtained at the first trial. The beginner is therefore sometimes discouraged because he does not obtain satisfactory results; but he should persevere. In acetylene welding practice, progress is slow, and it is best to undertake at first only such work as a novice is fitted to handle, until the operator gains sufficient experience to warrant him in undertaking more difficult work.

The experience of the author in the oxy-acetylene welding field has been unusually extensive, but having been mostly on repair work he has written for those engaged in a similar line. Little mention will be made of the many applications of the welding torch in manufacturing work, as these applications are special in each case, and sometimes require a great deal of experimenting before success is attained. Most of the work so far done with the oxy-acetylene welding torch has been on repairs, and while descriptions have appeared from time to time in the mechanical journals of repair work, they represent isolated cases, and not complete repair work practice; so this treatise will fill a gap in existing mechanical literature.

In this series time and cost data have been purposely omitted, because in the present state of the practice it is not possible to give accurate data on repair work. Two good welders working on repairs of a similar character will often vary as much as 50 per cent in the time consumed, and as shop conditions also vary to a great extent, it is almost impossible to give accurate figures regarding costs.

NEW AMERICAN INDUSTRIES

When the European war broke out, few manufacturers realized what the effect of the stoppage of commerce between America and Germany would be; but soon the full force of the embargo laid on many German manufactured products was felt, and consternation reigned. It was impossible to obtain supplies from abroad, and conditions in this country did not seem to warrant the establishment of factories for the manufacture of chemicals and other supplies formerly obtained from Europe. It was feared that if the war ended suddenly the "infant" industries established here would perish, because our markets would be again supplied with foreign products at prices much lower than American manufacturers could compete with.

The war has lasted over a year and its end is not yet in sight, so American manufacturers have taken courage and have established factories for producing many of the supplies formerly obtained abroad, and in many cases are making big profits. Last July the market price of picric acid was forty cents a pound; now it is $1.70. Before the war began the price of carbolic acid was seven cents a pound; now it is $1.35. Prices of metals have increased from 25 to 100 per cent. As a result of these unlooked for changes during the past year the great steel companies are planning to produce raw materials and by-products which formerly were purchased abroad to the extent of hundreds of dollars annually.

The effect of the war doubtless will be to give the industrial life of America a great impetus, and to make it more independent of foreign supplies than it was before. It will tend to develop here a class of industrial experts such as has flourished in Germany. But this must be done without expecting that a high tariff will be created for protection. This country is too great, and its tendencies are too well defined in the direction of freer trade, to permit it to revert to the high protective tariff policy.

* * *

THE THEORIST AS A FACTOR IN PROGRESS

The so-called "practical man" often sneers at the impractical ideas of the theorist; and just because he has sneered so much and so long at the man with a theory, he is today doing his practical work in much the same way as it was done a quarter of a century ago.

"The practical man," says one of the most brilliant and original of the investigators in the machine tool field today, "is a man who knows the limitations of doing certain work in a certain way; but he does not endeavor to exceed these limitations, because he knows from experience that he would meet with failure; and he does not inquire into the whys and wherefores of the limitations. He does not concern himself with the reason for the heating of a cutting tool beyond the limit of endurance, for example, when a certain cutting speed is exceeded. He accepts facts as they are presented."

Now the theorist comes along and says: "There must be a reason for this limitation. If I can *find* the *cause* I may be able to overcome it." So he sets out to think along new lines, not merely accepting the apparent results of past experience. He thinks out a new way of doing the same work, so as to avoid the causes that created the practical man's limitations. He broaches his new idea, and the practical men are likely to join in saying: "He is too impractical. He hasn't had experience. Whoever heard of anyone trying to do this work in such a way before?" If the man of theory—that is, the man of a new idea—has no influence to make himself heard, that is the end of it; but if he has a chance to experiment, to try out his ideas, the result in the end is often a complete reversal of practice. After having been shown, the practical man adopts the *new theory*, calls it *good practice*, and holds on to it tenaciously if anyone attempts a change.

The practical man believes that there is "too much theory." As a matter of fact, there is too little. The theory of yesterday is the practice of today, and the more assistance we can enlist from theory today, the better practice will we have tomorrow.

Preparation of the Work for Oxy-Acetylene Welding

IT is generally essential that a weld be made through the whole section of a break. Sometimes this is not necessary, and in exceptional cases it may be impossible; for instance, in the case of a break through the eye of a cast-iron piece, where the diameter of the hole is small, compared with its length, it is generally impossible to reach all of the crack with the torch from the inside of the hole, and there is danger of producing hard spots, which cannot be removed except with special grinding machinery that is not usually available. In such cases extra cantion must be used to insure a satisfactory job.

For ordinary work it is sufficient to bevel the edges of the broken parts so that when placed together the included angle will be 90 degrees, and so that just enough of the old break will be left to enable it to be correctly set up for welding. The reason for opening the break to a 90-degree angle is to permit the flame of the torch to get to the bottom of the V, so that the metal may be melted thoroughly and the natural bridging effect of the melted metal, with the resulting imperfect weld, may be avoided. It is not unusual for even an experienced welder to find such an imperfection in one of his welds, particularly if it is a rush job; and it is one of the difficulties a beginner must carefully avoid, particularly if the piece can be welded from one side only, as is frequently the case. In such cases the crack must be entirely burned through with the torch, even if drops of metal remain hanging under the weld.

It is especially important that the 90-degree angle be maintained in preparing steel. This metal sets so rapidly that the bottom of the weld will be full of cold shuts, or a great amount of time will be lost and gases wasted in burning away metal to get a good weld, unless the beginning of the weld is made easy to reach. It is also advisable, particularly with torches having comparatively light tips, to have plenty of room for the flame to spread, and avoid burning the tip.

A very good way of preparing parts where there is not sufficient room for a 90-degree angle, and also for heavy welds, by which a considerable saving of gases and time may be accomplished, is to drill out the bottom of the crack with a $\frac{5}{8}$-inch drill and bevel the sides to less than 90 degrees. This applies to both steel and cast iron, and is especially useful when the break is in a corner, where it is evident that a 90-degree angle cannot be obtained. This method also frequently reduces the time of preparing the work, as with cast iron the remainder of the V can be easily removed with a sledge and handle chisel.

The piece should always be prepared from both sides when possible, resulting in a double V, as shown in Fig. 1. It will be evident, upon a little consideration, that this needs only half the welding that a single V does, besides which, it tends to produce a better weld. A crack remaining in the center of a piece is not nearly as dangerous as if it were on the outside, and the shallower the V, the more readily is a good weld made.

Any method of making the V is allowable, the object being to open up the V well, and to permit of making the best and easiest weld. For small pieces of any metal, an emery wheel is probably as good as any. Cold chisels and sledges or hammers are excellent for cast iron, where the piece will stand their use. In some cases a hacksaw is most useful. Drilling along the crack and chipping out the bridges roughly is a good method where the piece is cracked and not broken. The drill should be ground to an included angle of the lips of about 120 degrees, and the point of the drill should just go through the metal. If it goes too far, there will be trouble on account of the bottom of the hole burning through too quickly, especially if a heavy tip must be used. The diameter of the drill should be about equal to the thickness of the piece to be welded.

There is one method which is of much assistance in such cases, for example, as that of a large pipe or pipe fitting flange broken off at the root, where the body of the casting is not very thick, say $\frac{3}{4}$ inch. A fitting, such as an elbow, must be kept in a fire to avoid cracking and is awkward to turn while red hot, as well as hard on the welder. The part being welded would ordinarily be above the fire by an amount equal to about the diameter of the flange, which would allow it to cool rapidly, making welding difficult and probably resulting in a cracked casting when cooled. If, however, the inside of the crack be chipped out to the regular V

half way through, and the outside edges left nearly parallel, and about 1/8 inch apart, leaving a few narrow parts of the old crack to line it up by, the elbow can be set with the flange downward in the fire and allowed to remain there until the outside is entirely welded. This is easily done by playing the flame between the parallel sides of the crack, which, as they confine the heat closely, soon become melted, and run together at the bottom, with careful handling of the torch; after this, sufficient metal is added to complete the outside of the weld. It is then an easy matter to weld the inside, as the part worked on can be in the fire all the time.

Fig. 1. Work beveled from Both Sides

It is sometimes best not to bevel the edges of the pieces. This is true of thin pieces, where it is unnecessary. In the case of cast iron and steel, pieces 1/8 inch thick or less can be welded without making the V. In aluminum nothing less than 1/2 inch thick and in brass and bronze nothing less than 1/4 inch thick should be beveled. These rules are only approximate and experience will determine what should be done. At the beginning, it may be best to bevel everything with the exception of very thin pieces, except in aluminum.

Sometimes it is best to burn out the crack without beveling it. This is true of an irregular piece, not very heavy in section, on which there are no finished surfaces that can be used for lining up, and which has to be lined up true by the crack. It should not be forgotten that burning out is expensive and should not be resorted to unless necessary. The metal is melted with the torch, and pulled out with the welding stick, until the V is made, when welding proceeds as usual.

It requires considerable ingenuity sometimes to prepare a piece, especially a heavy one, with an irregular break, so that a minimum of handling will result, as it is neither desirable nor comfortable to handle a heavy red-hot piece. After it is once set up, it is sometimes dangerous to turn a heavy piece over, as the weld may break, or a sudden draft may crack it outside of the weld. The author has seen many pieces where the first consideration in preparing has been ease of handling while hot, and the cheapness of preparing has been a minor matter.

Handling Heavy Hot Pieces

It is well to speak here of handling heavy hot pieces; they have frequently, even with the best preparation, to be turned over or moved during the welding. It does not do to be at all uncertain of what will have to be done at such times; and it has been found very helpful in case of doubt, to put the cold piece through the motions that are thought to be advisable when welding, using chains, hoists, bars, rollers, etc., just as if the piece were hot. The temptation to use the hands on the piece in this test must be carefully avoided. This trial shows what changes, if any, should be made in the plans, and also has the advantage that all tools used may be laid together till needed, and great loss of time and temper avoided by not having to hunt for them while under stress of work. It would appear, therefore, that before starting a job, careful attention must be paid to planning, as the preparation has a very important bearing on the quality, speed, ease and cost of the work.

General Remarks on Preparation for Welding

After the piece is beveled, it is necessary to set it up so that it can be readily welded; the method of preparation will have an important bearing on this, sometimes deciding the question. Other things being equal, the piece should be set with the weld on top, so that the melted metal will not run away. It is easy to weld steel on the side or even on the bottom of a piece, and cast iron, brass and bronze may also be so handled by an expert welder; but it is more difficult to produce as good a weld, and some metal is lost, making it a slower and more expensive process. Aluminum can also be so welded, being nearly as easy to handle as steel, but it is seldom necessary to resort to the practice.

Next in importance to a sound weld, and even sometimes more necessary, is the need of so welding the piece that it has such finished surfaces as required in line. Of course it is not possible in all cases, and is difficult in any case, to produce a perfect condition. In some cases, allowance must be made for machining. No rules can be laid down; but sometimes metal can be added so that the part can be machined to the original size; sometimes machining may be done without adding metal. Sometimes the metal may be heated and sprung or peened into place, or this may be done cold. Steel may be so treated, either hot or cold, depending on the nature of the piece; aluminum, brass, bronze and malleable castings must be peened or bent cold; cast iron cannot be so treated, but may sometimes be bent or straightened by clamping one end on the table, heating with the torch to nearly the melting point, and pulling down on the other end with another clamp very slowly.

Warping or Cracking

Warping or cracking is caused by the expansion and contraction due to the heat of welding. It is not possible to avoid these conditions, and they, therefore, must be controlled by making allowance for them. The principle of control is best illustrated by a simple test, as follows: prepare two pieces of cast iron as shown in Fig. 2 and bolt them tightly to some heavy piece of metal; the sides of the holes should bear against the bolts and the bottom edges of the V just touch. The heavy piece to which the smaller pieces are bolted is kept from being expanded by the heat from the torch, by putting it in water or by some similar method. Then make the weld, using no more metal than enough to fill the V and doing the work as quickly as possible, but being sure to burn through the bottom so that the weld will be sound. On cooling off, the piece will invariably break somewhere, and there will be a gap between the pieces which in the case shown amounted to 0.011 inch. If the piece the work is bolted to is not rigid enough, or the fit of the bolts

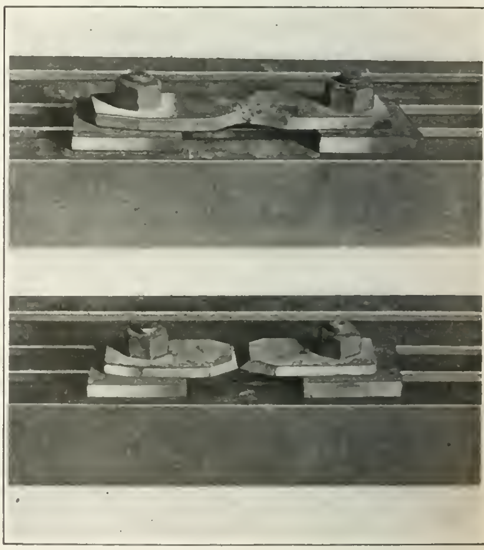


Fig. 2. Illustration of Contraction Stresses

against the holes is not tight, or if there is a trifle of spring in some of the parts, a light tap on the piece may be necessary to cause it to break; but the gap will always be there after breakage. If another test piece be made, and the ends left free, there will be no difficulty in making a satisfactory weld. Again, if the bottom edges of the V are butted together, the ends of the piece will rise, which is only another manifestation of shrinkage, as the metal on top is hotter than at

the bottom, and the bottom edges act as a fulcrum. The remedy is to leave the pieces slightly apart, or to clamp or weight them down.

These things occur in every welding job, whether it appears so or not. Holding the ends rigid, compels the expansion from the heat to go to the center, and when the piece cools off, there is sufficient contraction to break it. It is very easy to see what happens in a simple case like the one given, but the successful application of the principle to complicated and unusual cases is a different matter. As a matter of fact, making a sound weld is a comparatively easy thing to learn and many learn it; but the control of expansion and contraction is much more difficult to understand, as it requires a development of the imaginative faculty that is rarely met with, and there are few indeed who master it. It is a specific application of inductive reasoning. The proposition is not, 'if we do not control the expansion and contraction in this piece, it will warp or crack, and be useless", but, "how shall we control the expansion and contraction in this piece so that it will not crack or warp"? In other words, "what cause or combination of causes will produce the result we so much desire"? The practical reply to this question requires experience and imagination, the latter of which enables the welder to successfully apply his experience to an entirely new problem, which could not otherwise be solved, except by cut-and-try methods which are tedious and expensive and generally impossible. In this connection the author advises, when a difficult or unusual piece of work comes in, to sit down quietly and reason out completely the entire method to be followed. Do not decide hastily; time spent in planning is well spent. Control of expansion and contraction will be further discussed in connection with specific cases.

Setting up

In setting up a piece for welding, do it if possible, on a planed surface plate or table, using the finished surfaces of the piece, if any, to go by. If there are none, or if they cannot be used, set up the piece before making the V, using the crack to determine the necessary amount of blocking to hold it in line, and clamping it to be sure that it will not move. Then remove the pieces without disturbing the blocking, V them, replace on the blocking and reclamp. It is well in all

Fig. 3. Hoisting Engine Drum prepared for Welding

cases of complete breakage to separate the parts at the final set-up by just enough to compensate for the shrinkage of the weld. This is absolutely necessary if the original dimensions have to be maintained. The amount of separation varies with the piece and material, but generally 1/32 inch in cast iron and 1/8 inch in aluminum will be sufficient; experience alone will tell. Sometimes the allowance will be incorrect, and the piece will have to be cut and rewelded, changing the allowance. In case great accuracy is needed, tram-marks must be made on the pieces with a very fine pointed tram, so that it will be possible to tell just what is happening. Center-punch marks are of little value, except to keep the tram-marks from being lost, and the tram-marks must be used.

Frequently it is necessary to set up pieces in the fire, either because they are too heavy to weld otherwise, or because of

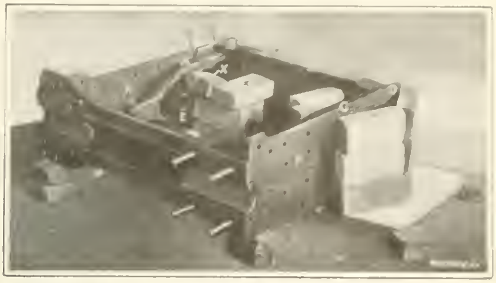


Fig. 4. Example of Preheating

expansion or contraction causing them to break if welded cold In such cases block them up as if on the table, but be sure that the heat does not affect the blocking or pieces so as to destroy the alignment, which should be again tested before welding; be careful to arrange the blocking to allow this. Sometimes such pieces may be clamped to a heavy block, preferably of cast iron, which does not bend as readily under heat as does steel. The clamps and block should be protected from the fire, or exposed to air to keep them cool, if possible. It is also possible, at times, to take red-hot pieces from the fire and clamp them on the table, or on previously prepared blocking, as the torch will keep the parts hot enough while welding. With heavy pieces in large fires on the floor, it is necessary to be exceedingly careful that the alignment does not change during preheating. The blocking must be of such material (preferably cast iron) and so arranged, that the danger of moving will be reduced to a minimum. The blocking must be on a foundation independent of the fire support, if there is any danger of the latter moving on account of the heat. In any case, allowance must be made for the contraction of the weld, by holding the crack open in some way.

Materials Used for Welding

In almost all cases it is necessary to use additional material to fill up the V left by the preparation of the piece. The material to use for this purpose depends partly on the metal in the piece and partly on the result desired; in almost all cases this additional metal is furnished in the form of wire or rods from 1/16 to 3/8 inch in diameter. Special cases may require larger or smaller sizes, but it has been found that the range given is ample to cover the ordinary run of repair work.

For cast iron the material comes in rods from 3/16 to 3/4 inch in diameter, the small rods being used for small work and small tips, while the heavier rods are for the larger work and heavy tips. When pieces are used up so they are too short to hold comfortably, they may be welded together; but it does not pay at the current prices of this material to weld 1/4-inch pieces of cast iron less than 4 inches long, or 3/8-inch pieces less than 3 inches long, as the cost of the gases and labor required is more than the cost of the metal. The cast iron in these rods should be of first-class quality, high in silicon and low in manganese and sulphur, so that it may be easily melted, reducing the gas consumption and consequently the expense, and producing a soft weld These rods are at present a specialty, and an ordinary foundry cannot produce them. It is a serious mistake to use cheap welding rods of any material, as the gas consumption is much higher and the work much slower, resulting in increased cost.

In welding steel nothing but the best and most suitable wire should be used Wire purchased at an ordinary hardware store is of no value, as it is hard to melt and will not give good results. It is generally claimed that Norway iron wire is the best for this purpose and that the imported wire

is better than the domestic. The writer is inclined to believe that this is true for ordinary steel, although it does not make a homogeneous weld. A highly polished section through a weld made with Norway iron wire shows a very marked difference between the original and added materials. Etching such a piece for microscopic examinations shows the difference still more clearly, the etching action being much slower on the added material. It is, however, somewhat of a question in the writer's mind as to whether material with a small percentage of carbon, say 0.1 per cent, would not give better results, provided the impurities such as sulphur and phosphorus were kept to as low a point as is the case in Norway iron. The trouble with ordinary iron or steel wire is not so much the carbon percentage, the writer believes, as the impurities present, such as slag, sulphur, phosphorus, etc. There are other matters in connection with this subject that have never been investigated as far as the author knows, and inasmuch as their investigation requires great accuracy, and considerable time and expense, the lack of information is not to be wondered at. It is a fact, however, that the use of Norway iron or any pure iron wire gives good results, and until the matter is more carefully investigated, one is safe in using that material.

There are advertised a number of other materials such as nickel steel, vanadium steel, etc., with which the writer has had no experience. On theoretical grounds, however, the use of these materials is questionable. Vanadium is never added to steel in any appreciable amount. Whether such steel would retain its properties on heating to the welding temperature is still another question, and if a weld can be produced by the use of Norway iron, which is strong and ductile enough, the use of alloy steels appears to be unnecessary. The use of alloy steels for welding has never been investigated, and as in other matters of this kind, innovations should be followed with caution.

Fig. 5. Same Drum as in Fig. 3, welding completed

For cast aluminum, an alloy of 93 per cent aluminum and 7 per cent copper, which is the standard No. 12 mixture, gives satisfactory results and can be cast by any good aluminum foundry in sticks 1/4 inch in diameter and 12 inches long. It is convenient for small work to have sticks 3/16 inch in diameter and sometimes for large work 3/8 inch is better, but it is seldom that either of the two latter sizes is required. For sheet aluminum, strips of the same metal are generally most satisfactory, though aluminum wire will frequently be all right. Cast aluminum sticks cannot be used.

For welding copper, copper wire or rod having a small percentage of phosphorus is necessary. The phosphorus eliminates the oxygen which would otherwise be absorbed by the copper, and which would make the weld porous.

For almost all brasses and bronzes, manganese bronze is most satisfactory. It can be used in the form of 1/4-inch sticks 12 inches long and can be made by any good brass foundry. For sheet brass, rolled manganese bronze or tobin bronze rods of the proper size, 3/16 or 1/4 inch, are most satisfactory, as they make a little smoother weld and are more fluid. This fluidity is sometimes a disadvantage, particularly in welding on curved surfaces, and it is well to have the various kinds of welding rods on hand, using the one that suits the case best. As far as strength is concerned, there appears to be no practical difference.

In the case of thin sections of malleable iron which are "white-heart" entirely through, it is possible to weld them with regular steel welding wire, and this should be attempted in such cases before anything else is done. In "black-heart" castings, the use of steel wire will simply result in the metal sticking to the wire and pulling away from the casting, the same as when it is attempted to use welding wire on cast iron. In addition to this, blow-holes apparently form in the piece. In cases where strength is not necessary, such as in filling holes or covering over defects, cast iron is the best material to use. It amalgamates quickly with the malleable iron and makes a good smooth job, but the chances are in favor of hard spots being produced, or the melted malleable iron becoming white or chilled iron on solidifying. For the majority of work, manganese bronze is the best to use, and that coming in rolled rods is most satisfactory. Properly used, a first-class job can be done, and as the bronze is stronger than the malleable iron, the weld, if properly made, will give no trouble. Malleable iron should not be brought quite to the melting point, and after a little experience, this can be determined with great accuracy. If it is hotter than this, it is detrimental to the strength of the casting. It should not be forgotten that no two pieces of malleable iron are alike and that it is impossible to predict what the result will be before the welding is begun.

Fig. 6. Drum shown in Fig. 3 finished

It is sometimes advisable or necessary to weld broken leaves in automobile springs, and while it appears a doubtful performance as far as strength is concerned, the writer has never known one welded in his shops to break. The proper material to use for this is old bed springs, which can usually be found around an ordinary scrap yard. Ordinary welding wire is not satisfactory. Care must be taken in using this material not to burn it. A fairly large tip should be employed and the work done rapidly.

The welding of cast steel is generally possible and gives good results. There are some kinds, however, that are difficult to weld, and others can only be welded with cast iron. Evidently, if strength is a consideration, cast iron must not be used. Usually ordinary welding wire is suitable, but it is well to keep the pieces that are cut out during the preparation, so that in case it is found difficult to weld with ordinary steel, the pieces themselves may be used as a filler, at least as far as they will go. Sometimes it is possible to cut off surplus metal from other parts of the casting and use it.

The welding of tool steel is generally unsatisfactory, particularly where the material is to be used for heavy cutting. It is not possible to avoid entirely the burning of the metal. Borax or other suitable flux should be used as a coating for the steel, to keep the air from it. The use of spring steel wire for filling, and of a rather large tip, with the quickest possible speed for doing the work, will give as good results as can be obtained. It is a material that is very seldom handled in repair shops.

Preheating

In order to make a fusion weld, the metal in the pieces to be welded must be brought to the melting point; and as all metals are good heat conductors, the pieces will be heated for some distance from the weld, the temperature of the piece decreasing as the distance from the weld increases. All of this heat must be supplied in some way, and it is possible

to do it with the welding torch in case the section is light. The matter is different for heavy sections; for, while the intensity of temperature of the welding flame is very high, the quantity of heat in it is very small; also, the cost of the welding gases is high, so that some other fuel is more economical where much heat has to be provided.

Many pieces must be kept hot all over while being welded, and this cannot be done with the torch. Such parts as water-jacketed cylinders, cast-iron heating boiler sections, aluminum and cast-iron crank-cases and transmission cases for automobiles, and other large castings come under this head. Good hardwood charcoal is then the best all-around fuel. It burns without smoke, does not injure finished surfaces as does coal, gives off no offensive odors, burns slowly and evenly, does not need a fan blast to keep it going, will heat any piece red-hot, and is easily controlled. Many pieces have to be cooled off in the fire so that they will not contract too fast or unevenly. Charcoal is also the best fuel for this purpose, as the heat from it dies out slowly.

The best hardwood charcoal is necessary. That made from soft wood breaks up easily, has little heat, and clogs up the fire so that it does not burn well. It is advisable to remove the dust and small pieces, by screening through a ½-inch mesh sieve. For handling charcoal from the storage bin to the fire, old carbide cans with the top cut out, are very convenient, and save many steps. It is well to store as little charcoal as possible, as it is easily ignited by a chance spark; and as it gives no warning by smoke, it is liable, if ignited, to gain considerable headway before being observed.

Gas furnaces are very convenient for preheating to reduce the torch gas expense, but for anything else they are of little value. Kerosene torches are frequently of value for heavy work of certain kinds, especially where no contraction strains exist. Gasoline torches cannot be recommended in a welding shop. In some cases ordinary Bunsen burners or modifications similar to those used in gas stoves may be used, particularly on light work. They are of special value where many pieces of one kind have to be welded, because the burner can be made to suit the job.

A very satisfactory method of preheating shafts and other solid pieces is by the use of a gas torch using illuminating or natural gas and compressed air under about one pound pressure. These torches may be held in clamps, and mounted on a flat firebrick-covered table, which may be surrounded with firebrick, to keep in the heat. It is necessary to have a blower to obtain the air pressure, and its operation is somewhat costly, unless there is plenty of work of this kind, which is not often the case in a repair shop.

There are two objects for which preheating is used. The first, merely to heat the piece to save time and gas and make a better weld; and the other, to take care of the natural contraction of a welded piece. In the first case, which applies to plain heavy pieces, it is only necessary to put them in the fire, heat them as rapidly as possible, weld them, and let them cool off slowly. The second case is very different. Such pieces as gas engine cylinders (which have two walls joined together to form a water space), flywheels with heavy rims and light spokes, stamping press and punch press frames with two rigid uprights, automobile crank-cases of aluminum or cast iron, or any other pieces where the shrinkage of the weld would produce a strain, should be preheated in part or as a whole so that the strains during the cooling may be equalized or eliminated. It is impossible to give any general directions, but specific cases are treated of later.

The only guide at the present time as to the amount to which a piece should be preheated is experience. It may be said, however, that as far as eliminating strains or securing a sound weld is concerned, taking nothing else into consideration, the hotter the piece is heated the better. Care should be taken, however, not to heat a piece so that it will distort. It is easily possible to heat a cast-iron piece so hot that if not properly supported it will sag at the unsupported place, and, of course, care must be taken to avoid this. This property of cast iron is, however, of value at times in straightening pieces that have been warped by welding, it being possible in many cases to clamp a piece at one end rigidly on a true surface and pull the other end down slowly with another clamp, while keeping the weld quite close to the melting point with the torch.

Examples of Preheating

In Fig. 4 is shown an instance of the necessity of proper preheating to insure sufficient expansion so that there will be no strain in the piece after welding. The two sides *K* are identical in construction and the section below the piece broken out is identical with it. The casting is about 3½ feet square, and the thickness of the welds, except at the flange, is about 1¼ inch. In order to check the expansion tram-marks were made at *A*, *B*, *C* and *D*, *AB* being equal to *CD*. Inasmuch as the casting was very rigid, it was necessary to take special precautions to avoid strains in the welded piece. The method followed was to heat the side *CD* both top and bottom to a sufficient temperature to give an equal expansion to that of the side *AB* which was heated only at the bottom, in order to keep the top as cool as possible, forcing the expansion to take place everywhere except at the break, the torch being sufficient to counteract the heat at the part below the break. The fires were started slowly, charcoal being used. The fire on the side *CD* is longer than the one at *AB*, the latter being very little longer than the piece broken out, but care was taken to tram both sides just before welding to be sure that the expansion was the same. During the firing, side *CD* was kept covered with asbestos paper, while the piece broken out and the casting in the vicinity were not so covered. Care was taken, however, to prevent sparks from rising from the fire by covering the space between the bricks and *AB*. The illustration shows the bricks *X* laid on their side to permit a good view of the breaks, but they were later placed on edge in order to confine the heat. The fire, however, was not allowed to reach the break, but was kept about 3 inches above the bottom section. A large tip was used to make the welds, as the casting was comparatively cold. Weld *F* was made first, allowed to cool to the temperature of the casting, the tram-marks checked again, and then weld *H* made. Both welds were burnt entirely through from the top, and each one was finished underneath after it was made, taking down enough of the outside bricks to reach it, and covering over the fire to hold the heat in the bottom section. After welding, this cover was removed, the bricks replaced and the casting allowed to cool down in the fire. It was found that before welding at *H*, the crack was open about 1/32 inch, which was sufficient under the conditions to take care of the contraction. It is necessary in this and similar cases to make the weld as quickly as possible, so that the heat conditions at all points will remain as nearly constant as possible.

Fig. 3 shows the method of preparing, blocking up and preheating the rope drum from a hoisting engine. Both ends were cracked in the same way, although the upper one in the illustration was not cracked so badly. It was impossible to prepare the drum from the other side, which would have been desirable on account of the greater ease of doing the work, as it could have been done under a drill press. The crack extended through at the root of the friction block cavity, making it impossible to prepare by any other method except that used. An electric drill was used and the necessary material chipped away as shown, the same procedure being followed on both ends to produce the V's. As the casting was quite heavy, it was necessary to block it up inside of the crack, because if it had been blocked up under the outside, it would probably have been distorted when it became red-hot.

Fig. 3 also shows the pieces of sheet iron practically surrounding the casting, and the charcoal in place ready to ignite. Of course, pieces of sheet iron entirely surrounded the flange during the preheating, welding and cooling off. Care was taken to melt through the bottom of the crack to insure a sound weld. Fig. 5 shows the piece after welding. There was no necessity for any finishing except just sufficient grinding with a flexible shaft emery wheel to remove the principal roughness, so that the rope would not chafe.

THERE are a number of points to be considered in a general way in oxy-acetylene welding, which apply equally to the welding of all metals. These will now be considered, and in subsequent articles the special points applying individually to each metal will receive attention. Some of the instructions may seem unnecessarily minute, and even superfluous. In some cases full explanation cannot be given without going into metallurgical theories more than is thought wise, but the reader may rest assured that for what is said there are good reasons, and the author has obtained the best results by adhering closely to the rules laid down.

General Rules

1. Follow strictly and without deviation the instructions given by the manufacturers of the apparatus used, in every respect. Reputable manufacturers, the only ones whose apparatus should be purchased, are not only willing, but anxious, to assist when difficulties are encountered. These manufacturers have spent thousands of dollars to find out how to handle their apparatus, and it is to be assumed that they know the best way and instruct accordingly.

2. Remember that a welding torch is an instrument of precision, and handle it as such. Throwing it down on a table, dropping it on the floor, or other misuse, is sure to result in more or less injury to the welds made. If the torch tip becomes hot, do not plunge the whole head in water. Cool off the tip first. When it is thoroughly cool, the head may be cooled off. Lack of attention to this point in certain types of torches will damage the end of the tip in the head, and may cause injury to the threads in the head, when the tip is removed.

3. Keep all the torches in first-class condition, free from leaks, and with clean tips. See that the gages register properly at all times, and that the reducing valves act promptly. Good results cannot be obtained with defective apparatus. See that all joints are tight, so that neither acetylene nor oxygen may be wasted. An oxygen leak may not seem very dangerous, but it may result in a rapid burning of the welder's clothes or cause some wooden article to burn where a spark falls on it, when otherwise no damage would result. An acetylene leak is dangerous. If it were generally appreciated that a quart can filled with an explosive mixture of acetylene and air has enough potential energy to kill a person nearby, no acetylene leaks would be permitted. Be particularly careful to see that no leaks exist in the hose or torch. The hose on the floor is liable to have pieces of metal dropped on it which damage it, and even with the best of care it will in the course of time wear out, the inner lining becoming porous and allowing the escape of the gases. Hose in this condition cannot be repaired; it is dangerous and should be replaced at once. Leaks around the torch are liable to burn the welder and cause explosions, and should not be tolerated.

4. Adhere strictly to the pressures specified by the manufacturer for the different sizes of tips. Do not attempt to force the tip by increasing the gas pressure to obtain a larger flame, but use a larger size of tip. The excess of oxygen caused by the forcing of the tip will result in decreasing the strength of steel welds and will damage other welds seriously. This is a point which is generally overlooked, but which is exceedingly important. Use a tip large enough to do the work easily, but under no circumstances use too large a one, as damage to the weld will probably result.

5. Unless otherwise specified, always use a neutral flame. The flame of a torch may contain an excess of acetylene or an excess of oxygen, or it may be strictly neutral. It is not to be understood by the expression "neutral" that one torch may not consume more oxygen than another even when the flames appear neutral in both cases. The neutrality of the flame refers to the small welding flame only, and simply indicates that to the eye the flame has just sufficient oxygen to burn the acetylene completely and no more. If care is not used a considerable amount of oxygen, over and above this requirement, may escape through the torch tip and damage the weld.

Fig. 1 shows a photograph of the neutral flame as it appears to the eye, but magnified three times. The length is about three times the diameter of the largest part; the small, intensely white flame A is sharp in outline, and is symmetrical and smooth. A jagged or irregular flame indicates that the hole in the end of the tip is not true, or is rough; it is necessary occasionally to run a drill of the

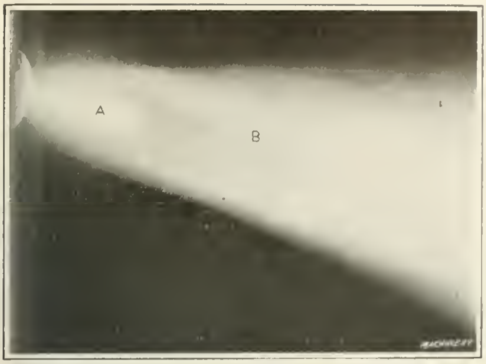


Fig. 1. Neutral Flame enlarged about Three Times

Fig. 2. Neutral Flame photographed through a Light Filter

proper size carefully into this end and to clean it out and true it up. The thinner flame *B*, as it appears in the illustration, is due to the burning of the hydrogen left when the acetylene is broken up into its constituents, carbon and hydrogen. The fact that the photograph was given a one-minute exposure with a very rapid plate shows that the conditions were not very different during that time, because of the sharp outlines of both flames. It might be stated that this stability of the flame is characteristic of the torch used to produce the photograph.

Fig. 2 shows the correct shape of the neutral flame. This photograph was taken with quite a long exposure through a light filter, the conditions not being changed in any way from those under which Fig. 1 was taken. It will be noticed that, while the flame is of the same length, the width has been reduced; the hydrogen flame has practically disappeared. It will be also noticed that there is a considerable halo on both sides of the flame, which the writer believes is caused by a small amount of acetylene which escapes without combining directly with the oxygen, and which is probably burnt by oxygen from the surrounding air. It will be noticed that there is none of this halo at the end of the flame. This, however, does not appear to be of serious importance from the practical side of welding.

In Fig. 3 it will be noticed that the neutral flame has entirely disappeared and in its place is a longer white flame, characteristic of an excess of acetylene. When the acetylene is reduced, or the oxygen increased, this flame decreases in size and becomes sharply defined. Upon a further increase of oxygen with no change in the acetylene this sharply defined neutral flame becomes somewhat shorter and takes on a violet tint which indicates a surplus of oxygen in the flame itself. If the increase of oxygen continues, the flame will be blown out. This excess of oxygen flame is shown in Fig. 4, and it will be noticed that it is shorter than the neutral flame and also smaller in diameter, and that it has a bulbous enlargement at the end, while the neutral flame, as it appears to the eye, is more elliptical. It will also be noticed that the outline of this flame is sharper. The hydrogen flame has a peculiar shape at the top. The cause of this is not at present known, but it is probably due to the peculiar shape of the small flame, which is not symmetrical. It is believed that this is the first time that micro-photographs of the various flames have been published, and their appearance indicates the necessity of further study of them. For the present purpose, it is enough to show them as they actually appear.

6. Always light the acetylene first and turn it off last. In some types of torches this may avoid an explosion or "back-fire," which, while it may cause no damage, is to be avoided whenever possible. Back-fire, as it is commonly called, is really a burning of the acetylene inside of the torch. This, of course, is accompanied by a deposit of soot which may collect in the small passages and prevent the torch from working satisfactorily. If this is the case, the passages will have to be cleaned out, although sometimes the deposit will burn out after a short period of use. The temporary reduction in the size of the welding flame, however, tends to make a bad mixture, with resulting damage to the weld. Never use any oil or grease around a torch, or for that matter, around anything exposed to the action of oxygen. Fires may result from this, as the oil is rapidly oxidized with a considerable increase of temperature.

7. It may seem superfluous to call attention to the fact that an acetylene leak, particularly in a generator, should not be stopped by attempting to weld it, or by using any heat at all; but the writer knows of one case of this kind which resulted in the explosion of the generator and the instant death of the man who attempted to weld it.

8. In case repairs are needed on the torch, it is best to send it to the manufacturers. Of course, a mechanic familiar with the construction can make repairs, but the relation of the sizes of the passages to each other must be maintained for efficient work, and the manufacturer can do this best

Fig. 3. Appearance of Flame with an Excess of Acetylene

Fig. 4. Appearance of Flame with an Excess of Oxygen

Fig. 5. Section of Cast-iron Weld broken at Right Angles to the Line of Weld and magnified about Three Times. Note Uniformity in Grain of Iron

9. Never use copper tubing for acetylene piping. It is easily attacked by acetylene, particularly if it is impure, and an explosive compound is created which detonates at the least shock.

Welding Cast Iron

Cast iron is the easiest metal to weld and therefore should be the first one tried by the beginner. It is best to begin with small pieces, say ⅜ by 2 inches in section. Bevel both sides of the two pieces so that the included angle is about 90 degrees (see Fig. 1 in the preceding article) and grind off the sand, scale and dirt for about ½ inch away from the V. Set the ends about 1/32 inch apart, and somewhat above the surface of the table, say on two V-blocks of the same thickness. Use the size of tip recommended by the manufacturer, adjust the flame to neutral and bring both edges to a bright red; then melt down the bottom of the V, applying a little flux or scaling powder with the heated end of the filling rod. Do not add any metal from the filling rod until the bottom of the V is filled from the sides. Be sure that the metal runs together freely. When ready to add metal, put the end of the filling rod in the melted metal of the weld and play the flame on both the rod and the weld so that the metal runs together. As often as is necessary dip the rod in the scaling powder and proceed with the filling in. Be careful not to add too much at one time, using just enough to make the metal run freely. The weld should be made in steps. If too much metal is added in one place, it is likely to run over into the bottom of the V, and unless the welder is experienced and careful, will cause a cold shut which, of course, makes a defective weld. As the filling progresses, be sure that the metal is welded at both sides. Most welders are right-handed and the tendency is to get the left side of the weld well made, while the right side is likely to be "cold-shut" on account of sufficient heat not being applied at that point. The "feel" of the torch in the hand turns the tip toward the left rather than the right. Left-handed welders, therefore, will do just the reverse.

After all the metal necessary has been added (it should be enough to raise the weld slightly above the surrounding surface), play the torch flame at the junction of the old and new metal until the new metal runs into the old. At this time, do not add any scaling powder. If this is done properly, and it should, in fact, be done at intervals, as the weld progresses, there will be no hard spots at the junction. These hard spots are caused by the melted metal striking a colder surface and chilling. They may be caused, even with the utmost care on the part of the welder, by unsatisfactory welding material, but with good material and care they will not exist. The scaling powder has nothing to do with them, but does at times, if of certain compositions, produce a thin intensely hard scale, which, however, is readily removed by chipping or grinding.

It should be remembered that the beginning and end of a weld require less heat than the middle, because there is not the amount of metal present to absorb the heat, and unless care is taken to keep the torch somewhat away from the metal at the beginning and end, the tendency will be to burn it; also, at these points, in the case of cast iron, there is a tendency for the metal to run away, and when adding metal there, the torch flame should be directed toward the center of the piece rather than toward the edge. It will also be found best to use but little scaling powder, as the slag which forms on the surface of the iron tends to hold the melted metal in place. In many cases the welding rod can be held close to the edge, and by manipulating it and the torch the metal will be held in place.

After one side is welded, turn the work over and repeat the operation on the other side, beginning where the weld on the first side ended; this saves gas. After the sides are welded, it is advisable to touch up the edges so that the metal will be welded entirely through the V's. Enough metal should be added so that the piece will "square up" when ground to its original size, and care should be taken that it does not run away. Evidently the full heat of the torch is not

Fig. 6. Weld in Cast Iron beveled from One Side. Top of Weld

Fig. 7. Weld in Cast Iron beveled from One Side. Bottom of Weld

Fig. 8. Weld in Cast Iron beveled from One Side, but Broken, showing Defects

needed at these points. In the case of a small weld like the one described, there will probably be no casting strains. It is wise, however, to take the precaution of heating the weld uniformly in order to be sure that this difficulty does not exist. After the weld is finished, allow it to cool off in a dry, warm place. When cold, grind or otherwise remove the surplus metal to the same size as the original casting, and put it in a vise with the top of the jaws at the center of the weld. If the weld has been properly made, it will be found impossible to break the piece with a hammer, except outside of the weld. It should be necessary to break off the piece at both ends of the weld and then break the weld crosswise (or lengthwise of the original piece) to see what the fracture looks like. If this is done, it will be noticed that the weld merges into the original metal without any distinct line of demarkation, and that the grain of the weld is somewhat finer than that of the casting; also that the color is slightly different, being generally a trifle darker. The finer grain is due to the fact that the metal is added in small quantities, and therefore cools more quickly than the whole casting does, which produces a finer grain. In a properly made weld, the V should be much larger than the one made in the preparation before welding, because of the melting down of the sides. The difference in color is due to the difference in quality between the filling rod and the casting.

Fig. 9. One of the Pieces in Fig. 8 shown about Three Times Natural Size

Fig. 10. Cast-iron Manifold on which Broken Lug is to be welded

Fig. 11. Completed Weld of Manifold shown in Fig. 10

Fig. 5 shows the uniformity of structure of a properly made cast-iron weld. There is a slight difference in the size of the grains between the center where the weld is, and the body of the casting, the latter being somewhat larger. This difference is more noticeable in a larger piece, and is more apparent in the piece itself than in the illustration.

There is a small projection just to the left of the center of the large blow-hole, which is a particle of foreign matter, probably sand, that gave off enough gas to produce a blow-hole. This can be eliminated in welding by melting to the bottom of the hole and floating the dirt to the surface.

The first piece welded by a beginner will probably show defects caused by the metal not being thoroughly melted and only sticking together in some places instead of being solid. The only way to gain experience is to break a considerable number of pieces and repeat the trials until a sound weld is easily made. The difficulty in making sound welds increases with the size of the piece, and until one is sure that he can make good welds in small pieces, he should not try large ones. It may also be found that the proper size of tip is not used. Too small a tip will result in cold shuts and slow work. Too large a tip will result in blowing the metal away on account of the higher oxygen pressure used, which also makes the work slow, and tends to burn out the carbon of the iron, making it hard and brittle. The proper size of tip can be found after a few trials, and experience will soon tell a welder what tip to use without trial.

As an illustration of the defects that are likely to occur in a cast-iron weld, the piece shown in Figs. 6 to 9 was prepared, the beveling being done from one side only, and the piece nicked with a hacksaw and broken in order to show the defects more clearly. Fig. 6 shows the front of the weld or the top as the work was being done, and shows how the weld should be made in steps in order to prevent cold shuts. The steps extend from *A* to *B*, the portion from *B* to *C* being welded entirely through, some of the metal hanging from the bottom of the weld in drops. Fig. 7 shows the back of the weld, and it will be noticed that from *A* to *B* the original break remains, while from *B* to *C* it has disappeared. In this view it would appear that the weld is very nearly through, but upon examining Fig. 8 it will be found that it is not through by about 1/8 inch, due to the bridging action of the melted metal heretofore referred to. This is the real danger of a weld that is not burnt through. It is apparently sound, but really the condition is much worse than it appears. It will be seen, however, that where the metal has been burnt through, the weld is perfectly sound. As a matter of fact, it was found impossible to break the weld without nicking it with a hacksaw. At *C*, Figs. 8 and 9, will be seen a spot where the metal has run over from the added material, forming a cold shut, which is very distinct, and, of course, a serious source of weakness. In addition to the above, it will seen that the weld is full of blow-holes for some distance from the bottom of the V. These were caused by adding metal before the pieces were thoroughly hot. The part of the weld which is level with the original pieces seems to be sound at the top, which is proof that while a weld may be sound to all appearances, it may be very far from sound inside.

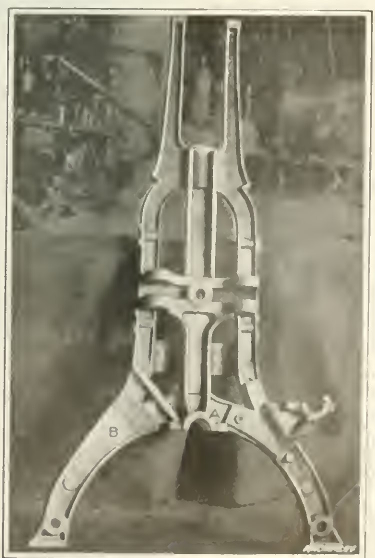


Fig. 12. Machine Frame with Babbitted Bearing close to Weld

Examples of Cast-iron Welds

Fig. 10 shows a cast-iron exhaust manifold with one of the bolting lugs broken off. This is quite a frequent occurrence, and is generally due to the sharp corner left when the nut side of the lug is machined. In order to keep the broken lug straight with the rest of the face, a planed piece of cast iron is clamped across the face, as shown. It is best to weld the back of the lug first on both sides of the clamp, going almost through. Then the clamps and block can be removed and the job finished.

It is easier in many cases to hold such pieces in a vise than to block them up on the table. After the weld is made on the outside, the inside

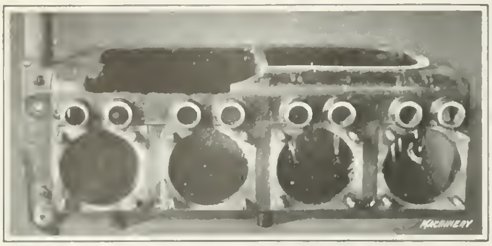


Fig. 13. Cast-iron Crank-case in which Broken-out Piece is Missing

should be finished, care being taken to burn out all remnants of the crack. The last thing done should be the finishing of the faces, and care should be taken to avoid hard spots. If it should so happen that the lug does not come true after the weld is finished (it should be tested with a straightedge), a small amount of metal can be added so that there is sufficient stock to grind and file. The finished weld is shown in Fig. 11.

Fig. 12 shows the frame of a machine in which the break *B* occurred close to a babbitt bearing *A*. It was decided to save this bearing if possible, as there would have been considerable expense in renewing it, not so much on account of the babbitt, as because of the difficulty of alignment. No finishing was necessary at the weld. This made it much easier to save the babbitt, because even if a few hard spots did exist at the weld, it would make no difference. The casting was laid flat on the table, the parts lined up after preparation, and preheated with a Bunsen burner, during which time wet crushed asbestos was kept on both the top and bottom of the babbitt bearing. At frequent intervals water was poured on the asbestos to keep it wet. As soon as the casting had been well warmed, the weld was made on one side, using a heavy tip, which was necessary on account of the absorption of heat by the cool metal. After the first side was finished, the work was turned over, repacked in asbestos, and the weld completed. The weld was then heated uniformly its entire length with the torch and allowed to cool in the air. Had the break occurred at about the place where the rule is shown, it would have been impossible to save the babbitted bearing, and an entirely different procedure would have had to be followed. Undoubtedly the babbitt would have been melted out and more care would have had to be taken to prevent the contraction of the weld. Two torches would have been advisable, welding both breaks at the same time.

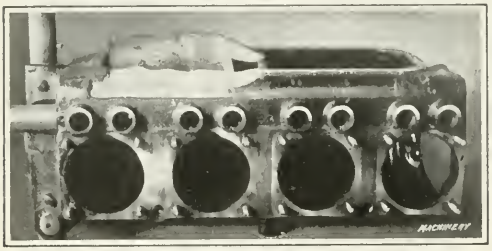


Fig. 14. Asbestos Backing for Plaster-of-Paris Pattern in Place in Casting shown in Fig. 13

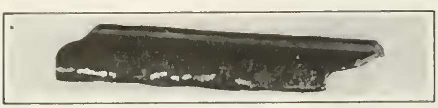


Fig. 15. Casting that is to be inserted in Place of Broken-out Piece in Fig. 13

Welding a Cast-iron Crank-case

Figs. 13 to 17 show a large cast-iron crank-case of the barrel type, with a piece broken out and missing. Fig. 13 shows the preparation of the edges, which was done prior to making the pattern for the missing piece. This is permissible in this instance, because the metal is cast iron and somewhat over 1/4 inch in thickness, and also because the new casting used in repairing was made with enough stock on it to allow for finishing on the hand-hole face. Fig. 14 shows the asbestos backing for the pattern, supported by a sheet of iron and a mandrel through the cam-shaft bearing holes, this being an easy way of supporting the backing in this case. Broken up asbestos paper is now used altogether in the author's shops for the purpose indicated, on account of the ease and rapidity with which it can be applied. Prior to its adoption, it was the custom to use plaster-of-paris, trimming it off to the inside surface of the pattern it was desired to make. The asbestos used is soaked in water and squeezed out until it is just plastic. It is then pressed into place and smoothed down uniformly to the desired level. A sheet of tissue paper is then placed on it and oiled to prevent the plaster-of-paris used for the pattern from sticking to it. The plaster-of-paris is next poured into place, and as it gradually hardens, it is brought to the required contour and allowed to dry. The result is shown in Fig. 16, in which it will be noted that sufficient stock for finishing has been left on the hand-hole face of the casting, and that the plaster-of-paris, when dry, has been beveled out to make the V. A gentle tapping on the casting around the pattern loosens it, and it is easy to lift it out without breakage. Care should be exercised at this stage of the operation, and the plaster-of-paris should be allowed to become quite hard, although it need not be entirely dry. Upon removal, air-holes and irregularities on the inside face will be found, and they should be filled up. Attention should also be paid to so making the pattern that it can be drawn from the sand.

The casting made from this pattern is shown in Fig. 15, and the welded job in Fig. 17. This job was welded in a large forge, the break being turned downward into a charcoal fire, allowed to get nearly red-hot, turned over, carefully covered with asbestos paper and welded, but only from the outside, as it was not necessary from the standpoint of strength to do more than this. The weld, of course, was made entirely through the section, and what beads resulted were chipped off after the case was cold. After welding, the weld was turned into the fire again, allowed to come to a uniform temperature, and then packed in asbestos to cool. In this instance it was not necessary to heat the entire casting to the same high temperature, but the casting was all hot, the coolest part being at a temperature much above that of boiling water. It is one of the instances where it is not necessary to heat the whole casting to as high a temperature as the part to be welded, nor indeed is it desirable to do so. The case is stiff enough to gradually force the contraction to take place in the weld as it is made, and by allowing it to come to a uniform high temperature after

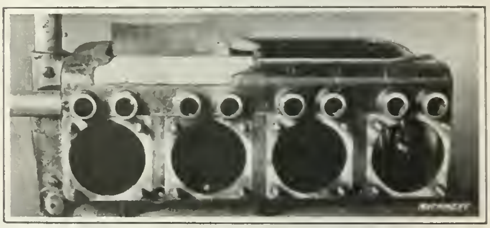


Fig. 16. Plaster-of-Paris Pattern Completed


Fig. 17. Weld Completed

the weld is finished, any strains that may be caused in welding are eliminated.

Welding a Shaper Rocker Arm

Fig. 18 shows a cast-iron arm from a shaper. An attempt was made to weld this by some one without either the necessary knowledge or facilities, with unsatisfactory results. The weld at *A* and the opening at *B* showed that the weld did not extend in more than $\frac{1}{2}$ inch. The work was not preheated or prepared. The photograph was taken after the break at *C* was partly prepared at the writer's shop. The essential thing in this piece was to make the edges of the slots *D*, which form a fork at the end of the casting, come at right angles to the surfaces *E* and *F*, and also to have these two surfaces in line. It was necessary also to be sure that the surfaces *H* and *I* were parallel, as a sliding block operates between them. The method of doing this was to clamp the piece on the corner of the welding table, as shown in Fig. 19. In order to remove the chill from the casting to some extent, a Bunsen burner as shown at *A* was directed against the break at *B*. The upper half of the weld was made, the casting turned over and blocked up carefully and the weld finished. It was then tested to see that everything was straight and square. It was found to be in good shape, but if it had not been, the difficulty would have been corrected by heating the weld *B* with a large torch, when the piece *C* could be carefully pulled into position by means of wedges and clamps. The weld was allowed to cool and the piece blocked up on the table as shown in Fig. 20, all the surfaces on the lower side being laid on V-blocks of the same height. The fork-end was then clamped into position so that the slots were true with a square both ways and the top half of the weld *E* made. It should be noticed that there was enough of the finished surfaces underneath *B* and *C* to allow a narrow V-block to be set underneath which held it true in one plane, while blocking was put under the fork to hold it true in the other direction. Of course, the piece was clamped down to the table, while the first part of weld *E* was being made.

Fig. 18. Shaper Rocker-arm broken in Three Places. This Arm has been improperly welded and is broken again

It was then turned over and the weld finished, and the piece again tested to see that it was in good condition. It is evident that after these operations the piece was true and in line, and with reasonable care would remain so. There was, however, danger of a strain in making the last weld. This was overcome by putting tram-marks at *A* and *B*, Fig. 21, and heating the opposite side in a charcoal fire sufficiently to give the necessary expansion, which was, of course, checked by the tram-marks. The piece was carefully blocked up to be sure that no sagging would take place and half the weld made. It was then turned over and the weld finished, the piece

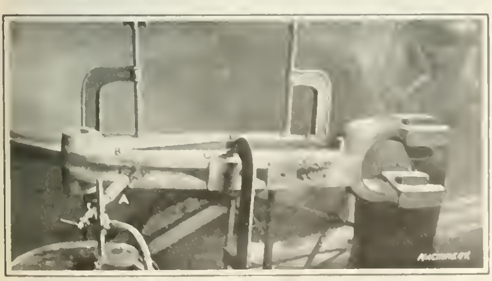


Fig. 19. Method of Holding Rocker-arm while Welding

Fig. 20. Blocking [illegible] to insure Proper Alignment of Welded Parts while making Final Weld

removed from the fire and allowed to cool down in asbestos. The conditions required that all of these welds be made without heating the piece red-hot, because it would have been very difficult to keep the parts in line, had the whole piece been put in a hot fire.

One difficulty in this case was that all of the faces were more or less worn, and some judgment had to be used in checking them up. However, the piece after finishing gave entire

Fig. 21. Completed Rocker-arm properly welded

satisfaction. The use of small torches or gas burners in this or similar cases is of great assistance, because while they do not bring the piece to a red heat, yet enough of the chill is taken from the metal to save a considerable amount of welding gases, and this helps to make a better weld. It is evident that it would be quite difficult, if not impossible, to block up such a piece on the table and build up a charcoal fire under it, the heat being likely to warp or crack the table.

A Difficult Repair Job

Fig. 22 shows what frequently happens when some part of the connecting-rod in a motor lets go. This damage is generally the result of not keeping the rods tightened up as they should be. The case illustrated is not nearly as bad as some instances, but great care must be exercised in following the crack to the end. If the crack extends entirely through a piece, it will prevent the heat of the torch, when applied to one side, from passing to the other, with the result that where the piece is heated it will become red, while the other side will stay black; but if the crack extends only partly through, as is frequently the case, this test is valueless, and the only thing to do is to melt the iron in the direction in which the crack extends and pull it out with the welding rod. If there is a crack, it will show up as a white streak in the center of the melted portion. Therefore in all cases of this character, and in the case of jacket cracks, the weld should be made entirely through the piece at least 1 inch further than the crack shows on the surface, in order to be sure that the end is reached. In the present instance, the crack at corner *A* extended $\frac{3}{4}$ inch beyond where it was visible. The pieces were not prepared, nor is it the practice in the writer's shops to V the pieces in such cases.

Cylinders should always be heated slowly, and the base of the cylinder kept somewhat away from the fire, which should not be too heavy at the beginning. The cylinder should be tilted at an angle so that the heat will pass up through the bore and around the outside, underneath the asbestos paper with which it is covered. After the work is thoroughly warmed through, the defective part should be placed in the fire so as to become more thoroughly heated than the remainder. At this stage the heating should be watched carefully, and when it has arrived at the proper point, while the temperature is still rising, it should be welded in the fire. Under no circumstances must a cylinder be removed from the

Fig. 22. Automobile Cylinder with Dome broken and Jacket cut away in order to Reach Broken Portions

Fig. 23. Automobile Cylinder shown in Fig. 22 after Dome has been welded

fire while the weld is being made, and sufficient asbestos paper should be properly located to cover all the cylinder except the part being worked upon.

It is very difficult to explain how hot to heat a cylinder. If possible to avoid it, the heat should not be great enough to make it red at any point. In certain cases, the cylinder must be heated to a red heat, particularly where there is a rigid connection between the barrel and the jacket at several points, or where the cylinders have large flat sides. Frequently the proper temperature can be determined by the paint and filler on the cylinder being turned to a rusty brown powder. This test is only of value when the cylinder is on a rising temperature. It is evident, if it has been heated to this point and then allowed to cool, that it may not be warm enough to avoid shrinkage cracks, while it may appear so to the eye. The best way to obtain experience is to get some old cylinders and experiment with them. More can be learned in this way in a short time than by pages of description.

In this case, as soon as the cylinder arrived at the right temperature, which was higher than for an ordinary jacket crack—very close to a red heat—it was turned into the position shown in Fig. 22, and the pieces welded on. The welding began at *A*, went from there to *B* and *C* and so on back to the starting point. This gave the maximum chance for contraction to take place without difficulty. The weld was burnt completely through, and as soon as finished, the cylinder was turned over in the fire and the inside of the weld completed and smoothed off with a special torch. This is necessary in order to prevent pre-ignition in operation due to small points projecting into the cylinder becoming red hot, or to carbon collecting on such points and causing the same trouble. It is sometimes necessary to have more than one special torch to reach all the corners. Occasionally a cylinder broken in the dome is split part way down the barrel. Sometimes this weld can be made from the outside of the barrel, and the inside not welded. A better job, however, is made by welding on the inside as well as the outside, and afterward regrinding the cylinder.

After the dome was welded, the cylinder was packed away in powdered asbestos until it was cold; the proper openings were then plugged and the cylinder tested for leaks. This is always a safe precaution, because while, if the work is properly done, there is little chance for trouble, yet, if there is any difficulty, or if any crack is overlooked, it can be welded much more easily than if the jacket is welded right away. However, when time is an object, as it occasionally is, and if the welder is sure that he has welded the dome

Fig. 24. Cylinder in Fig. 22 with Piece of Jacket set in Place ready for Welding

Fig. 25. Cylinder Jacket with Crack not Visible from Outside

Fig. 26. Jacket with Crack Clearly Visible from Inside

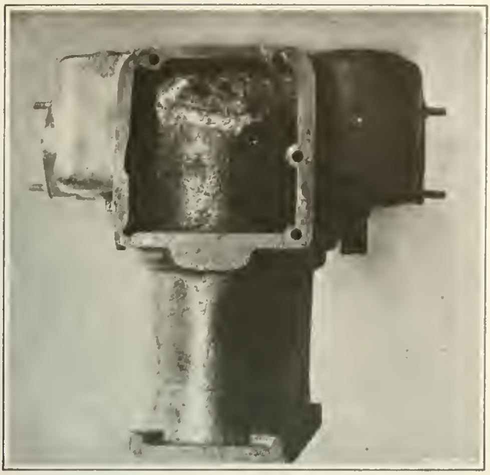


Fig. 27. Improperly Welded Cylinder

properly, the jacket may be welded at once, the whole cylinder packed in asbestos and allowed to cool.

After the cylinder was tested and everything found satisfactory, it was reheated, the jacket put in place as shown in Fig. 24 and welded, beginning at *A* and going to *B*, after which it was welded around the boss, again started at *B* and continued around to *C*. This took care of the contraction better than any other method. The surface *C* was set, before starting to weld, a little higher than *D* to allow of finishing the boss around the center hole.

Mention has been made of the possibility of a crack extending on the inside of a piece where it is not visible on the outside. A very good illustration of this is shown in Figs. 25 and 26, which show a piece broken out of an automobile cylinder jacket in order to weld the dome. In Fig. 25 a crack was visible at the top and bottom of the piece as a very fine line, but it was not visible for more than 3/8 inch in either case on the outside of the piece. However, it will be noticed that it extends along and is quite clearly visible inside in Fig. 26. This condition may exist not only in cylinder jackets, but in any other pieces of the same general nature, and the illustrations are shown to emphasize the necessity of following the crack all the way to the end.

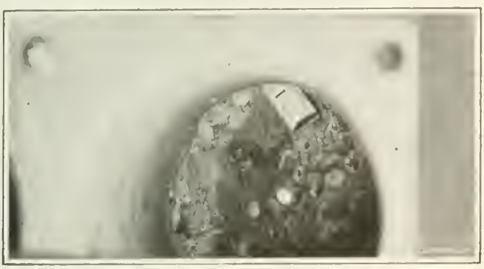


Fig. 28. Rough Condition of Inside of Dome of Improperly Welded Cylinder

Improper Welding of Cylinders

As an illustration of what results from improper welding of cylinders, Figs. 27 to 29 are shown. The original damage to this cylinder is indicated in Fig. 27, and consisted of a crack in the dome. From the appearance of the inside of the cylinder shown in Fig. 28, it looks as if the dome was broken in a number of pieces. It does not appear on examination of the cylinder whether the jacket was cut out to get at the broken dome, or whether it was broken out originally by the damage. However that may be, in attempting to put it back, the cracks kept on extending until the cylinder was cracked through two port plug holes. In addition to this, the corner of the cylinder as welded, was much flatter than it should be, the result being that it would have been impossible to grind out the cylinder without going through the weld. In addition to the above, there was no attempt made to smooth off the inside of the dome, with the result that the cylinder would have knocked, on account of pre-ignition due to the roughness. The cylinder as it stands is not beyond repair, if handled by one who knows how to do it, but the owner purchased a new cylinder, believing that it could not be fixed.

This is a good instance of the damage to the reputation of the oxy-acetylene welding process caused by those who do not know how to do the work and who have not the proper facilities. This cylinder was not preheated, and nothing else than what happened could have been expected. The possession of a hammer, chisel and monkey wrench does not make the owner a machinist; neither does the fact that one has a welding torch and oxygen and acetylene tanks enable him to weld anything that comes along. It should be emphasized that proper apparatus, instructions and training are necessary for the successful carrying out of work like that shown.

As a contrast to the foregoing, Figs. 30 to 33 are shown. Fig. 32 shows the damage to the dome, and the pieces of the jacket cut away to reach it. Fig. 30 shows, on the right, the pieces of the dome, and on the left the pieces of the jacket. In the center is shown the plug going through the top of the dome and jacket. It will be seen that the thread on this is badly damaged. The dome was broken into twelve pieces and the jacket into eight pieces. At *A*, *B*, *C* and *D* are shown the points where the four ribs extending between the dome and jacket are located, the ribs themselves not being shown.

The pieces are shown laid together on wet asbestos and carefully lined up. They were then "tacked" together with the torch so that they could be used as patterns for castings, the amount of welding all the pieces being too great; besides, it would be difficult to put the pieces accurately into place. On the castings from these patterns, as shown in Fig. 34, stock was left for finishing, except at the points *A*, *B*, *C* and *D*, where the connecting ribs between the dome and jacket had to be built up. Fig. 31 shows the dome welded in. Fig. 33 shows the jacket welded in and the dome plug with metal added on the threads. All the machining was done on an ordinary lathe. It was not possible to get exactly the same thread on the dome plug as on the original, but this made no difference, as the stock on the threads permitted any suitable thread to be used. It was impossible in this case to obtain a new cylinder, as the manufacturers had gone out of business; but the cost of repairs was considerably less than the cost of a new cylinder.

For the benefit of those who do not have any foundry located near them, it should be stated that the welding of the pieces together and setting them back into place is perfectly possible. They should all be welded together on both sides, the inside of the dome smoothed off by grinding, fitted in place and welded. In such cases enough of the jacket should

Fig. 29. Contraction Cracks in an Improperly Welded Cylinder

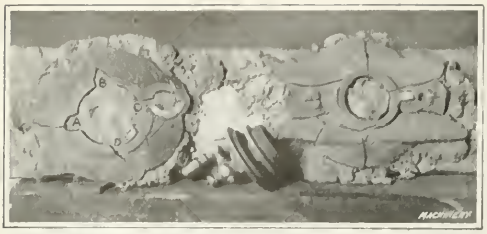


Fig. 30. Pieces of Broken Dome and Jacket of Cylinder shown in Fig. 32

Fig 31. Dome welded in Place

be cut away at the beginning to enable the work to be done rapidly, and the planning should be done ahead, so that it will be known exactly how the work is to be handled. There is no necessity of having to plan these things while the work is being done.

Welding a Heating Boiler Casting

Figs. 35 to 39 show a section of a cast-iron heating boiler. Quite a number of these heater sections break, and as they are expensive, they are well worth welding. The reasons for their breaking generally come under three heads: 1. Allowing the water to become too low in the boiler. This permits the section to become red-hot, and when it is cooled off, or cold water turned in, a crack results. 2. Casting strains in the pieces. The writer has seen new sections not yet installed with bad cracks which certainly could not have passed inspection at the foundry. Sometimes, upon inquiry about a cracked section, the statement is made positively that the water was not low, and while this statement may not always be true, although the person making it believes it to be so, yet a sufficient number of cases have come to the writer's attention in which he believes the information to have been correct, to warrant the belief that strains in the casting are really a frequent cause of breakage. It is also well known that it is difficult to cast pieces of the shape of these sections without experiencing casting strains due to the difference in temperature of different parts while cooling off in the sand. 3. Strains are sometimes caused by the holes for the push nipples, which connect the sections, not being bored true, or in line; or if the sections are not put up correctly, the same trouble may exist. It is also possible to pull the sections together too tightly, and as the push nipples are tapered and fit in tapered holes, an enormous strain can be set up by too much tightening.

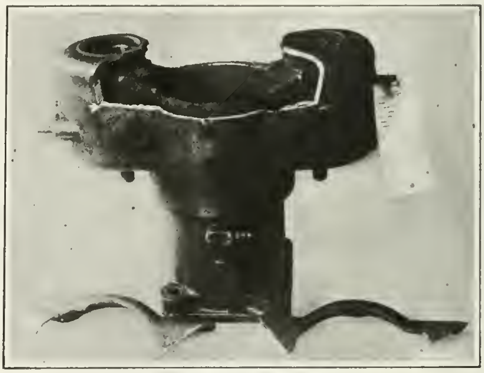


Fig. 32. Cylinder badly damaged and Jacket cut away to enable Welding to be done

Cracked heater sections are generally very difficult to weld, particularly if the cracks are in the body of the section. Of course, if only a corner is broken off, or if the section has a long leg on each side and the defect is in one of them, the difficulty is materially decreased. Considerable experience is required to make a sound permanent job, and even then satisfactory results may not be obtained at the first trial. The difficulties met with are the trouble of controlling the contraction when cooling, and of preheating correctly, if this is done locally, as well as the trouble of turning the section over while heating in order to reach the other side of the weld.

In order to overcome these difficulties, it is necessary, in the first place, according to the writer's experience, to heat the entire section red-hot; this heat must also be uniform. It is believed useless to spend any time trying to heat such a casting locally, or to provide for the contraction by heating one part somewhat more than another. The cause of the crack cannot always be known, and inasmuch as the real cause may be a combination of causes, the only safe way is to eliminate all strains by thoroughly preheating to a high temperature. The contraction while cooling may be overcome by slow cooling obtained by packing the welded casting in asbestos and thoroughly protecting it from drafts. In the case of large sections, this cooling may require forty-eight hours. If the work is to be done outside, in cold weather, great precautions must be taken to insure that the outside edges of the casting do not cool too quickly.

The difficulty of turning over the casting can best be overcome by providing special means for handling. What is done depends on conditions, and no fixed rule can be laid down; but the casting must be handled quickly, and if it is turned over, it must be allowed to reach to a uniform temperature before the final weld is made. After welding, the casting should again be brought to a uniform temperature and then carefully packed as outlined.

Fig. 35 shows a section in which the crack was probably caused by an original strain in the casting. The crack was barely visible, and in order to show in the photograph, it was necessary to wedge it open somewhat. There was some discussion in the shop as to just how to prepare the crack for welding. It was manifestly impossible to get any torch tip into the hole, which is about 1 inch in diameter, as the section

Fig. 33. Jacket welded in Place

Fig. 34. Castings used in making Repairs shown in Figs. 31 and 33

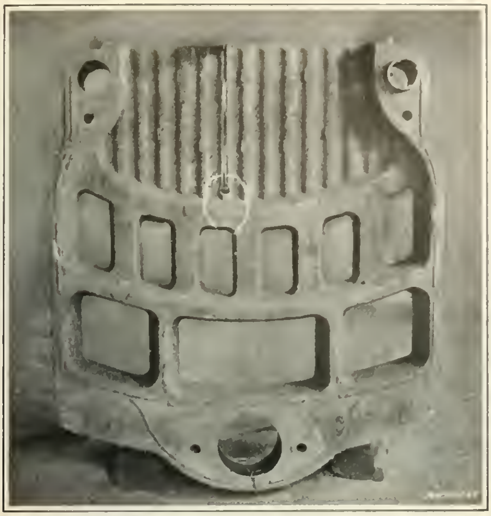


Fig. 35. Crack in Section of a Cast-iron Heating Boiler

Fig. 36. Heating Boiler Casting prepared for Welding

was about 4 inches thick at that point. It was finally decided to prepare the casting as shown in Fig. 36, saving the piece that was cut out (the cutting being done by a hacksaw and hammer and chisel), so that it could be replaced. The wisdom of this method was apparent when the piece was removed, as it was found that there was a boss $1\frac{1}{4}$ inch thick around the 1-inch hole, the piece cut out of the boss being shown in Fig. 36 at A, while the main piece removed is seen at B. The boss can be seen in Fig. 38, where the section is shown laid on steel plates blocked up from the concrete floor and with firebricks under the corners to leave space for the fire. The tram-marks will also be noticed at A, B and C, the distance AC being equal to AB, and being used as reference length.

Fig. 37. Heating Boiler Casting in which Weld is finished

Fig. 39 shows the use of old carbide cans cut up into strips of the proper size for confining the fire. These are very satisfactory for the purpose, as they can readily be bent to any shape and are inexpensive. The fire is applied to such a casting by lighting a considerable quantity of charcoal in a forge and shoving it underneath the casting, being sure to distribute it so as to obtain a uniform increase in temperature. This is a hard thing to do, and experience is the only guide.

It is evident that there is more chance for a draft around the outside of the casting than in the center, that a heavier section will require more charcoal than a lighter one, and that in the open spaces too much charcoal should not be applied. In this particular case, in spite of what was thought to be right, it was found that too much fire had been put along the part AB, Fig. 39, so that after the casting had become quite warm, the distance between the tram-marks had increased $\frac{3}{4}$ inch. In order to remove the strain set up, the fire was shifted toward both ends, but still after the casting had become red, it was found that after allowing for expansion, the tram-marks had separated $3/16$ inch, which indicated that there was a strain somewhere in the original casting.

When the charcoal was first placed underneath the section, care was taken not to use too much, and from time to time, as the casting became warm, it was added in small quantities, but more rapidly toward the latter part of the heating; of course, during all this time,

Fig. 38. Heating Boiler Casting showing Arrangement for Preheating

Fig. 39. Heating Boiler Casting ready for Preheating Fire to be started

Fig. 40. Upright of Broken Press Frame

Fig. 41. Showing Breaks through Metal 5 by 17 and 5 by 14 Inches

the top of the casting was kept covered with asbestos paper. It is necessary, however, to punch holes in the paper to permit of sufficient draft to keep the charcoal burning. The paper tends to distribute the heat more uniformly.

The first welding done was to weld the boss. On account of the difficulty of reaching it, it was necessary to raise the casting from the fire and stand it on end, so that the work could be done quickly. It was carefully covered with asbestos paper while this weld was being made, then replaced in the fire and allowed to come to a uniform temperature. Then the piece which had been cut out was put into place, and the sides *C* and *D*, Fig 39, welded. The casting was then turned over, again allowed to come to a uniform temperature, and, beginning at what was then the bottom of the welds, the V's were filled up and the weld finished at the boss.

During the welding it was necessary to pack the top of the casting heavily with asbestos, as the welders had to stand over it to reach the bottom of the vertical welds. It always pays to protect the welders as well as possible in case of heavy fires, as if this is not done, they cannot do good work.

After the weld was finished, it was found that the trammed distance had increased 1/8 inch. Inasmuch as there was no strain in the casting after the work was done, as it had been uniformly heated after welding, this 1/8 inch represented the total amount of strain in the casting. Where it was, it is impossible to say, but it evidently was there. When cold, a thorough hammer test with a light sledge was made, as well as a pressure test, and everything was found to be in good condition.

It is evident that this 1/8-inch expansion had to be taken care of, as the push nipples could not be put back in place if it were not. The following method of taking care of it has been found in all cases to be entirely satisfactory. The push nipples are made either of cast iron or steel, and the method followed is to cut the nipple in half with a hacksaw. The section is erected in place with each half of the push nipple in its respective hole. A line is then carefully scribed with a sharp point along the exposed surface where the two halves offset, the pieces removed and welded to suit their new position. If this is carefully done, it will be found that the result is entirely satisfactory.

Welding a Press Frame

Fig. 45 shows a large press frame which is broken. The top of it is very close to the wooden roof of the building. Inasmuch as it would have been quite expensive to remove the casting, it was thought wise to attempt to weld it in place. Fig. 40 shows the size and nature of the breaks, the bottom of one of which was comparatively easy to reach, both to prepare and weld.

Fig. 41 shows that the top break was prepared nearly through the casting at the point *A* from the side shown, while at *B* the preparation was made equally on both sides. This was done in order to save the bearing. It will be noticed from Fig. 45 that the bearing on the inside of the broken side had a large projection, and nearly half of this would have had to be cut off if the bevel had been prepared evenly on both sides.

The heating of these breaks, particularly the upper one, was quite a problem, and trouble was anticipated in controlling the contraction, partly because the upper part of the casting was much heavier than the lower part, and also because, as it was very close to the wooden roof, it was feared that sufficient heat could not be applied to raise the casting to the same temperature as below; that this fear was justified was proved by the results. However, it was determined to make the attempt, a plan having been worked out whereby, if trouble should occur, it could be overcome. The heating was done by pans made of old carbide cans hung by wire from the upper part of the casting and surrounding the welds. These pans were located to get as uniform an expansion as possible, and while the breaks shown in Fig. 41 were being welded, fire was maintained in pans on the opposite side in order to avoid any irregular strains due to vertical contraction. It was, however, not anticipated that any trouble would come from the vertical contraction. The difficulty feared was the difference between the horizontal contractions at *C* and *D*, Fig. 41. It is evident that section *C* is much lighter than *D* and that in order to extend the castings the same amount, a much heavier fire would have

Fig. 42. Press Frame showing Breaks prepared for Welding by drilling and chipping Metals

Fig. 43. Crack on Opposite Upright prepared for Welding

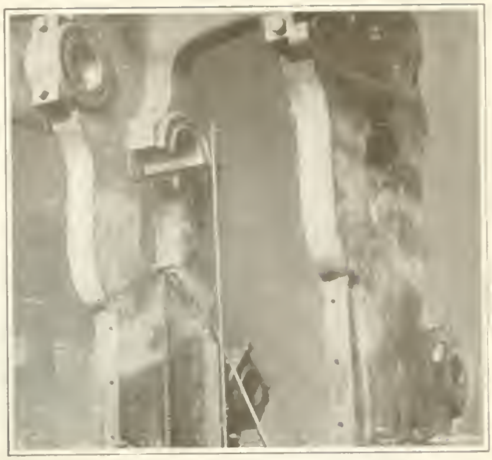


Fig. 44. Section of Press Frame after Welding

to be maintained at the latter point than at the former. While the pans were placed entirely across the top at *D*, it was found impossible with as heavy a fire as could be kept up, to get the same amount of expansion horizontally, although the width of the fire was about 4 inches all around the casting, except at *E* where the pan was cut off to allow the casting to stay as cool as possible. In other words, the lower pan went no further than the break, while the upper pan not only covered the break but also the opposite side of the casting.

In spite of these precautions, and while no new cracks appeared directly after the welds were made, a hammer test later developed a crack at *A*, Fig. 43. This was the result anticipated. The solution of the trouble was to first cut the casting entirely through, as at *B*, and weld *A*. The crack at *A* only extended about 4 inches from the inside corner, but the V was made on both sides about 1½ inch deep at *C*, in order to insure uniform heating with the torch. It was an easy matter to place a pan opposite *B* and one at *D*, and also two others opposite *B* and *D* on the other side of the frame. The desired expansion was obtained without any trouble, and the casting welded at *B*; the tram-marks showed that the casting came back to its original position.

In Fig. 42 will be seen the preparation of a small crack on the left upright. This gave no trouble in welding, as the large body of metal left forced the expansion to take place as was desired. However, the precaution to heat the other upright also was taken while welding. The whole casting weighs about twelve tons.

The problem in this case was to do the welding without removing the frame. There would have been no trouble in welding it had it been removed, because not only could the different parts of the casting be brought to a uniform temperature, but as the welding would have been done horizontally, it would have been much easier. As it was, all the metal had to be added on the side. The two main breaks required four welders for a period of twenty-two hours, as the heat was very great due to the low roof which it was necessary to protect from damage by fire, and also due to the fact that the space between the uprights was only about three feet, so that part of the time the men were working between the pans on the upright.

There was a shrinkage strain in the original casting; this made it necessary to rebore the bearings. It was, of course, realized before the job was started that this would have to be done. This frame has been in service several months since welding, and has been subjected to heavier work than ever before, with entirely satisfactory results.

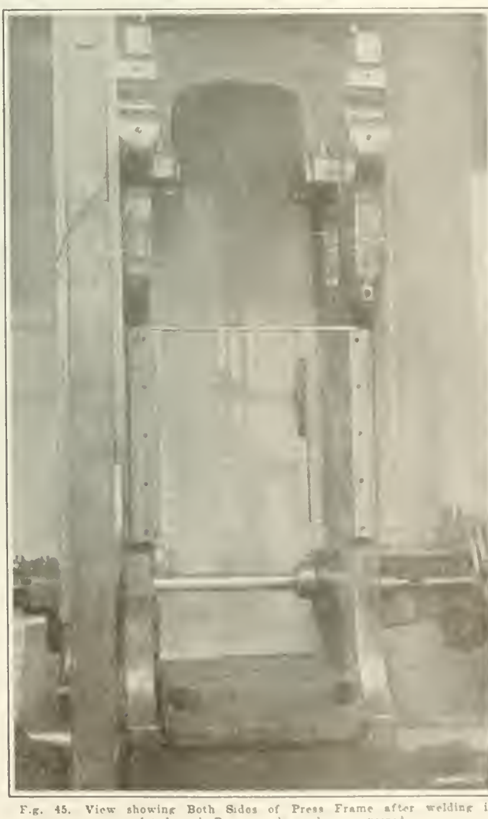
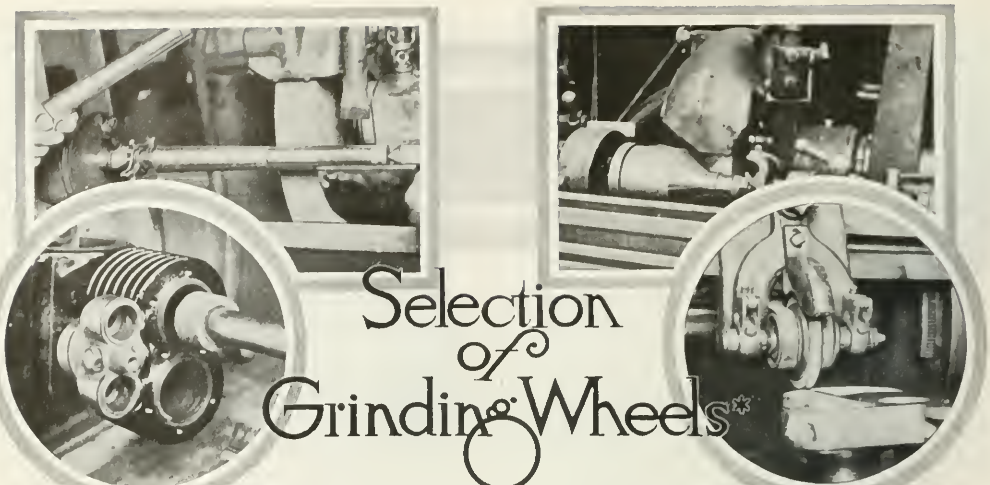


Fig. 45. View showing Both Sides of Press Frame after welding is completed and Bearings have been repaired

* * *

SWAGING HEXAGON HOLES

The hexagon holes in one make of safety set-screws are neatly shaped in a punch press operation. The screws are blanked on screw machines, the hole for the wrench being drilled to a diameter equal to the distance across the corners of the hexagon desired. The exterior of the screw is turned to two diameters, that at the point being the external thread diameter. The body of the blank is turned sufficiently larger than the point to reduce to the external thread diameter when the hexagon socket is swaged. The swaging is done in a punch press, using a hexagon punch which, seated in the hole, pushes the blank through a die. The die reduces the diameter and the excess metal is forced inward against the punch, which acts as a former. The blank, thus reduced to the correct external thread diameter throughout its length, is threaded in a bolt cutter.



Selection of Grinding Wheels*

Abrasives, Processes of Manufacture, Bonds—Choosing Grade and Grain for Grinding Under Varying Conditions

by Douglas T. Hamilton †

THE modern grinding wheel, when properly selected for the work upon which it is used, is very efficient, especially for the finishing of accurate work. The developments in the manufacture of grinding wheels within the past few years have assisted in placing the grinding machine in a class with other highly productive tools and have made possible great decreases in manufacturing costs. A grinding wheel may be compared to a milling cutter having an infinitely greater number of teeth or cutting points. For instance, on an average wheel 24 inches in diameter and 4 inches face, approximately, 1,086,171,000 cutting points come into contact with the work each minute. The teeth or points that do the cutting are called "grains", whereas the material used for holding the grains in the form of a wheel is called the "bond".

Grade of Grinding Wheels

The term "grade", as applied to a grinding wheel, refers to the tenacity with which the bond holds the abrasive grains in place, and does not refer to the hardness of the abrasive. A wheel from which the abrasive grains can easily be dislodged is said to be soft or of soft grade, whereas one which holds the grains more securely is called a "hard wheel." By varying the amount and composition of the bond, wheels of different grades are obtained. The hardness of the wheel is also governed to a certain extent by the size of the grains; for instance, if two wheels have the same bond, the one composed of the finer grains of abrasive is the harder. In other words, a 120-grain wheel would be harder than a 24-grain wheel of the same bond. The combination of different sized grains also causes a variation in the hardness of the wheel.

Grinding Wheel Grading Systems

The grade of a grinding wheel is designated either by letters of the alphabet or numbers, or a combination of both, as will be seen by referring to Table I. According to the system employed by some manufacturers, the letter M represents a medium grade, and the successive order of letters or numbers preceding and following M denote softer or harder wheels. This method of grading wheels is not universal, as no standard system of grading has been adopted by the various manufacturers.

Table I gives lists of grading letters and numbers used by the principal grinding wheel manufacturers, and in this connection it should be clearly understood that these should not be used on a comparative basis. In the first place, the present method of grading wheels is not a mechanical test, but is done by hand as shown in Fig. 1, and requires considerable skill and experience. The tool used has a ball-shaped handle and a blade which is beveled on the end like a cold chisel. When making the test, the beveled end of this tool is simply pressed into the side of the wheel and then turned. The resistance offered by the bond of the wheel to this twisting action indicates, to the experienced man, the grade of the wheel. The extremely delicate sense of touch essential is soon lost even by an expert, who finds it necessary to discontinue the work now and then for a short time.

Considering the method used in testing, it is not surprising to find that the grade letters or numbers adopted by different manufacturers cannot be used interchangeably. A few examples will probably make this point clear. Careful comparison of the grade marks used by the Norton Co. and the American Emery Wheel Works has shown that a grade L American wheel agrees closely with a Norton L wheel as to hardness, but by referring to Table I it will be noted that

* For additional information on grinding, see the following articles previously published in MACHINERY: "Surface Grinding," September, 1915; "Internal Grinding," August, 1915; "Plain Cylindrical External Grinding," July, 1915; "Holding Roller Bearing Races for Internal Grinding," May, 1915; "Grinding Practice," February, 1915; "Selection of Wheels for Cylindrical Grinding," January, 1915; "The Tolford Ball Grinding Machine"; "Grinding vs. Milling"; "Operation of Grinding Wheels in Machine Grinding"; "Data on Surface and Cylindrical Grinding," December, 1914; "Ring Wheels and Solid Wheels for Disk Grinding"; "Wheels for Cylindrical Grinding," November, 1914; "Grinding and Lapping Small Work"; "Selection of Wheels for Cylindrical Grinding," October, 1914, "Making Aloxite Grinding Wheels," September, 1914; "Lobdell Calender Roll Grinding Machines"; "Work-holding Fixtures for the Vertical Surface Grinder"; "Crankshaft Grinding," August, 1914, engineering edition; "Safety as Applied to Grinding Wheels," July, 1914, engineering edition, and other articles there referred to: "The Use of Photographs in Grinding and Polishing Departments," July, 1914; "Work Speeds in Grinding," April, 1914; "Machining Armature Shafts," February, 1914; "Grinding Wheel Protection Devices," January, 1914, engineering edition; "Fixture for Grinding Valve Push Rods," June, 1913; "Exhaust System for Grinding, Polishing and Buffing Wheels"; "A Three-Point Micrometer and Its Use," May, 1913; "Efficient Grinding of Cylindrical Work," December, 1912; "Commercial Grinding," October, 1912; "Grinding Calender Rolls," August, 1912; "Grinding and Corrugating Flour Mill Rolls," July, 1912; "Internal Grinding Practice in Hardinge Bros. Shop," May, 1912; "Holding Work for Grinding"; "Efficiency in Cylindrical Grinding," March, 1912; "Grinding Aluminum Castings on a Vertical Spindle Disk Grinder," January, 1912, "Grinding Hardened Gears," September, 1911; "The Field for Grinding—A Comment," July, 1911; "Rough-turning vs. Rough-grinding of Crankshaft Pins," March, 1911; "The Field for Grinding"; "Precision Grinding," January, 1911; "Grinding Adding Machine Side Frames," December, 1910; "Grinding Economy," July, 1910; "History of the Invention of the Universal Grinding Machine," July, 1910, engineering edition; "Grit and Grinding Chips," June, 1910, engineering edition; "Economy in Grinding," May, 1910; "Errors in Grinding Tapered Reamers and Milling Cutters," December, 1909; "Form Grinding Operations in the Shop of the Landis Tool Co.," August, 1909; "Twist Drill Grinding," June, 1909; "Cylindrical Grinding," May, 1909; "Grinder Kinks," December, 1908; "Grinding Threading Chasers for Brass Work," November, 1908; "Devices for Grinding Fluting Cutters," October, 1908; "Helps and Don'ts for Grinding," August, 1908, "Grinding Threading Dies," December, 1907.

† Associate Editor of MACHINERY.

the Norton grade L wheel is graded as fourth in the "medium soft" column, whereas the "American" L wheel is graded as third in the "soft" column. The grade marks used for wheels made by the various processes also indicate different grades, although the wheels in each case may be known as soft, hard, etc. For instance, in the Norton list a grade 1 elastic wheel is not of the same hardness as a grade E vitrified or silicate wheel, although both are called soft wheels.

Fig. 1. Method of determining Grade of Grinding Wheels

Grain of a Grinding Wheel

The grain or coarseness of a wheel is designated by numbers which indicate the number of meshes to the linear inch through which the kernels of abrasive will pass. For instance, 36 grain means that the abrasive will pass through a sieve having 36 meshes to the linear inch. The grains commonly used for plain cylindrical grinding vary from 24 to 60. There are two kinds of grains—straight and combination. In a straight-grain wheel all the particles of abrasive are of about the same size, whereas in a combination grain wheel the particles of abrasives are of different sizes. The combination of grains in a wheel is never specified by a manufacturer, as it requires considerable experimenting to determine the correct proportions for any combination. Sometimes a number is arbitrarily selected to indicate the combination of grains, whereas in other cases the number given indicates the coarsest grain in the wheel. A correct combination of grains cuts fast and leaves a good finish on the work; moreover a combination wheel will generally remain in a good cutting condition longer than a straight-grain wheel.

Abrasives Used in the Manufacture of Grinding Wheels

The abrasives used in the manufacture of grinding wheels are both natural and artificial. The chief natural abrasives are emery and corundum. Those artificially produced are adamite, aloxite, alundum, boro-carbone, carborundum, carbolite, crystolon, etc. Of the natural abrasives, corundum is the most widely used; it contains a much larger percentage of crystalline alumina, than emery does, this being the element in both abrasives that does the cutting. Emery is very tough, but contains iron and other non-cutting elements, and is seldom used in wheels employed on automatic grinding machines. With the exception of corundum, most of the

TABLE I. GRADING SYSTEMS USED BY GRINDING WHEEL MANUFACTURERS TO INDICATE HARDNESS OF BOND IN GRINDING WHEELS

Grade	GRINDING WHEEL MANUFACTURERS																				
	Abrasive Material Co.		American Emery Wheel Works			Carborundum Co.		Cortland Corundum Wheel Co.		Detroit Grinding Wheel Co.		Norton Co.		Safety Emery Wheel Co.		Sterling Grinding Wheel Co.		Vitrified Wheel Co.		Waltham Emery Wheel Co.	
	Grade Index of Grinding Wheels used for Different Processes of Manufacture																				
	Vit. and Sil.	Elast.	Vit.	Sil.	Elast.	Vit. and Sil.	Elast.	Vit. and Sil.	Elast.	Vit. and Sil.	Elast.	Vit. and Sil.	Elast.	Vit.	Sil.	Vit. and Sil.	Elast.	Vit. and Sil.	Elast.	Vit. and Sil.	Elast.
Extra Soft	G	¾E	..	..	..	Z	..	D	D	C	½	..		C	6	1	1	.	.		
	..	..	..	..	..	Y	..	E	E	D			..	C½	..	1¼	1¼	.			
	.	..	..	.	..	X	..	F	F			.		..			.		.		
Very Soft	H	1E	G	½	½E	W	11	..	..	..	..		..	H	5½	1½	.	.			
	I	..	H	¾	¾E	V	10	..	..	E	¾			H½	5	1¾	.				
		..	I	1	1E	U	..	..	.	F		..					..				
Soft	J	.	J	1½	1½E	T	9	G	G	G	1	E	1	A	4½	2	2	C	½E	1½	1½R
	K	1½E	K	2	2E	S	8	H	H	H		F	1½	A¼		2¼	2¼	C1	1E	1¾	
	..	..	L	2½	2½E	R		I	I		..	G	.	A½	.		2½	C2	1½E	2	
	..	..	.	..	.		..	..	..	..		H		A¾			2¾	..		.	
Medium Soft	..	..	..	..	..	P	7	J	J		..	I	2	M	1	2½	.	C3	2E	2¼	2R
	L	2½E	..	.	..	O	6	K	K	I	1½	J	2½	M¼				D	2½E	2½	
	..		..	..	..	N	5	L	L	K		K		M½	.			D1	3E	2¾	
	.	..	..	..	..	..	..		..	..		L	.	M¾		2¾		D2		3	
Medium	M	3½E	M	3	3E	M	..	M	M	L	2	M	3	P	3½	3	3	D3	3½E	3¼	2½R
	..	.	N	3½	3½E	L	4	N	N	M		N	4	P¼		3¼	3¼	E	4E	3½	
		4E	O	4	4E	K	3	O	O	..		O	..	P½		..		E1	4½E	3¾	
	..	..	..		..	J	..	.		.		P		P¾			.	E2		4	
Medium Hard	N	5E	P	4½	4½E	I	.	P	P	..	..	Q	5	I	3	3½		E3	5E	4¼	2¾R
	O	6E	Q	5	5E	Ix	2	Q	Q	N	2½	R	..	I¼				F	5½E	4½	
	P	7E	R	6	6E	H	1	R	R	P		S		I½				F1		4¾	
	.	..	..	..	..	Hx				..		T		I¾		3¾		.		5	
Hard	Q	..	.		..	G	½	S	S	Q	3	U	V6	O	2½	4	3½	F2	6E	5½	[illegible]R
	R		..		.	Gx	.	T	T	R	4	V	V7	O¼	2		3¾	F3	6½E		
	..	..		..	.	F	..	U	U		.	W	.	O½							
		..	..	.	.	E				..		X		O¾		4¼					
Very Hard	S	..	S	7	7E	D		..						N	1½	4½	4	G			¼R
	T	..	T	..	..	.							.	N¼			4¼				
	U	.	U	..	..					T	5			N½			4½				
	.	..	.	..	..					U	6			N¾		4¾	4¾				
		..	..	..	..						..										
Extremely Hard	V		V	..	.			V	V			Y		F	1	5	5			6	
	..		..	..	..							Z		F¼		5¼	5¼				
				.	..									F½		5½	5½				
	.			..			.	..						F¾		5¾	5¾				
Special Extra Hard	Z		..											D		6	6				4R

Machinery

Note: This list of wheel gradings as given by the various manufacturers should not be used on a comparative basis.

abrasives used in grinding wheels are produced artificially in the electric furnace from bauxite and carbide of silicon. The chief constituents and methods of manufacture of a number of the natural and artificial abrasives—designated by various trade names—are given in the following:

Adamite is an artificial abrasive produced in Austria and used by the Detroit Grinding Wheel Co. The chief constituent is aluminum-oxide, which is mixed with certain ingredients to remove the impurities and is fused at a high temperature in the electric furnace. This abrasive is used in wheels for grinding materials of high tensile strength, such as soft and hardened steel, etc.

Alundum is an artificial abrasive first produced by Charles B. Jacobs, consulting electro-chemical engineer. The original process, however, has been perfected and commercially applied by the Norton Co. Alundum is made by fusing the mineral bauxite in the intense heat of the electric arc furnace. Bauxite is a soft earth resembling light yellow clay, and, chemically, is the purest form of aluminum-oxide found in nature. It is one of the most commonly occurring substances in nature and is usually found mixed with other materials from which it is exceedingly difficult to separate it. Separation was impossible previous to the invention of the electric furnace. Bauxite derives its name from the ruined city and castle of les Baux, in the southern part of France, where it was originally discovered. Large quantities of this mineral are now mined in Georgia, Alabama, and Arkansas. It is found in pockets and is mined in open cuts, then carefully washed, dried and shipped to the plant where it is purified and subsequently fused in the electric furnace. Alundum is used in wheels for grinding materials of high tensile strength. A special temper or "white" alundum is used by the Norton Co. in the manufacture of wheels for certain classes of work. This is designated as No. 38 to distinguish it from ordinary alundum.

Alowalt is a trade name given to an abrasive used by the Waltham Emery Wheel Co., which is the product of the electric furnace and is made from aluminum-oxide in practically the same manner as aloxite.

Aloxite is the trade name given to an abrasive manufactured by the Carborundum Co. that is made from pure crystalline aluminum-oxide, produced by fusing bauxite in the electric arc furnace. In converting bauxite to aloxite, three operations are necessary: first, the removal of approximately 15 per cent of moisture; second, the removal of iron and silica; and third, the changing of amorphous bauxite into crystalline aloxite. Bauxite is received from the mine in small lumps, and after being crushed it is calcined in rotary kilns, fired with producer gas, which removes the moisture and volatile matter. It is then mixed with a certain percentage of coke, after which it is placed in the electric furnace. The furnace consists of a crucible-shaped steel receptacle, about five feet in diameter, which is lined with carbon and is movably mounted. The top is open and two vertical carbon electrodes extend down into the charge, which is fused between the arcs formed by the electrodes. The electric arcs generate a temperature estimated to be about 4000 degrees F. The charge of bauxite is fed into the furnace from time to time until an ingot has been formed weighing several tons. The current is then shut off, and the mass allowed to cool slowly. The ingot is then removed, freed from unfused mixture and metallic reduction products, and broken into small blocks. It is then crushed, concentrated and graded, and mixed with the bond ready for molding, truing and burning. Aloxite is used for grinding materials of high tensile strength.

Boro-carbone is the trade name for an abrasive used by the Abrasive Material Co. which is also a product of the electric arc furnace. It is manufactured in southern France and is oxide of aluminum in crystalline formation produced by fusing bauxite at a temperature of about 3800 degrees F. The temper of boro-carbone is varied according to the kind of work on which it is to be used, and its physical formation is such that it presents sharp cutting points when fractured. It is used for grinding materials of high tensile strength.

Carbide of silicon is the name given to an abrasive used by the Abrasive Material Co. in making grinding wheels for materials of low tensile strength, such as cast iron, brass, etc. The chief constituents of this abrasive are coke and sand. The coke supplies the carbon and the sand the silicon. These two substances are volatilized in the electric furnace.

Carbo-alumina is the name of an artificial abrasive used by the Detroit Grinding Wheel Co. in the manufacture of wheels for grinding materials of high tensile strength. It is produced from bauxite in a somewhat similar manner to alundum.

Carbolite is the trade name given to an abrasive used by the American Emery Wheel Works in the manufacture of wheels for grinding materials of relatively low tensile strength, such as cast iron, brass, aluminum, etc. Carbolite is another name for carbide of silicon in crystalline form, and is made from coke and sand which is volatilized in the electric furnace.

Carbolon, which is manufactured by the Exolon Co. and sold by Alden Speare's & Sons Co., is used by the Vitrified Wheel Co. in the manufacture of wheels for grinding materials of low tensile strength. Pure silicon carbide is a hard crystalline material in which the individual crystals are arranged in comparatively thin transparent layers of a greenish hue. Commercially, silicon carbide may be of a greenish hue, black, or highly colored. The black variety frequently has extremely thin layers of impurities, such as metallic silicon, metallic iron, etc., deposited between the crystalline layers. Carbolon is made from coke and sand in the electric furnace in a manner similar to carbolite. It has been found that an accurate control of temperature in the reaction zone of the furnace is of the utmost importance, and also that the slightest variation in the mixture of raw materials produces a marked effect on the nature of the resultant crystalline mass.

Carborundum is the trade name given to an artificial abrasive manufactured by the Carborundum Co., which is a chemical combination of carbon and silicon, discovered by Edward G. Acheson in 1891. The principal materials used in the manufacture of carborundum are coke and sand. The coke is used to supply the carbon, and the sand the silicon. These two substances are raised to a temperature of about 7000 degrees F. All the impurities and other substances in the coke and sand other than carbon and silicon are driven off in gaseous form, and these two elements unite, forming the abrasive known as carborundum.

Carbowalt is the name of an abrasive used by the Waltham Emery Wheel Co. It is manufactured from coke and sand in a somewhat similar manner to carborundum.

Corex is the trade name for an abrasive used by the Safety Emery Wheel Co. in the manufacture of wheels for grinding cast iron, unannealed malleable iron, brass, bronze, etc. It is produced from coke and sand in the electric furnace.

Corowalt is a special temper corundum abrasive used in the manufacture of grinding wheels by the Waltham Emery Wheel Co. It is especially useful for the grinding of hardened low or high carbon steel. It is produced in the electric furnace in a manner similar to alundum.

Corundum is the purest of natural abrasives and is a mineral composed of native alumina, which is noted for its hardness. This mineral was first found in India in the eighteenth century, and derives its name from a native Indian name, kurundam. The finely colored transparent varieties of this abrasive include such gems as the ruby and sapphire, while the impure granular and massive forms are known as emery. Next to the diamond, corundum is the hardest known mineral. Large deposits of this mineral are found in Georgia and North Carolina, and also in Ontario, Canada. Corundum is also produced artificially, although it is artificial only in the sense that it is crystallized by means of the electric arc furnace instead of by nature. Chemically, natural and artificial corundum are alike, both being composed of aluminum oxide in the crystalline form. A special grade of artificial corundum made by the American Emery Wheel Works is known as No. 58 to differentiate it from the natural corundum. Artificial corundum was first made by Moissan, in Paris, in the electric furnace, about twenty-three

years ago. Shortly afterward, the original process was improved by Werlem and patented in France. By these improvements, the impurities in the natural alumina were removed in the crystallizing process, so that practically pure crystalline alumina was the result. Wheels made from artificial corundum are either given a trade name, such as "Oxaluma," or are designated by some number to distinguish them from wheels made from natural corundum. For instance, for grinding certain materials, such as steel, etc., the American Emery Wheel Works produces an abrasive known as No. 58 corundum.

Crystolon is an artificial abrasive produced by the Norton Co., the chief constituents of which are carbon and silicon. Crystolon is made from coke, sand, sawdust and salt. Coke is used to furnish the carbon element; the silicon comes from a pure silica sand which is secured from large deposits in Illinois. Crystolon is a very hard brittle abrasive, and ranks next to the diamond in hardness. It is a mass of gray or green multi-hued crystals of attractive appearance. The elements previously mentioned are fused in an electric furnace, at a temperature varying between 3500 and 4500 degrees F., the sand and coke combining to form carbide of silicon. This abrasive is used in the manufacture of wheels for grinding cast iron, brass, bronze, etc.

Emery is a natural abrasive, and is an intimate mixture of corundum (oxide of aluminum) and magnetite or hematite (oxide of iron). It usually occurs in large irregular masses resembling a fine grain of iron ore, which it was originally thought to be. In the Grecian and Turkish mines it occurs in nodules or irregular masses, some of which are several yards in diameter and average about 40 tons in weight. Prior to 1847 all emery used throughout the world came from the Grecian Isle, principally from the Isle of Naxos, but in 1847 Dr. J. Lawrence Smith of Louisville, Ky., discovered considerable masses of emery ore in Asiatic Turkey. Emery is also mined in Chester, Mass. Emery is classed as a form of corundum, corundum itself being divided into three classes, viz., sapphire, comprising the transparent form, such as the ruby and sapphire; corundum, comprising the translucent form, such as commercial corundum; and emery, comprising the massive and black or dark colored varieties. Emery is a very tough and durable abrasive, but contains iron and other non-cutting elements, and is seldom used in grinding wheels for use on automatic or semi-automatic grinding machines. Analysis of emery obtained from the three principal sources showed the following percentages of crystalline alumina: Naxos emery, 63 per cent; Turkish emery, 57 per cent; Chester emery, 55 per cent.

Oxaluma is a trade name given to an aluminum-oxide abrasive used by the Cortland Corundum Wheel Co. in wheels for grinding materials of high tensile strength, such as soft or hardened steel, etc.

Rex is the trade name for an aluminum oxide abrasive used by the Safety Emery Wheel Co. in wheels for grinding either soft or hardened steel. This abrasive is the product of the electric furnace, the process of manufacture being similar to that of alundum.

Bonding Processes Used in the Manufacture of Grinding Wheels

By the use of different abrasives, grinding wheels can be produced which are adapted to a variety of purposes. The important properties of an abrasive are hardness, toughness, absence of impurities, uniformity and "fracture" or sharpness. Inasmuch as these qualities vary to some extent in different abrasives, grinding wheels may be produced which possess varying characteristics, and therefore are effective in grinding not only metals of different compositions but various other materials. The characteristics of a grinding wheel can also be changed by using different bonds, the bond being the substance which holds the abrasive grains together. The three most important bonding processes are known as the vitrified, silicate and elastic processes, and these names are applied to the wheels. For instance, a wheel made by the vitrified process is commonly referred to as a vitrified wheel. Other processes occasionally employed are the vulcanite process, the celluloid process, and the oil process.

The first abrasive wheels known were natural stones, but the uses of these were greatly limited because they did not possess the required physical properties for the efficient cutting of metals. Subsequently, artificial abrasive wheels for grinding metals were bonded with hydraulic cement, which did not prove very satisfactory. Attempts were then made to use organic substances which melt when heated and become hard when cold. Shellac-, resin-, sulphur-, and rubber-bonded wheels were then tried, and, of these, shellac and rubber were successful to a certain degree. The next advance was to use silicate of soda, and the vitrified or fused clay processes. These two processes are largely used today, the latter chiefly in the manufacture of wheels for use on automatic grinding machines.

The Vitrified Process

As vitrified grinding wheels are used to a greater extent in connection with machine shop practice than those made by the silicate or the elastic process, the manufacture of wheels by this process will be described at some length. The bond consists of suitable clays—generally a pure grade of kaolin, which is a clay used in the manufacture of porcelain. When the material for vitrified wheels is mixed by the wet process, power-driven kettles are used. When the mixture attains the consistency of thick paint, it is transferred from the mixing kettle to a mold. When the mold is full, the mixture is carefully worked to remove all air bubbles and insure a solid wheel. The molds are then partially dried in an open room to prevent formation of cracks. This preliminary drying is followed by a more complete drying in the heated room. When the molds of the wheels are hard enough to be handled, they are ready to be turned to shape preparatory to burning in the kiln. The wheels are, of course, molded large enough to allow for turning and also to compensate for shrinkage in drying.

The molded wheel is then trued and turned to the required form on a "potter's" wheel. This is a very simple device and consists principally of a revolving table and a horizontal cross-rail, along which the tool-slide is fed by hand. The wheel to be trued is not held in any way, but is simply placed on the center of the table, which is made of plaster-of-paris. The tool used for turning plain surfaces is a piece of flat unhardened steel. This can be fed either vertically or horizontally, and the graduated scales on the machine enable the operator to turn to the required dimension without taking any measurement.

The wheel is not reduced to the size finally required, an allowance being made for shrinking in the kiln, and also to provide for the final turning operations after burning. This allowance depends upon the size and grain of the wheel. A coarse wheel requires a greater allowance than a fine grain one, other conditions being equal. In the operation of the potter's wheel, hand tools are used to a certain extent, particularly in the formation of special shapes.

The next process in connection with vitrified grinding wheel manufacture is the burning of the wheels in order to partially melt the bond and form a solid but porous wheel. Much skill and care is required to burn wheels successfully, as the temperature must be very accurately controlled for a long period. The wheels to be burned are stacked in a brick kiln and are protected against the direct action of the flames and gases by packing them in fireclay saggers. When the kiln is full, the door is closed and luted with fireclay and the burning begins. This is continued without interruption for a period of from three to five days. The furnace is then allowed to cool slowly for a week.

When very hard close vitrified wheels are required, they are molded under hydraulic pressure. Very strong molds must be used, as the pressures are enormous. For example, a 36-inch wheel would require a pressure of about 1000 tons. The bond and grain for pressed wheels are first mixed dry in a tumbling barrel, after which water is added until the proper consistency is obtained. The mixture is then placed in a steel mold and pressed, after which the wheels are removed from the mold, dried and "fired" in the same manner as other vitrified wheels.

Still another method of molding vitrified wheels is known as the "tamped" process. The abrasive grains and clay for the bond are mixed together in a comparatively dry condition, and this mixture is then tamped into molds of the required size. After molding and drying, the wheels are burned in the kiln the same as wet mixed wheels. The tamped process is used principally for making small wheels.

A vitrified grinding wheel has the following qualities: it is very porous and therefore free cutting; it is not affected by water, oils, temperature or climatic conditions; the bond is hard and practically an abrasive itself. The wet-mixed vitrified process insures uniformity in the wheel, there being no hard or soft spots. The high temperature required for vitrified wheels burns out impurities, leaving nothing but the abrasive and its bond.

The disadvantages of the vitrified process are that it is slow; large wheels are likely to be cracked in the kiln; it is impracticable to produce wheels larger than about 34 inches in diameter and many manufacturers will not make wheels larger than 24 or 30 inches; the burning process is difficult to control perfectly, so that a given lot of wheels are likely to be somewhat off grade.

Vitrified wheels are extensively used for cylindrical grinding, for surface grinding when a disk form of wheel is used, for internal grinding, and for cutter grinding. They can readily be distinguished from other wheels by the reddish or reddish-brown color and the clear ringing sound produced when they are tapped.

The Silicate Process

In the silicate process, silicate of soda is the chief constituent used. The abrasive grains are first mixed with the bond in special machines, and the mixture is then tamped in a mold by hand. Some shapes of wheels are molded under hydraulic pressure, this method being used for disk and very hard wheels. After the wheels are molded, they are dried and baked in special ovens, from which all the fire gases are excluded. This causes a chemical reaction which hardens or sets the bond. The temperature of the oven is much lower than that required in the vitrified process. Silicate wheels can be made of large size and can be produced in a comparatively short time. Silicate wheels are made as large as 60 inches in diameter, and are especially adapted for grinding operations in which it is important to have the lowest possible wheel wear compatible with free cutting. One particular use of these wheels is for the grinding of large calender rolls used in paper mills. For this kind of work silicate wheels give excellent results, producing the desired "mirror" finish.

Elastic and Vulcanite Processes

Very thin wheels are made by the elastic or the vulcanite process. In the elastic process shellac is the principal ingredient in the bond, and the wheels are baked at a low temperature to set the shellac. Wheels made by this process are strong and have considerable elasticity, so that very thin wheels can be used with safety. Vulcanite wheels are bonded with vulcanized rubber. Very hard, tough, thin wheels can be made by this process, but they are rather expensive. Elastic and vulcanite wheels are made by a pressing or rolling operation, and have a very dense structure, the abrasive grains being embedded in the bonding material. This does not permit of as fast grinding as is possible with vitrified or silicate wheels.

Elastic and vulcanite wheels can safely be run in water, but elastic wheels should not be used in oil or caustic soda. The oil softens the bonding material so that the wheel wears down quickly, and the caustic soda causes disintegration of the wheel structure. This is not the case with vulcanite wheels, as they can be operated in both the liquids mentioned without injury to the bond or abrasive.

Elastic and vulcanite wheels are made as thin as 1/32 inch up to 4 inches in diameter, 1/16 inch up to 8 inches in diameter and 3/32 inch up to 12 inches in diameter. Wheels of very fine grain and of small diameter have been made as thin as 1/64 inch. Solid elastic wheels are being made commercially as large as 26 inches in diameter with a 2-inch face and vulcanite wheels 16 inches in diameter with a 2-inch face.

Thin wheels are used for slotting and cutting off stock, whereas thicker wheels are used for saw grinding, grinding between the teeth of gears, sharpening milling cutters, etc. They are also used on roll grinding for cutlery work where a very smooth polished surface is desired. For cutting off, a wheel speed of from 9000 to 11,000 feet surface speed has been found most efficient, but for most other operations a wheel speed of from 5000 to 6000 feet surface speed is recommended.

For general-purpose cutting-off wheels, where the speed of cutting is not a decided factor, vulcanite wheels seem to be the best. However, for cutting off tempered tool steel or alloy steel tools, where cool cutting is the main consideration, elastic wheels are the best, because of their softer grades and resulting cooler grinding action. While elastic and vulcanite wheels are being used for other operations, aside from slotting, grooving, nicking and cutting off, they are slowly being superseded by wheels manufactured by the vitrified process. The more porous structure of the vitrified wheels allows of a much freer and cooler grinding action with a proportionate increase in production.

Celluloid and Oil Processes

Grinding wheels made by the celluloid process have a bond of celluloid, as the name implies. The abrasive grains are mixed with the celluloid and this mixture is then rolled in sheets from which the wheels are cut. After seasoning for several months, the wheels are ready to finish. In the oil process, an oxidizing oil is mixed with the abrasive grains. This mixture is then formed into wheels by compressing it into molds in a hydraulic press. Oil-bonded wheels are similar in action to vulcanite wheels but are less dependable as to grade and uniformity. Celluloid and oil process wheels are only used to a very limited extent.

Selection of Wheels for Grinding

In selecting a grinding wheel, there are several factors to be considered. The grain and grade depend largely upon the area of contact between the wheel and work, the kind of material to be ground, the degree of hardness, etc. A harder wheel should be used on soft machine steel than on hardened tool steel. The reason for this will be best understood if we think of a grinding wheel as a cutter having attached to its periphery innumerable small teeth. When the wheel is of the proper grade, each small piece or cutting particle is held in place by the bond until it becomes too dull to cut effectively, when it is torn out by the increased friction. Obviously, these grains or cutters will become dull sooner when grinding hard than when grinding soft steel; hence, as a rule the harder the material the softer the wheel, and *vice versa;* although soft materials, such as brass, are ground with a soft wheel which crumbles easily, thus preventing the wheel from becoming loaded or clogged with metal, which would be the case if a hard-bond wheel were used.

When a hard wheel is used for grinding hard material the grit becomes dulled, but it is not dislodged as rapidly as it should be, with the result that the periphery of the wheel is worn smooth or glazed, so that grinding is impossible without excessive wheel pressure. Any undue pressure tends to distort the work, and this tendency is still further increased by the excessive heat generated. If the surface of the wheel becomes loaded with chips and burns the work, even when plenty of water is used, it is too hard. When too soft a wheel is used, the wear is, of course, greatly increased, as the particles of grit are dislodged too rapidly and consequently the wheel is always "sharp." This means that the abrasive has not done sufficient work to become even slightly dull, and the result is a rough surface on the work.

In regard to selecting the proper grinding wheel, as a general rule, materials of high tensile strength, such as soft and hardened steel, etc., require a wheel made from an aluminum-oxide abrasive; whereas, for grinding materials of low tensile strength, such as cast iron, brass, bronze, etc., a wheel made from a carbide of silicon abrasive should be used.

Arc of Contact a Deciding Factor in the Selection of Grinding Wheels

One of the many factors to consider in the selection of grinding wheels is the grading of the wheel with reference to the arc of contact that it makes with the work. Fig. 2 shows diagrammatically the principal conditions that must be met when selecting wheels from the standpoint of the arc of contact. These diagrams have been arranged in the order of the care necessary in selecting the proper grain and grade.

For grinding small cylindrical work, as shown at *A*, the conditions are almost ideal, because of the small arc of contact; the work and wheel are easily cooled, and, in addition, the dull abrasive grains readily fall out of the way and do not interfere with the grinding operation. An increase in the diameter of the work *b*, in relation to the wheel diameter, increases the arc of contact and may necessitate using a wheel of different grade. All other factors being equal, the larger the diameter of the work, the softer the grade of the wheel should be.

On surface grinding with a disk wheel, as shown at *B*, the conditions are not quite so satisfactory because, in this case, a greater portion of the wheel surface comes into contact with the work. When a narrow wheel of this shape is used and is fed across the work *c* a certain distance for each traverse of the table, very little difficulty is encountered if water or other cooling lubricants can be used. When the grinding must be done dry, however, considerable trouble is sometimes experienced due to heating and warping, especially when the work is thin; therefore wheels of a softer grade are used for grinding under the conditions shown at *B* than for grinding cylindrical parts as indicated at *A*.

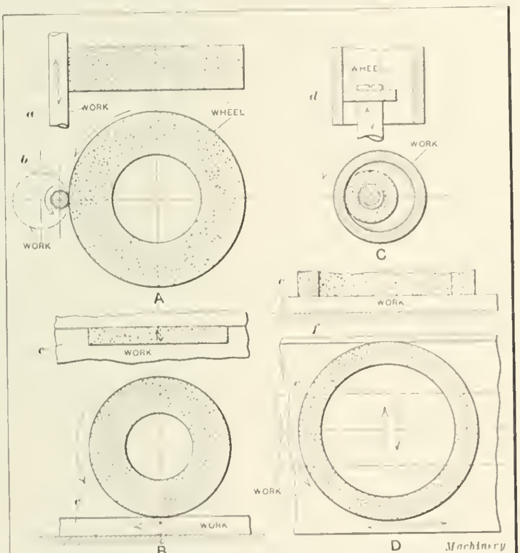


Fig. 2. Diagram illustrating Relation of Arc of Contact of Wheel to Work—A Deciding Factor in the Selection of Wheels

For internal grinding, as shown at *C*, still more attention must be given to the grading of the wheel, because the arc of contact between the wheel and work *d* is much greater than in the other cases mentioned, and the difficulty of using a cooling lubricant is also increased. On small-hole work, wheels are usually specified to be of the same diameter as the hole or slightly larger, and then are trued until they just enter the hole. In such a case, the arc of contact is greatly increased, and the work and wheel tend to heat more rapidly; the difficulty of injecting a cooling lubricant into the hole is also increased. This makes it necessary to use a much softer wheel than if the wheel were smaller in relation to the diameter of the hole.

The most severe condition under which a grinding wheel operates and the one that requires the greatest attention in the selection of the proper grade and grain is that of surface grinding by the method illustrated at *D*. There are two conditions that must be taken into consideration. The first one is where the work *f* is wider than the diameter of the ring or cylinder wheel used. As the entire cutting face of the wheel is in contact with the work, a wheel of extremely soft bond and coarse grain should be used to secure satisfactory results; otherwise, the work will be heated to such an extent that it will spring out of shape and accurate results will be impossible. It is also necessary to have a copious supply of cooling liquid to reduce the heat.

The other condition is where the work *e* is less in width than the diameter of the wheel. In this case, the work has a tendency to tear the grains out of the bond; hence, a wheel of harder bond is required because of the chisel action of the edges of the work on the surface of the wheel. As the contact area is reduced, a wheel of finer grain and harder bond may be used.

Selecting Wheels for Plain Cylindrical Grinding

While it is impossible to give definite information regarding the selection of grinding wheels under all conditions, owing to the different factors which must be considered in each case, the wheels listed in the accompanying tables will enable one to obtain a general idea of the grades and grains that are commonly used for grinding different materials under ordinary conditions.

In the article on "Cylindrical Grinding" in the July number of MACHINERY, considerable space was devoted to the selection of wheels, and in order to amplify this data, the information given in Table II has been compiled. This table gives a list of wheels recommended by various wheel manufacturers, for grinding soft, hardened, and alloy steel, cast iron, brass, bronze and aluminum and can be used as a basis in making the proper selection. By referring to this table, it will be noticed that for grinding cast iron, cast brass, bronze, and aluminum, in most cases wheels made from carbide of silicon abrasives are recommended, although a few manufacturers recommend aluminum-oxide abrasives for this work. It will also be noticed that the bonding processes recommended by the various manufacturers differ to some extent.

For large-diameter cast-iron work, the Norton Co. recommends a grain 30, grade J, crystolon wheel, and for small-diameter cast iron, a grain 30, grade K, crystolon. The wheel for large diameters is one grade softer than that for comparatively small diameters. For bronze, a grain 30, grade K crystolon wheel has been used to advantage. When grinding armatures or other parts where copper and wrought iron pieces are arranged alternately, a Norton crystolon elastic wheel, grain 46, grade 2, has been used with success. For grinding chilled cast iron rolls of large diameter, where it is desired to have a surface free from scratches, a crystolon wheel, grain 80, grade J has given good results. Of course it should be understood that this information is intended only as a general guide.

There are so many different alloys in use that it is difficult to specify any particular grain or grade of wheel that can be used satisfactorily on all of them. For instance, it is now necessary to distinguish between numerous kinds of brass of high and low zinc content, such as "red" and "yellow" brass, bronze, naval brass, and many others. The term "bronze" was formerly employed to indicate an alloy whose chief constituents were copper and tin-copper—but in recent years many different alloys are referred to as bronzes.

Commercial brass is generally understood to mean an alloy of two-thirds copper and one-third zinc, but this varies. The copper content may vary from 60 per cent to 80 per cent, likewise the amount of copper and tin in bronze also varies considerably. With but two exceptions alloys of zinc, tin, lead, iron, manganese, and nickel with copper require no change in the grade and grain of the grinding wheel. The exceptions are nickel-bronze and bell metal—two of the hardest alloys. These can be ground with success by the same wheel as the other alloys, but where a large number of pieces are to be ground a different wheel should be selected. For nickel-bronze a wheel made of crystolon, grain 24, grade Q,

gives good results. For bell metal, a wheel of the same material but of a little harder grade is recommended, such as grade R and grain 24 or 30. Comparatively thin wheels are often used for such metals, and the work is ground by what is known as the "fixed wheel" method. Careful experiments made in grinding brasses and bronzes with a crystolon wheel, showed that a grain 30, grade P wheel gave the best results.

Wheels for Form-grinding

In form-grinding, the wheel is fed straight in on the work without being traversed and therefore is required to take both a roughing and a finishing cut. Usually pieces that are form-ground—crankshafts not included—are finished right from the rough-turning to the final grinding in one straight-in cut. It is not uncommon, therefore, to find that the wheels generally recommended for form-grinding are of a combination grain. Table III gives the grain and grade of wheels for form-grinding, as recommended by various grinding wheel manufacturers. The conditions that govern the grain and grade of the wheel for form-grinding are: the width of the face of the wheel in contact with the work, the rigidity of the machine in which the wheel is held, and the speed at which the work is rotated. For average work a combination grain, grade M or N wheel is recommended. These grades have been found to give good results on 0.20 to 0.50 carbon steel, not hardened, as well as chrome-nickel or chrome-vanadium steel heat-treated.

Wheels for Internal Grinding

The selection of the proper grain and grade of wheel for internal grinding is one that cannot be easily decided upon. The grain and grade to use on any given job depends not only upon the kind of work and the work and wheel speeds, but also very largely upon the stiffness of the machine and the firmness with which the wheel-spindle is supported. Briefly summarized, some of the points to take into consideration are: diameter of hole; speed of wheel-spindle; kind of work; whether the hole is plain or keyseated; nature of material; stiffness of machine; rigidity of wheel-spindle; method of holding grinding wheel; and character of operation—whether cut is for roughing or finishing.

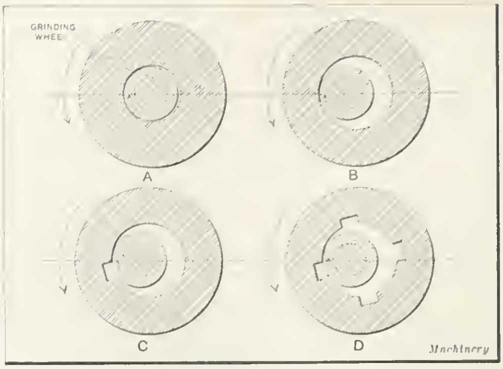


Fig. 3. Diagram illustrating Cases governing Selection of Wheels for Internal Grinding

As regards the diameter of the hole, there are several points to consider. In the first place, where the hole is below ¾ or 1 inch diameter, for economical reasons, it is necessary to have the wheel as large as possible; the wheel is usually ordered of the same diameter or larger than the hole to be ground and is then trued until it enters the hole. By using a wheel of practically the same size as the hole, as shown at A in Fig. 3, the arc of contact of wheel and work is large and, consequently, a much softer bond wheel must be used than if the wheel were small in relation to the diameter of the hole. Where the wheel is small, in proportion to the diameter of the hole, a harder bond and finer grain wheel can be used.

The speed at which a wheel should be operated for internal grinding is not always an easy matter to determine. In the first place, if the wheel is very small a high peripheral speed is necessary, and difficulty is experienced in obtaining a

TABLE II. GRAIN AND GRADE OF GRINDING WHEELS FOR PLAIN CYLINDRICAL GRINDING

Wheel Manufacturers	Abrasive (All Wheels Bonded by Vitrified Process)	0.20 to 0.50 Per Cent Carbon Steel (Soft)		0.20 to 0.50 Per Cent Carbon Steel (Hardened)		Chrome-nickel or Chrome-vanadium (Heat-treated)	
		Grain	Grade	Grain	Grade	Grain	Grade
Abrasive Material Co.	Boro-carbone	24 to 46 Comb.	L to M	24 to 46 Comb.	K	24 to 46 Comb.	M to N
American Emery Wheel Works.	Corundum	58—24 Comb.	L to M	46 to 60	K	58—24 Comb.	L
Carborundum Co.	Aloxite	36	M to O	36	P	40	J
Cortland Corundum Wheel Co.	Oxaluma	36	M to N	38 to 46	K to L	24 to 36	M
Detroit Grinding Wheel Co	Corundum	46	M to N	46	O to P	24 to 36	M to O
Norton Co.	Alundum	38—36 Comb.	L	46	K	38—24 Comb.	L
Safety Emery Wheel Co.	Rex	30 to 36	M to P	30 to 36	M to P	24 to 36	M to P
Sterling Grinding Wheel Co.	Corundum	20 to 36	2 to 2½	36	2	20 to 30	2½ to 3
Vitrified Wheel Co	Corundum	24 to 36	D^2 to D^3	36 to 40	E^1 to E^2	24 to 30	D^3 to E^1
Waltham Emery Wheel Co.	Alowalt	30 Comb.	3¼ to 3¾	....	....	30 Comb.	3¼ to 3¾
Waltham Emery Wheel Co.	Corowalt	....	....	50	2¾	....	....

Wheel Manufacturers	Abrasive (Vitrified Bond except where marked under grade)	Cast Iron		Cast Brass and Bronze		Cast Aluminum	
		Grain	Grade	Grain	Grade	Grain	Grade
Abrasive Material Co.	Carbide of Silicon	30 to 60	K to M	30 to 46	L to N	30 to 30	2E to 3E†
American Emery Wheel Works.	Carbolite	36 to 54	K to M	....	....	46 to 60	2E to 2½E†
American Emery Wheel Works.	Corundum	....	....	24	M to N	....	....
Carborundum Co.	Carborundum	24 to 60	L to N	24 to 36	L to M	16 to 24	2†
Cortland Corundum Wheel Co.	Carborundum	16 to 30	L to M	....	....	....	..
Cortland Corundum Wheel Co.	Oxaluma	....	....	20 to 36	M to O	16 to 30	N to R
Detroit Grinding Wheel Co.	Carborundum	16 to 36	G to 5*	36 to 46	N to P*	20 to 36	J to K*
Norton Co.	Crystolon	30	J to K	30	K to L	36	4†
Safety Emery Wheel Co.	Corex	24 to 36	M½ to P½	20 to 30	P½ to 1½	30 to 36	M½ to P½
Sterling Grinding Wheel Co.	Corundum	20	2 to 3	30	3	30 to 36	3 to 3½
Vitrified Wheel Co	Carbolon	24 to 46	D_2 to E	....	....	36	4½†
Waltham Emery Wheel Co.	Corundum	....	....	24 to 30	E_3	....	....
Waltham Emery Wheel Co.	Carbowalt	24 to 46	2¾ to 3½	30 to 46	2¾ to 3½	30 to 46	2½ to 3†

Machinery

* Grinding wheel bonded by silicate process.
† Grinding wheel bonded by elastic process.
Note: The numbers 38 and 58 preceding, in some cases, the grain sizes, indicate a special manufacturing process for the abrasive listed.

TABLE III. GRAIN AND GRADE OF GRINDING WHEELS FOR EXTERNAL FORM GRINDING

Wheel Manufacturers	Abrasive (Vitrified Bond except where marked under grade)	0.20 to 0.50 Per Cent Carbon Steel (Soft)		0.20 to 0.50 Per Cent Carbon Steel (Hardened)		Chrome-nickel or Chrome-vanadium Steel (Heat treated)	
		Grain	Grade	Grain	Grade	Grain	Grade
Abrasive Material Co..........	Boro-carbone	24 Comb.	L to M	24 Comb.	J to K	24 Comb.	L to M
American Emery Wheel Works.	Corundum	58-24 Comb.	L to M	46 to 60	K to L	58-36 to 58-60	J to L
Carborundum Co.	Aloxite	24 to 30	J to K	24 to 30	M	24 to 30	J to K
Cortland Corundum Wheel Co..	Oxaluma	24 to 54	L to M	24 to 60	K to L	30 to 46	K to M
Detroit Grinding Wheel Co....	Carbo-alumina	36 to 46	M to P*	36 to 46	L to O*	36 to 46	M to O*
Norton Co.	Alundum	24 Comb. or 46	L to N	20 Comb. or 46	L to N	24 Comb. or 46	J to M
Safety Emery Wheel Co.......	Rex	24 to 60	M½ to P½	24 to 60	M to P	24 to 60	M to P
Sterling Grinding Wheel Co....	Corundum	20 to 36	2 to 2½	20 to 30	2	16 to 20	3½
Vitrified Wheel Co.............	Corundum	46	E	36 to 54	D_2	36 to 46	D_3 to E
Waltham Emery Wheel Co.....	Alowalt	46	3 to 3½	50	2¾ to 3¼	46 to 60	3 to 3½

Machinery

* Grinding wheel bonded by silicate process.
Note: The number 58 preceding, in some cases, the grain sizes indicates a special manufacturing process for the abrasive listed.

bearing for the spindle that will stand up to the speed at which the grinding wheel would give the best efficiency. The lower the wheel speed, the harder the bond should be, other conditions remaining the same.

When a smooth hole is plain, as shown at *B*, Fig. 3, a softer wheel should be used than when the hole is keyseated, as shown at *C* and *D*. Slots or keyseats have a chisel action on the wheel face and quickly tear out the grains; hence for keyseated work a harder wheel should be used than on plain-hole work, and it should also have a wider face.

The nature of the material to be ground is also a determining factor in the selection of the grade and grain of the wheel, as well as the abrasive. For grinding soft steel varying from 0.20 to 0.30 per cent carbon content, the bond should be harder than for grinding the same steel in its hardened condition. Hardened steel has a tendency to glaze the wheel much more rapidly than soft work, and glazing is one of the greatest difficulties met with in grinding. Wheels made from aluminum-oxide abrasives give excellent service on steel. For grinding cast iron, carbide of silicon abrasives are more satisfactory; the latter can also be used on brasses and bronzes, aluminum, nickel-bronze and government bronze.

The rigidity of a machine has about as much to do with the selection of the grade and grain of the wheel as any other one factor. The fact is often overlooked that a machine which is not rigid should use a harder bond wheel than one which is. The greater the rigidity of the machine, the softer the grade and the coarser the grain of the wheel should be. Of course the rigid machine also has the advantage of being able to remove the stock with rapidity and without chatter marks.

For rough internal grinding it is generally advisable to use a wheel of coarse grain and soft bond, because of the greater cutting capacity of the wheel; under average conditions, a wheel of finer grain and harder bond would be better for finishing. In commercial grinding, however, the time necessary to change the wheels for roughing and finishing would

TABLE IV. GRAIN AND GRADE OF GRINDING WHEELS FOR INTERNAL GRINDING

Wheel Manufacturers	Abrasive (Vitrified Bond except where marked under grade)	0.20 to 0.50 Per Cent Carbon Steel (Soft)		0.20 to 0.50 Per Cent Carbon Steel (Hardened)		Chrome-nickel or Chrome-vanadium Steel (Heat-treated)	
		Grain	Grade	Grain	Grade	Grain	Grade
Abrasive Material Co..........	Boro-carbone	46 to 60	L to M	46 to 60	J to K	46 to 60	J to L
American Emery Wheel Works.	Corundum	34 to 46	K to L	46 to 60	J to K	58-46	J to K
Carborundum Co.	Aloxite	50	M to N	60	M to N	50	M to N
Cortland Corundum Wheel Co..	Oxaluma	46 to 50	J to K	46 to 60	J to K	46 to 50	K to L
Detroit Grinding Wheel Co....	Carbo-alumina	46	L to N*	60	J to L*	46	I to K*
Norton Co.	Alundum	38-46	J to M	38-46	J to L	38-46	J to K
Safety Emery Wheel Co.......	Rex	46	M to P	60	M to P	46	M to P
Vitrified Wheel Co.............	Corundum	46	D_2 to D_3	60	D_2 to D_3	46	D_3
Waltham Emery Wheel Co.....	Alowalt	46 to 60	2½ to 3	46 to 60	2½ to 3	46 to 60	2½ to 3

Wheel Manufacturers	Abrasive (Vitrified Bond except where marked under grade)	Cast Iron		Cast Brass and Bronze		Cast Aluminum	
		Grain	Grade	Grain	Grade	Grain	Grade
Abrasive Material Co..........	Carbide of Silicon	46 to 60	K to M	46 to 60	L to M	46 to 60	2E to 3E†
American Emery Wheel Works.	Carbolite	46 to 60	J to L	....	....	46 to 60	1½E to 2E†
American Emery Wheel Works.	Carbolite or Corundum	....	....	46 to 60	K	....	....
Carborundum Co.	Carborundum	36 to 40	P to S	40 to 50	M to P	50	P to R
Cortland Corundum Wheel Co..	Carborundum	30 to 46	K	....	....	....	....
Cortland Corundum Wheel Co..	Oxaluma	....	....	46 to 60	L to M	36 to 54	M to N
Detroit Grinding Wheel Co....	Carborundum	36 to 46	K to M*	36 to 46	J to L*	24 to 36	H to K*
Norton Co.	Crystolon	30 to 46	I to L	30 to 46	K to M	36	2 to 3†
Safety Emery Wheel Co.......	Corex	36 to 60	M to M¾	36 to 60	M to M½	36 to 60	M to M¾
Vitrified Wheel Co.............	Carbolon	36	D_3	....	....	46	4†
Vitrified Wheel Co.............	Corundum	....	....	46	D_3	....	....
Waltham Emery Wheel Co.....	Carbowalt	30 to 46	2 to 3	....	....	30 to 46	1¼ to 2†
Waltham Emery Wheel Co.....	Alowalt	....	....	50	2½ to 2¾	....	....

Machinery

* Grinding wheels bonded by silicate process.
† Grinding wheels bonded by elastic process.
Note: The numbers 38 and 58 preceding, in some cases, the grain sizes, indicate a special manufacturing process for the abrasive listed.

TABLE V. GRAIN AND GRADE OF GRINDING WHEELS FOR SURFACE GRINDING

Grinding Wheels of Disk Type

Wheel Manufacturers	Abrasive (Vitrified Bond except where marked under grade)	0.20 to 0.50 Per Cent Carbon Steel (Soft)		0.20 to 0.50 Per Cent Carbon Steel (Hardened)		Chrome-nickel or Chrome-vanadium Steel (Heat-treated)	
		Grain	Grade	Grain	Grade	Grain	Grade
Abrasive Material Co..........	Boro-carbone	24 Comb.	L to M	24 Comb.	J to K	24 Comb.	L to M
American Emery Wheel Works.	Corundum	30 to 46	J to K	36 to 46	I to J	58-30 to 58-46	I to J
Carborundum Co.	Aloxite	24	N to P	30	R to S	30	R to S
Cortland Corundum Wheel Co..	Oxaluma	24 to 30	K to L	24 to 30	K	30 to 46	J to K
Detroit Grinding Wheel Co....	Carbo-alumina	16 to 46	E to M*	24 to 46	E to G*	24 to 46	E to H*
Norton Co.	Alundum	14 to 24	J to K	14 to 30	H to K†	14 to 30	H to K†
Safety Emery Wheel Co.......	Rex	30 to 60	M to P	36 to 46	M to P	36 to 46	M to P
Vitrified Wheel Co.............	Corundum	36 to 46	E	46 to 60	D. to E	36	E
Waltham Emery Wheel Co.....	Alowalt	36 to 46	2½ to 3	36 to 46	2 to 2¾	36 to 46	2 to 3

Grinding Wheels of Ring Type

Wheel Manufacturers	Abrasive	Grain	Grade	Grain	Grade	Grain	Grade
Abrasive Material Co..........	Boro-carbone	24	J*	20 to 30	G to I*	24	J*
American Emery Wheel Works.	Corundum	58-20 to 58-30	¾ to 1½*	24 to 36	½ to 1*	58-20 to 58-30	½ to 1*
Carborundum Co.	Aloxite	24	N to P	30	R to S	30	R to S
Cortland Corundum Wheel Co..	Oxaluma	24 to 30	K to L	24 to 30	K	30 to 46	J to K
Detroit Grinding Wheel Co....	Carbo-alumina	16 to 24	E to G*	24 to 46	E to G*	24 to 46	E to H*
Norton Co.	Alundum	14 to 36	I to K†	14 to 36	G to K†	14 to 36	G to K†
Safety Emery Wheel Co.......	Rex	24 to 46	M to M¾	36 to 46	M to P	36 to 46	M to P
Vitrified Wheel Co.............	Corundum	36	D_3	36 to 46	D_2	36	D_3
Waltham Emery Wheel Co.....	Alowalt	36 to 46	2½ to 3	36 to 46	2 to 2¾	36 to 46	2 to 3

Machinery

* Grinding wheels bonded by silicate process.
† Vitrified or silicate bond.
Note: The number 58 preceding, in some cases, the grain sizes indicates a special manufacturing process for the abrasive listed.

more than overbalance the gain made by using a wheel best suited for both purposes, so that a wheel is generally selected which will be fairly suitable for both roughing and finishing. When a good finish is desired, it is the general practice to dress the wheel, after taking the roughing cut, by passing a diamond slowly across the face.

In Table IV are given the grade and grain selections of grinding wheels for the internal grinding of soft, hardened

TABLE VI. GRAIN AND GRADE OF GRINDING WHEELS FOR SURFACE GRINDING

Grinding Wheels of Disk Type

Wheel Manufacturers	Abrasive	Bonding Process	Cast Iron		Cast Brass and Bronze	
			Grain	Grade	Grain	Grade
Abrasive Material Co..........	Carbide of Silicon	Vitrified	30 to 46	L to M	30 to 46	K to L
American Emery Wheel Works.	Carbolite	Vitrified	36 to 46	K to L	36 to 60	K to L
Carborundum Co.	Carborundum	Vitrified	24	P to S	30	P to S
Cortland Corundum Wheel Co..	Carborundum	Vitrified	20 to 30	L to M	....	....
Cortland Corundum Wheel Co..	Oxaluma	Vitrified	....	....	20 to 24	K to M
Detroit Grinding Wheel Co....	Carbo-alumina	Silicate	16 to 36	D to H	24 to 46	F to H
Norton Co.	Crystolon	Vitrified or Silicate	20 to 30	I to K	....	....
Norton Co.	Crystolon	Vitrified	....	....	20 to 30	I to K
Safety Emery Wheel Co.......	Corex	Vitrified	20 to 26	M½ to P½	30 to 36	M½ to P
Vitrified Wheel Co.............	Carbolon	Vitrified	20 to 36	E_3 to E	....	....
Vitrified Wheel Co.............	Corundum	Vitrified	....	....	24 to 36	E_3 to E
Waltham Emery Wheel Co.....	Carbowalt	Vitrified	24 to 36	2 to 3	....	....
Waltham Emery Wheel Co.....	Carbowalt	Three Processes	....	....	24 to 36	2 to 3

Wheel Manufacturers	Abrasive	Bonding Process	Cast Aluminum		Malleable Iron Castings	
			Grain	Grade	Grain	Grade
Abrasive Material Co..........	Carbide of Silicon	Elastic	30 to 36	2E to 3E	....	....
Abrasive Material Co..........	Boro-carbone	Vitrified	....	....	24 Comb.	M
American Emery Wheel Works.	Carbolite	Elastic	36 to 60	1½E to 2E	....	....
American Emery Wheel Works.	Carbolite	Vitrified	....	....	30 to 36	K to L
Carborundum Co.	Carborundum	Elastic	36	5 to 6	....	....
Carborundum Co.	Aloxite	Vitrified	....	....	16 to 24	G to H
Cortland Corundum Wheel Co..	Oxaluma	Vitrified	20 to 24	K to M	14 to 20	Q to R
Detroit Grinding Wheel Co....	Carbo-alumina	Silicate	20 to 36	L_1 to M_1	16 to 30	F to H
Norton Co.	Crystolon	Elastic	24 to 46	1½ to 2½	....	....
Norton Co.	Alundum	Vitrified	....	....	14 to 36	I to K*
Safety Emery Wheel Co.......	Corex	Vitrified	36 to 46	M to P	....	....
Safety Emery Wheel Co.......	Rex	Vitrified	....	....	36 to 60	M½ to P
Vitrified Wheel Co.............	Carbolon	Elastic	20 to 36	4½	....	....
Vitrified Wheel Co.............	Corundum	Vitrified	....	....	16 to 30	E_1 to E_3
Waltham Emery Wheel Co.....	Carbowalt	Elastic	24 to 36	1¾ to 2	....	....
Waltham Emery Wheel Co.....	Alowalt	Vitrified	....	....	24 to 36	2½ to 3

Machinery

* For rough castings, unannealed, use crystolon, vitrified, grain 20 to 30, grade J to M.

TABLE VII. GRADE AND GRAIN OF GRINDING WHEELS FOR SURFACE GRINDING

Grinding Wheels of Ring Type

Wheel Manufacturers	Abrasive	Bonding Process	Cast Iron		Cast Brass and Bronze	
			Grain	Grade	Grain	Grade
Abrasive Material Co.	Carbide of Silicon	Vitrified	24-30	I to J	20 to 30	I to J
American Emery Wheel Works.	Carbolite	Vitrified	16-24	I to K	20 to 30	I to K
Carborundum Co.	Carborundum	Vitrified	24	P to S	30	P to S
Cortland Corundum Wheel Co.	Carborundum	Vitrified	20 to 30	L to M	....	....
Cortland Corundum Wheel Co.	Oxaluma	Vitrified	....	....	20 to 24	K to M
Detroit Grinding Wheel Co.	Carbo-alumina	Silicate	16 to 24	E to G	16 to 36	G to K
Norton Co.	Crystolon	Vitrified or Silicate	14 to 30	I to K	....	....
Norton Co.	Crystolon	Vitrified	....	....	14 to 30	I to L
Safety Emery Wheel Co.	Corex	Vitrified	20 to 36	M $\frac{1}{2}$ to P $\frac{1}{2}$	30 to 36	M $\frac{1}{2}$ to P
Vitrified Wheel Co.	Carbolon	Vitrified	30	E_2	....	....
Vitrified Wheel Co.	Corundum	Vitrified	....	....	30	E_2
Waltham Emery Wheel Co.	Carbowalt	Vitrified	24 to 36	2 to 3	....	....
Waltham Emery Wheel Co.	Carbowalt	Three Processes	....	....	24 to 36	2 to 3

Wheel Manufacturers	Abrasive	Bonding Process	Cast Aluminum		Malleable Iron Castings	
			Grain	Grade	Grain	Grade
Abrasive Material Co.	Carbide of Silicon	Elastic	24 to 30	$\frac{3}{4}$ E to 1E	....	....
Abrasive Material Co.	Boro-carbone	Silicate	....	....	20 to 24	J
American Emery Wheel Works.	Carbolite	Vitrified	20 to 30	I to K	14 to 24	I to K
Carborundum Co.	Carborundum	Elastic	36	5 to 6	....	....
Carborundum Co.	Aloxite	Vitrified	....	....	16 to 24	G to H
Cortland Corundum Wheel Co.	Oxaluma	Vitrified	20 to 24	K to M	14 to 20	Q to R
Detroit Grinding Wheel Co.	Carbo-alumina	Silicate	20 to 36	H to K	16 to 30	E to G
Norton Co.	Crystolon	Vitrified	16 to 30	H to K	....	....
Norton Co.	Alundum	Vitrified or Silicate	....	....	14 to 30	H to L*
Safety Emery Wheel Co.	Corex	Vitrified	36 to 46	M to P	....	....
Safety Emery Wheel Co.	Rex	Vitrified	....	....	36 to 60	M $\frac{1}{2}$ to P
Vitrified Wheel Co.	Carbolon	Elastic	20 to 36	4	....	....
Vitrified Wheel Co.	Corundum	Vitrified	....	....	24	E_1
Waltham Emery Wheel Co.	Carbowalt	Elastic	24 to 36	$1\frac{3}{4}$ to 2	....	....
Waltham Emery Wheel Co.	Alowalt	Vitrified	....	....	24 to 36	2 to 3

* For rough castings, unannealed, use crystolon, grain 16 to 24, grade J to M.

and alloy steels, and cast iron, brass, bronze, and aluminum. These gradings are supplied by the various grinding wheel manufacturers, and as will be noticed, cover a considerable range.

Wheels for Surface Grinding

There are several conditions in surface grinding which govern to a marked extent, the grain and grade of wheel to use. For instance, the arc of contact of a ring type wheel with the work is much greater than it is on disk wheels used for either cylindrical or internal grinding. In surface grinding there are three chief conditions: first, where a disk wheel is used, as shown at *B* in Fig. 2; second where a ring or cylinder wheel is used on work wider than the wheel diameter; and third where the work is less in width than the diameter of the wheel, as shown at *D* in the same illustration. In Tables V, VI and VII are given the wheel selections for surface grinding different materials with the disk type and ring or cylinder types of grinding wheels.

Some of the other conditions which govern the selection of wheels for surface grinding are: materials to be ground, degree of accuracy required, quality of finish, and shape and size of work. For grinding with disk wheels used on the planer type of surface grinding machines, the grain commonly used varies from 46 to 60, whereas the grade is about H for hardened steel, when using wheels made from aluminum-oxide abrasives. For hardened high-speed steel or very thin pieces of hardened carbon steel, the bond of the wheel should be about grade G, the same grain being used. For grinding cast iron, wheels made from carbide of silicon abrasives are employed, the grain being about 36, and the grade J.

When grinding with cylinder or ring wheels, the greatest trouble is to get rid of the chips and prevent heating of the work. The grinding of a continuous flat surface with a ring wheel makes it necessary to employ a rapid work speed and shallow cuts, using wheels of relatively coarse grain and soft bond. This is necessary so as to make very small chips which will not fill the spaces between the cutting points on the wheel. When the work is narrow in proportion to the diameter of the wheel, as shown at *D* in Fig. 2, there is less trouble with chips. For surface grinding work with ring wheels, the Norton Co. recommends the grades and grains as follows: cast iron, grade I; chilled cast iron, grade I or J; hardened steel, grade G or H; high-speed steel, grade I; nickel-bronze, grade Q or P; government bronze, grain 24, grade Q to grain 36, grade P.

For surface grinding unannealed rough malleable iron castings, the Norton Co. recommends a crystolon, vitrified wheel, grain 20 to 30, grade J to N for disk wheels, and grain 16 to 24, grade J to M for ring or cylinder wheels. For annealed malleable iron castings that are fairly smooth, the Norton Co. recommends an alundum wheel, vitrified process, grain 14 to 36, grade I to K for disk wheels, and alundum, vitrified or silicate, grain 14 to 30, grade H to L for ring or cylinder wheels. This same information applies to all other listings given in Tables VI and VII.

The wheels used on Blanchard vertical surface grinders are of the cylinder type, 16 inches in diameter, 5 inches high, and of widths of rims varying from $1\frac{1}{4}$ to $1\frac{1}{2}$ inch. All wheels used on Blanchard surface grinders are wire wound by the maker. In selecting wheels for this machine, the two most important factors to consider are the material to be ground and the area presented to the wheel. For grinding cast iron, aluminum, brass, and alloys of low tensile strength, wheels made from carbide of silicon abrasives, and having a vitrified bond have given the best results. For steel, either hard or soft, and for the tougher and stronger bronzes, wheels made from aluminum oxide abrasives and bonded by the silicate process are used. As a general rule, hard bond wheels should be used on soft tough stock, and soft-bond wheels on hardened stock.

The area to be considered in grinding on a surface grinder

of the rotary table vertical spindle type is that presented to the wheel by a group of pieces held on the chuck at one time. Those have been divided into three classes, *viz.*, those of narrow, medium, and broad surfaces. The wheels recommended by the Blanchard Machine Co. for these various classes of work are given in Tables VIII, IX, and X, respectively. These tables will serve as a general guide in selecting the wheels, but cannot be expected in all cases to give the best wheel for every job. The wheels listed are those made by the American Emery Wheel Works and the Norton Co. The reason for this is that a large number of tests have been made with these particular wheels, on the work specified.

The illustration shown in connection with Table VIII is given to indicate "narrow" surfaces. At *A* is shown a ring with a ¾-inch rim. At *B* is shown a group of rings with walls ¼ inch wide, whereas at *C* are shown castings having ribs ½ inch wide and small bosses that must be ground. These are shown to indicate in a general way what is meant by "narrow surfaces".

The illustration accompanying Table IX shows examples of work to indicate medium surfaces. Ring-shaped parts like the one shown at *A* may vary in width from 2 to 3 inches; the parts shown at *B* are washers 3½ inches in diameter with a 2-inch hole, leaving a wall of ¾ inch. Thirty-four pieces are held on the table. If a single instead of a double row of pieces was held on the chuck at one time, this class of work would be considered as having narrow surfaces. The castings shown at *C* have a ground surface about 1¼ inch wide, and sixteen pieces are held on the table.

Summary Points on the Selection of Grinding Wheels

The following are the most important conditions governing the selection of grinding wheels: Speed of wheel and work, size and shape of piece ground, composition and temper of metal, design and condition of machine, rigidity of floor, wet or dry grinding, quality of finish wanted, amount of stock to be removed, etc. Usually a wheel should be selected that is nearly the same as that found on previous jobs to give satisfaction, and then watched carefully under working conditions to see what the cutting action is. The following are a few of the most important points to be considered in making a selection of the correct grain and grade of wheel to use:

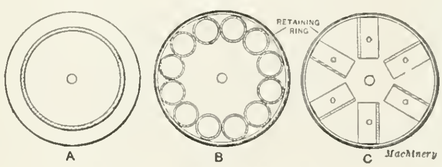
1. For materials of low tensile strength, use grinding wheels made from the carbide of silicon abrasives. For materials of high tensile strength, use grinding wheels made from aluminum-oxide abrasives.

2. If a wheel glazes over, fills, and cuts slowly, it is too hard—try one or two grades softer.

3. If a wheel wears away too fast, wears out of round or quickly loses its shape, it is too soft. Users often think that

TABLE VIII. WHEELS FOR GRINDING NARROW SURFACES ON VERTICAL SURFACE GRINDER*

Illustration Indicates General Class of Work for which the Wheels listed are adapted



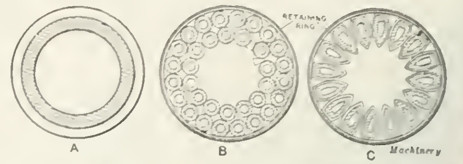
Material	Abrasive	Bonding Process	Width of Wheel Rim	Grain	Grade
Cast Iron†	Carbolite	Vitrified	1¼	30	I
	Carbolite	Vitrified	1½	24	I
	Crystolon	Vitrified	1¼	30	I
	Crystolon	Vitrified	1½	24	J
Chilled Cast Iron	Carborundum	Vitrified	1½	20	I
Soft Steel	Corundum	Silicate	1¼	58–30	I
	Alundum	Silicate	1¼	38–30	I
	Alundum	Silicate	1¼	38–30	J
Hardened Steel	Corundum	Silicate	1¼	30‡	¾
	Alundum	Silicate	1¼	38–30	H
Aluminum	Alundum	Vitrified	1½	38–14	I

Machinery

* Recommended by the Blanchard Machine Co.
† For brass, bronze, and similar alloys of low tensile strength, use same wheels as for cast iron. For hard bronze use same wheels as for soft steel.
‡ No. 46 grain and same grade is also used on narrow surfaces to obtain a smoother finish.
Note: The numbers 38 and 58 preceding, in some cases, the grain sizes indicate a special manufacturing process for the abrasive listed.

TABLE IX. WHEELS FOR GRINDING MEDIUM SURFACES ON VERTICAL SURFACE GRINDER*

Illustration Indicates General Class of Work for which the Wheels listed are adapted



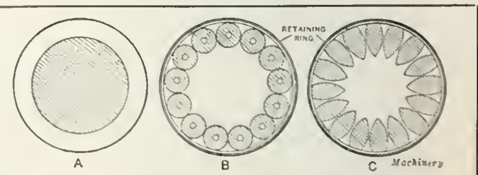
Material	Abrasive	Bonding Process	Width of Wheel Rim	Grain	Grade
Cast Iron†	Carbolite	Vitrified	1½	20	H
	Carbolite	Vitrified	1½	14	I
	Crystolon	Vitrified	1½	20	H
	Crystolon	Vitrified	1½	14	I
Chilled Cast Iron	Carbolite	Vitrified	1½	20	H
Soft Steel	Corundum	Silicate	1½	58–24	I
	Alundum	Silicate	1½	38–24	H
Hardened Steel	Corundum	Silicate	1¼	30	½
	Alundum	Silicate	1¼	38–24	H
High-speed Steel	Corundum	Silicate	1½	58–24	¾
Aluminum	Alundum	Vitrified	1½	38–14	I
Fiber	Alundum	Silicate	1½	38–24	G

Machinery

* Recommended by the Blanchard Machine Co.
† For brass, bronze, and similar alloys of low tensile strength, use same wheels as for cast iron. For hard bronze use same wheels as for soft steel.
Note: The numbers 38 and 58 preceding, in some cases, the grain sizes, indicate a special manufacturing process for the abrasive listed.

TABLE X. WHEELS FOR GRINDING BROAD SURFACES ON VERTICAL SURFACE GRINDER*

Illustration Indicates General Class of Work for which the Wheels listed are adapted



Material	Abrasive	Bonding Process	Width of Wheel Rim	Grain	Grade
Cast Iron†	Carbolite	Vitrified	1½	14	H
	Crystolon	Vitrified	1¼	24	G
Soft Steel	Corundum	Silicate	1½	58–14	⅜
	Alundum	Silicate	1½	38–14	I
	Alundum	Vitrified‡	1½	38–14	I
Hardened Steel	Corundum	Silicate	1¼	24	⅝
	Alundum	Silicate	1¼	38–24	G
High-speed Steel	Corundum	Silicate	1½	58–24	⅝

Machinery

* Recommended by the Blanchard Machine Co.
† For brass, bronze, and similar alloys of low tensile strength, use same wheels as for cast iron. For hard bronze use same wheels as for soft steel.
‡ Wheels made by vitrified process are used only for roughing purposes.
Note: The numbers 38 and 58 preceding, in some cases, the grain sizes, indicate a special manufacturing process for the abrasive listed.

because a wheel wears out of round, it has "soft spots", but this is a mistake. It is a sure indication that a harder grade or higher wheel speed is necessary.

4. Increasing the speed of a wheel will make it act like a wheel of harder grade, and decreasing the speed will make it appear softer. A wheel should be speeded up as the diameter is reduced by wear, in order to maintain the proper surface speed.

5. The greater the surface contact between the wheel and the work, the softer the grade of the wheel should be. Thus a ring, cylinder or cup-wheel should be softer than a disk wheel for grinding the same material, and a very thin disk wheel should be harder than a thick one.

6. In cylindrical grinding, work of large diameter will require a softer wheel than work of small diameter. Pieces which have a narrow surface or edge to be ground need a harder wheel than wide surfaces.

7. In cylindrical grinding, increasing the work speed tends to wear away the wheel faster. Vibration due to worn bearings, lack of rigidity in the machine, or a shaky floor, has the same effect. With any of these conditions, a harder wheel should be used.

8. The use of water permits a wheel of slightly harder bond to be used and improves the finish of the work. It also prevents overheating of the work and the resulting distortion.

9. A wheel is the most efficient when it is just soft enough to cut freely without excessive wear, and not hard enough to cause glazing.

10. To preserve some special shape of face, a relatively hard wheel should be used—generally a wheel of combination grain is recommended for form-grinding.

11. Always keep the face of the wheel true by frequent use of a diamond.

12. When surface grinding dry, do not let the wheel glaze. As soon as it shows a black spot indicating glazing, use a carborundum or aloxite block, depending on the abrasive used in the wheel.

13. Do not take heavy cuts with ring, cylinder or cup-wheels which grind on the edge, and use comparatively high work speeds.

* * *

AVOID UNNECESSARY PURCHASES

It hardly seems necessary to say that it is poor business management to purchase unnecessary equipment, whether it be intended for the home, the office or the factory. But many concerns are burdened by expenditures for equipment not needed, and which can never be made profitable. It is a case oftentimes of not knowing what is already available or what with slight changes could be made so. Take the case, for example, of shop trucks. They are constantly in demand throughout the plant, and if not promptly returned to some central spot much time is lost by the men in looking for them. The conclusion may be jumped at that more trucks are needed, when as a matter of fact there are plenty but no system is applied to effect their return when the workmen have used them. A rearrangement of machinery groups or a more systematic handling of materials that makes machines more effective may eliminate the necessity of purchasing more machines. To make equipment more efficient by re-arranging and facilitating movement of the work to and from the machines is obviously better management than building additions and installing more machinery.

* * *

In the exhibit of the United States Steel Corporation at the Panama-Pacific Exposition in San Francisco, more than six miles of motion picture films are shown to give visitors an idea of the operations required to convert iron ore into finished products. Those familiar with motion picture films know that each foot contains sixteen small pictures, $\frac{3}{4}$ by 1 inch. In six miles of films, therefore, there are somewhat more than 500,000 individual pictures, each slightly different from the one immediately preceding. In these 500,000 pictures is shown the entire "story of steel."

CHARTS FOR DETERMINING SIZES OF TRANSMISSION SHAFTS*

BY JOSEF Y DAHLSTRAND†

The relation existing between the power transmitted by a shaft and the diameter of the shaft and its torsional stress, when the shaft is subjected only to a torsional stress and is running at a certain number of revolutions per minute, can be expressed by the following equation:

$$\frac{12 \times 33{,}000\ \text{H.P.}}{2\pi\ \text{R.P.M.}} = \frac{S_t \pi D^3}{16} \qquad (1)$$

where H.P. = horsepower transmitted by shaft;

R.P.M. = number of revolutions per minute made by shaft;

S_t = torsional stress in shaft in pounds per square inch;

D = diameter of shaft in inches.

The preceding equation is one which the engineering department of almost every manufacturing plant has occasion to use. This is especially the case in factories engaged in the manufacture of turbines or motors, which are direct connected to fans, pumps, generators, and similar units where couplings are required between the driving and the driven members. The speed and power is varied to suit different conditions, and the shaft ends to which the coupling is connected have to be proportioned accordingly. If a number of couplings have been adopted as standards, with their respective bores of the proper sizes to receive different standard shaft ends, it is necessary to check up these dimensions against the power and speed conditions for each case in order that the most suitable size of coupling may be selected. It often happens that one manufacturer furnishes the turbine, motor or other driving member, while another manufacturer furnishes the fan, pump, generator, or other driven member; and in such cases the shaft end of either the driving or driven member frequently has to be made special to suit the coupling. This makes it necessary to check up the torsional stresses to be sure that they do not exceed the highest value that is suitable for the material from which the shaft is made.

The chart shown in Fig. 1 has been found extremely useful for determining the relation between the diameter of the shaft and the amount of power it is capable of transmitting, the chart being used both for determining the required shaft diameter to transmit a given amount of power and for checking up the capacities of existing transmission systems. Aside from the amount of time which is saved through the use of this chart, it has been found of value in eliminating errors which sometimes find their way into results obtained by calculation. The well-known fact that the amount of power transmitted by a shaft of given diameter, which is subjected to a certain torsional stress, is directly proportional to the speed at which the shaft is running can be readily seen from Formula (1). Sometimes it is found convenient to use the number of horsepower transmitted per hundred revolutions per minute as the unit of power transmitted by a given shaft at different speeds; and the curves shown in Fig. 1 (the curves on the right-hand side are a continuation of those on the left) represent the values of this unit for different sizes of shafts subjected to torsional stresses of 3000, 5000, and 7000 pounds per square inch, respectively.

As an example of the uses of this chart, consider a case in which it is assumed that a steam turbine developing 900 horsepower and running at a speed of 2000 revolutions per minute is to be coupled to a generator. It is desired to find the proper diameter of the shaft at the coupling, that will safely transmit the power from the turbine to the generator, it being assumed that it is the practice of the manufacturer to allow a maximum torsional stress of 5000 pounds per square inch for the shaft. Dividing 900 by 20, it is found that (so

* For other articles on determining the diameter of shafting and allied subjects, published in MACHINERY, see also: "The Angle of Torsion," by R. D. Pinkney, November 1914; "Heavy-duty Shafts with Two and Three Bearings," by W. G. Dunkley, April, 1914, "On Determining Shaft Diameters," by W. G. Dunkley, August, 1913; "Intermediate Supports for Long Shafts," by W. G. Dunkley, January, 1913, "Calculation of Bending and Turning Moments for Round Shafts," July, 1911; "Hollow Shafts," by E. Hammarstrom, April, 1911; "The Effect of Keyways on the Strength of Shafts," January, 1911; and "Table for Computing Hollow and Solid Shafting," September, 1905.

† Address: Care of Kerr Turbine Co., Wellsville, N. Y.

far as the torsional stresses are concerned) 45 horsepower per hundred revolutions per minute is equivalent to 900 horsepower at a shaft speed of 2000 revolutions per minute. From the 5000-pound curve in Fig. 1, the minimum shaft size is found to be 3.08 inches in diameter. The chart is used not only for determining the sizes of shaft ends to fit into a coupling; it can also be employed for determining the diameter of any shaft which is subjected only to torsional stresses. In cases where the bearing supports are close together, so that the stresses due to bending are small as compared with the torsional stresses, the curves can be used for finding the shaft size after all other considerations such as deflection and rigidity have been properly looked after.

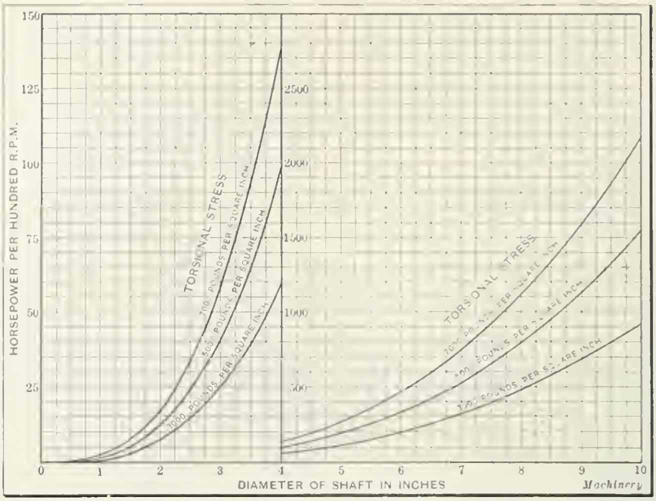


Fig. 1. Chart for determining Required Diameter of Shaft to transmit Various Numbers of Horsepower per Hundred R. P. M. for Torsional Stresses of 3000, 5000, and 7000 Pounds per Square Inch in Shaft

The three curves shown at the left-hand side of Fig. 2 are used for determining the required size of keys to use in a shaft, coupling, pulley, gear, or similar member which has to transmit a specified amount of power at a certain number of revolutions per minute, and with a fixed shearing stress per square inch in the key. The following formula shows the conditions which fix the value of the shearing stress S_s.

$$\frac{12 \times 33{,}000 \text{ H.P.}}{2\pi \text{ R.P.M.}} = \frac{S_sAD}{2} \qquad (2)$$

where H.P., R.P.M. and D have the values already given;

A = total shear area of key in square inches;

S_s = shearing stress in key in pounds per square inch.

These three curves at the left-hand side of Fig. 2 are plotted on the basis of horsepower transmitted per hundred revolutions per minute by one square inch shear area, with 2500, 4000, and 5500 pounds per square inch shearing stress in the key, respectively. On the right-hand side in Fig. 2 curves are drawn for the sake of convenience, which give the total shear area for different total lengths of keys, ranging in width from 1/4 to 2 inches.

As an illustration of the use of this chart, suppose it is necessary to determine the size of keys that must be used in the coupling for connecting the turbine and generator of the unit referred to in the preceding problem, assuming that the manufacturer allows a maximum shearing stress of 4000 pounds per square inch in the key. It is also assumed that 3.125 inches was settled upon as the proper diameter of the shaft end instead of the value 3.08 inches which was determined in the preceding problem. On the 4000-pound stress-curve in Fig. 2, it is found that 1 square inch of key-area is capable of transmitting 10 horsepower per hundred revolutions per minute, with this shaft diameter. Thus the transmission must have 4.5 square inches of key-area in order to transmit 45 horsepower at 100 R. P. M. or, what amounts to the same thing (so far as the shearing stresses in the keys are concerned) to transmit 900 horsepower at 2000 revolutions per minute. From the curves on the right-hand side in Fig. 2, it is seen that if two keys are to be used and the coupling fit made 5 inches long, giving a total key length of 10 inches, the keys would have to be made about 7/16 inch wide, or 7/8 inch in width if only one key were used.

The stresses allowed in each separate case are naturally dependent on the material and the uniformity with which the power is transmitted. For the best grades of steel and for a uniform load, a torsional stress of 7000 pounds per square inch in the shaft, and a shearing stress of 5500 pounds per square inch in the keys, gives a satisfactory factor of safety. For cases where the load is not uniform, lower stresses should be used, an allowance of 5000 pounds torsional stress and 4000 pounds shearing stress being representative of ordinary practice in designing the shaft ends of small steam turbines. In proportioning keys, it is common practice to make the height of the key equal to the width, so that the total crushing area is made half of the total shear area, on the assumption that the keys enter the shaft to the same depth as they enter the coupling or pulley. This is satisfactory so far as the keys and the shaft are concerned, but it may result in allowing too high values of the crushing stress for the material of the bored member, especially if the material is cast iron. In such cases, the curves in Fig. 2 may be used for determining the proper crushing area for a certain allowable crushing stress, in a similar manner to that employed when finding the shear area, and the keys are then proportioned accordingly.

These charts have been found useful by the writer in designing turbine shafts.

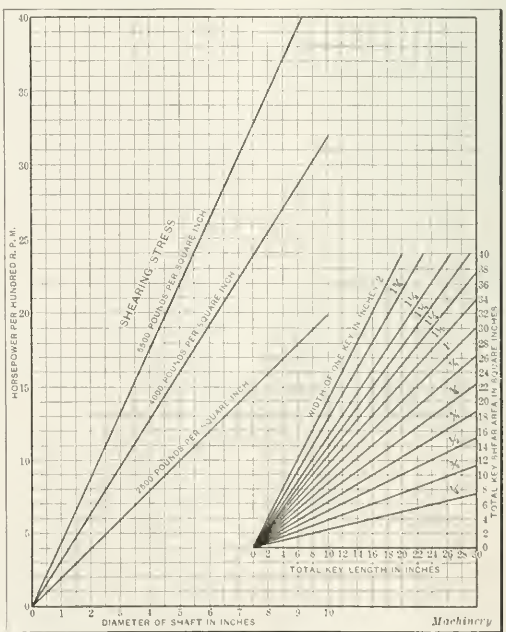


Fig. 2. Chart showing Horsepower per Hundred R. P. M. transmitted by One Square Inch of Key Area for Shafts of Various Diameters; Also Total Key Area for Keys of Various Widths and Lengths

GEAR DIAGRAMS*

METHODS FOR THE RAPID SOLUTION OF PROBLEMS IN GEAR DESIGN

BY H. D. HESS†

THE designing of gears by the usual method of trial is a tedious if not a difficult problem for the draftsman who has not had considerable experience with work of this nature; and, even the experienced designer frequently spends a lot of time before he obtains a satisfactory solution. For the purpose of affording a rapid method of handling problems in gear design, the writer developed a set of gear diagrams based on the Lewis formula, which forms the subject of this article. He has found them to be of considerable value in his own work, and they are presented with the hope that they may prove of equal value to other readers of MACHINERY. The significance of the symbols which are used in the text is as follows:

M = twisting moment, in inch-pounds;

H. P. = horsepower;

N = revolutions per minute;

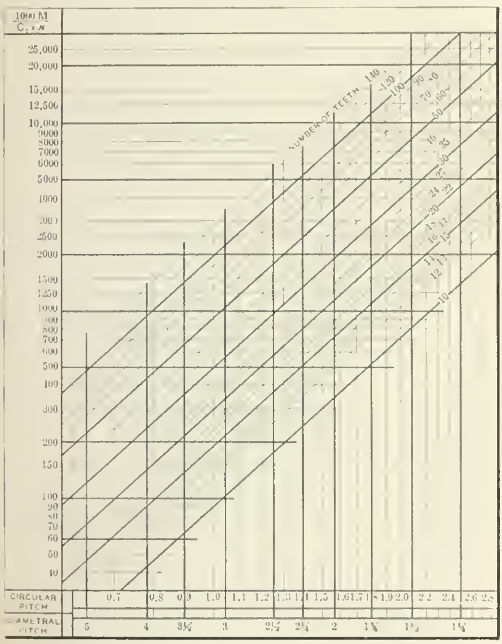


Fig. 1. Diagram for determining Required Pitch when Twisting Moment, Permissible Fiber Stress, and Ratio of Face Width to Circular Pitch are known

W = force acting on the face of a tooth, in pounds;

s = allowable working fiber-stress on the tooth at the velocity v, in pounds per square inch;

f = width of the tooth face, in inches;

n = number of teeth in the pinion or gear, depending upon which is being considered at the time;

r = radius of the gear or pinion, in inches;

p_c = circular pitch, in inches;

p_d = diametral pitch;

A and B = ordinates in the diagram;

v = velocity in feet per minute at the pitch circle;

C_1 = constant depending on the ratio of face width to the circular pitch;

C_2 = constant depending on the material and the desired working fiber-stresses.

The basis of the diagrams is the Lewis formula.

$$W = sp_c f\left(0.124 - \frac{0.684}{n}\right).$$

The diagram shown in Fig. 1 is intended to give the pitch when the twisting moment transmitted by the pinion or gear, the desired working fiber-stress and the ratio of face width to circular pitch are known. The diagram shown in Fig. 2 is quite similar, excepting that in this case the face width in inches is assumed. The algebraic calculations are as follows for 14½-degree involute teeth of standard height:

$$W = sp_c f\left(0.124 - \frac{0.684}{n}\right) \qquad (1)$$

$$M = Wr = sfnp^2\left(0.124 - \frac{0.684}{n}\right) \qquad (2)$$

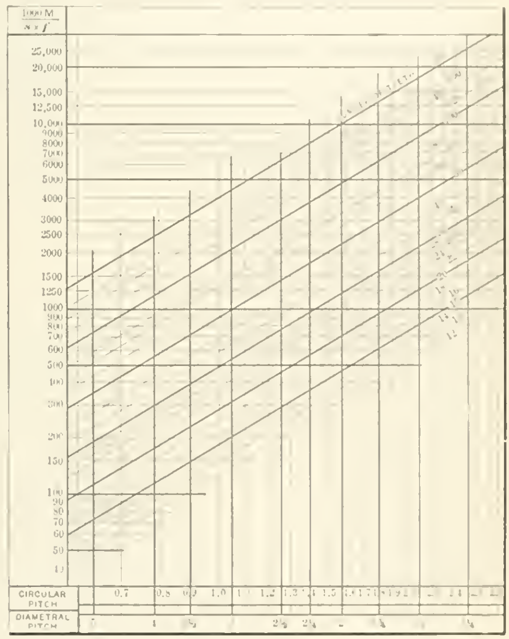


Fig. 2. Diagram for determining Required Pitch when Face Width of Gear is assumed

Substituting for r its value $\frac{np}{2\pi}$ we have

$$M = \frac{sfnp^2}{6.28}\left(0.124 - \frac{0.684}{n}\right) \qquad (3)$$

$$\frac{1000\,M}{sf} = \frac{1000\,np^2}{6.28}\left(0.124 - \frac{0.684}{n}\right) \qquad (4)$$

The quantity 1000 has simply been inserted on both sides of the equation to eliminate decimals. Equation (4) has been used to plot the diagram shown in Fig. 2.

If $f = C_1 p$ we have:

$$\frac{1000\,M}{sC_1} = \frac{1000\,np^3}{6.28}\left(0.124 - \frac{0.684}{n}\right) \qquad (5)$$

Equation (5) has been used to plot the diagram Fig. 1.

The solution of the following problems will serve to illustrate the use of the diagrams shown in Figs. 1 and 2.

Problem 1.—Considering the strength only, what pitch will be required for a 15-tooth, cast iron pinion, to transmit 20

* For additional information on the strength of gear teeth see also "Convenient Form of Lewis Formula for Strength of Gear Teeth," by J. H. Carver, published in MACHINERY for October, 1914, and other articles there referred to.

† Address: Sibley College of Mechanical Engineering, Cornell University, Ithaca, N. Y.

horsepower when making 225 revolutions per minute? The fiber-stress is not to exceed 6000 pounds per square inch, and the face width is 3.25 inches.

The twisting moment on the pinion shaft is:

$$M = \frac{63{,}025 \text{ H. P.}}{N} = \frac{63{,}025 \times 20}{225} = 5600 \text{ inch-pounds.}$$

Consulting the diagram Fig. 2 for $\frac{1000\,M}{6000 \times 3.25} = \frac{1000 \times 5600}{6000 \times 3.25} = 287$, we find that the required circular pitch, for $n = 15$, is 1.24 inch, which corresponds to a diametral pitch of 2.5.

Problem 2.—In Problem 1, if the ratio of face width to the circular pitch had been given, the diagram in Fig. 1 would have been used. Taking the same problem and assuming $f \div p_c = C_1 = 2$, the solution would be as follows:

$$\frac{1000\,M}{sC_1} = \frac{1000 \times 5600}{6000 \times 2} = 467.$$

The circular pitch given by the diagram Fig. 1, corresponding to the ordinate 467 and 15 teeth, is $p_c = 1.36$ inch; and the required face width would be $1.36 \times 2 = 2.72$ inches.

The diagrams shown in Figs. 3 and 4 are intended to permit of the selection of the proper pitch when the horsepower which is being transmitted or the twisting moment is known, together with the materials of which the gears are made, the number of revolutions per minute, and the law of reduction of the working fiber-stress with the increase of velocity. This law has been assumed as given by the heavy curves in the diagram presented in Fig. 5. The assumption for cast iron is that for velocities of the teeth at the pitch circle exceeding 100 feet per minute, the fiber-stress for cast iron may vary as $\frac{88{,}000}{\sqrt{v}}$. If the material is steel the fiber-stress may be taken as $\frac{220{,}000}{\sqrt{v}}$. These stresses were suggested by C. R.

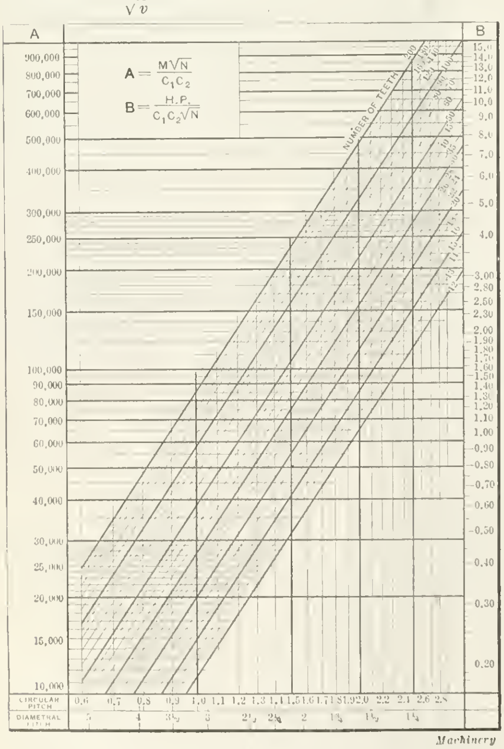


Fig. 3. Diagram for determining Required Pitch when Horsepower or Torque, R. P. M., Material and Ratio of Face Width to Circular Pitch are known

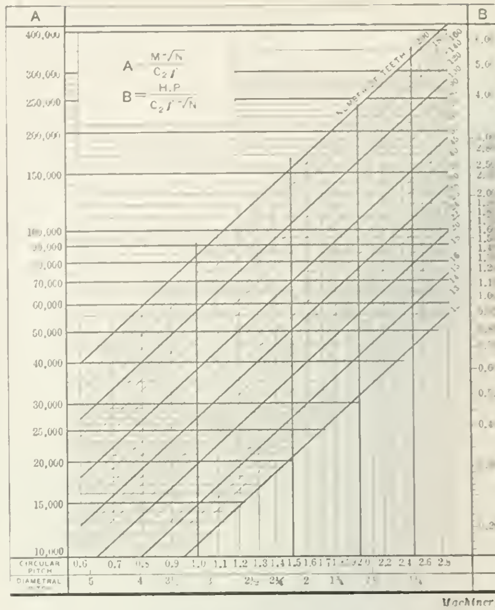


Fig. 4. Diagram for determining Required Pitch when Horsepower or Torque, R. P. M., and Material are known and Face Width of Gears is assumed

Whittier in MACHINERY for August, 1909, and agree very closely with those suggested by Wilfred Lewis for use with his formula. The purpose of the diagrams in Figs. 3 and 4 has been to provide charts that would avoid the necessity of making an initial guess as to the gear proportions in order to find the force W acting on the teeth and the allowable fiber-stress. In designing gears, either the horsepower they are to transmit and the number of revolutions per minute, or the twisting moment and the number of revolutions per minute will be given. When the horsepower and the number of revolutions per minute are given, the twisting moment is readily found from the relation:

$$M = \frac{63{,}025 \text{ H. P.}}{N}.$$

Formula (1) is now transformed by substituting the following values:

$$W = sp_c f\left(0.124 - \frac{0.684}{n}\right) \quad (1)$$

$$s = \frac{88{,}000}{\sqrt{v}} \text{ (for cast iron)}$$

$$r = \frac{np_c}{6.28}$$

$$v = \frac{np_cN}{12} = \frac{rN}{1.91} = \frac{nN}{3.82p_d}$$

Hence

$$M = Wr = \frac{88{,}000\sqrt{12}}{\sqrt{np_c N}} \times p_c \times f \times \frac{np_c}{6.28}\left(0.124 - \frac{0.684}{n}\right) \quad (6)$$

$$MN^{\frac{1}{2}} = 48{,}540\, n^{\frac{1}{2}}\, p_c^{\frac{3}{2}}\, f\left(0.124 - \frac{0.684}{n}\right) \quad (7)$$

The diagram shown in Fig. 4 has been drawn for a face width of f inches so that:

$$\frac{MN^{\frac{1}{2}}}{f} = 48{,}540\, n^{\frac{1}{2}}\, p_c^{\frac{3}{2}}\left(0.124 - \frac{0.684}{n}\right) \quad (8)$$

In the diagram shown in Fig. 3, $f = C_1 p_c$ so that:

$$\frac{MN^{\frac{1}{2}}}{C_1} = 48{,}540\, n^{\frac{1}{2}}\, p_c^{\frac{5}{2}}\left(0.124 - \frac{0.684}{n}\right) \quad (9)$$

The working fiber-stresses for cast iron and steel are given by the diagram Fig. 5, as recommended by Mr. Lewis, and as

suggested by Carl Barth and used with his slide-rule; and they are also given as conforming to the quantities $\frac{88,000}{\sqrt{v}}$ and $\frac{220,000}{\sqrt{v}}$, respectively. This leads to the introduction of a factor C_2 in the diagrams, Figs. 3 and 4. The value of C_2 for cast iron is 1; and this basis of the stress in cast iron corresponds to Lewis' value of a maximum of 8000 pounds per square inch at a velocity of 100 feet per minute. To plot the assumed curve for any other material or fiber-stress, multiply the quantity $\frac{88,000}{\sqrt{v}}$ by the ratio of the maximum desired fiber-stress to 8000; thus steel with an allowable fiber-stress of 20,000 pounds per square inch at a peripheral speed of 100 feet per minute, gives a ratio of $\frac{20,000}{8000} = 2.5$ and the quantity becomes $\frac{88,000 \times 2.5}{\sqrt{v}} = \frac{220,000}{\sqrt{v}}$. The curves thus constructed give values exceeding the maximum, for values of v below and approximating 100 feet per minute, so that the diagrams should be used with caution for these low values of v. On the diagram Fig. 5, the fiber-stresses have also been plotted for a maximum fiber-stress of 15,000 pounds per square inch at a speed of 100 feet per minute. This may be used for steel castings although some designers use 20,000 pounds per square inch on both rolled steel and steel castings.

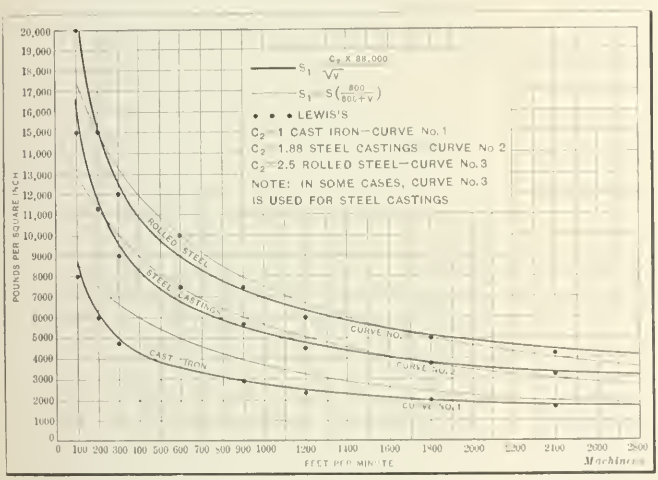


Fig. 5. Diagram for determining Safe Fiber-stress for Various Speeds met with in Practice

The ordinates for the diagram shown in Fig. 3 are:

$$A = \frac{M\sqrt{N}}{C_1C_2} \text{ and } B = \frac{\text{H.P.}}{C_1C_2\sqrt{N}}.$$

The ordinates for the diagram shown in Fig. 4 are:

$$A = \frac{M\sqrt{N}}{C_2 f} \text{ and } B = \frac{\text{H. P.}}{C_2 f\sqrt{N}}.$$

The solution of the following problems will serve the purpose of illustrating the method of using these diagrams.

Problem 3.—Design a pair of gears to transmit 25 H. P. at 150 revolutions per minute of the pinion, with a reduction of 5 to 1 to the gear. Assume both the gear and pinion to be made of cast iron, and that the desired fiber-stress will vary as given in the diagram Fig. 5 inversely with the square-root of the velocity at the pitch circle. Take the face as 3 times the circular pitch, and assume the pinion has 15 teeth.

As the gear and pinion are of the same material, the pinion teeth will be the weaker and we need only design for it. To use the diagram Fig. 3, we find:

$$B = \frac{\text{H. P.}}{C_1C_2\sqrt{N}} = \frac{25}{3 \times 1 \sqrt{150}} = 0.68.$$

In this diagram, for $B = 0.68$ and $n = 15$, we find $p = 1.52$ inch. This would make the face width $1.52 \times 3 = 4.56$ inches. Using the nearest stronger diametral pitch would require 2 diametral pitch, and the face could be made 4.5 inches. The pitch diameter of the pinion is $\frac{\text{number of teeth}}{\text{diametral pitch}} = \frac{15}{2} = 7.5$ inches. The gear diameter is $7.5 \times 5 = 37.5$ inches. If desired, the velocity at the pitch line and the working fiber stress may be found. The velocity is $v = \frac{nN}{3.83\,p_d} = \frac{15 \times 150}{3.83 \times 2} = 295$ feet per minute. The diagram Fig. 5 gives the fiber stress corresponding to this velocity as 5000 pounds per square inch.

Problem 4.—The conditions of this problem will be the same as in Problem 3, excepting that the face width will be assumed as 3.75 inches. The solution requires the use of the diagram shown in Fig. 4.

$$B = \frac{\text{H. P.}}{C_2 f\sqrt{N}} = \frac{25}{1 \times 3.75\sqrt{150}} = 0.545.$$

From Fig. 4 the circular pitch corresponding to $B = 0.545$ and $n = 15$ is $p = 1.74$ inch; and this is approximately equal to a diametral pitch of 1.75. The pitch diameter of the pinion then is $\frac{n}{p_d} = \frac{15}{1.75} = 8.57$ inches, while the pitch diameter of the gear is $\frac{75}{1.75} = 42.86$ inches. The face width, as assumed, is 3.75 inches.

Problem 5.—The conditions of this problem are also like those of Problem 3. The twisting moment on the pinion shaft is 10,500 inch-pounds, but the pinion and gear are made of different materials. Assume the pinion to be made of forged or rolled steel and the gear of cast iron. The fiber-stresses will be those given by the diagram Fig. 5, for the upper and lower curves. Considering first the pinion, the twisting moment M on the pinion shaft is 10,500 inch-pounds and the face width will be taken as three times the circular pitch. In the diagram Fig. 3, we have:

$$A = \frac{M\sqrt{N}}{C_1C_2}$$

For rolled steel $C_2 = 2.5$ and in this problem $C_1 = 3$.

$$A = \frac{10,500\sqrt{150}}{3 \times 2.5} = 17,150$$

For $A = 17,150$ and $n = 15$ the diagram gives $p = 1.06$ inch. Now for the gear, the twisting moment M will be $10,500 \times 5 = 52,500$ inch-pounds and $N = \frac{150}{5} = 30$. For cast iron $C_2 = 1$.

$$A = \frac{M\sqrt{N}}{C_1C_2} = \frac{52,500 \times \sqrt{30}}{1 \times 3} = 96,000.$$

In the diagram Fig. 3, $p = 1.32$ inch, for $A = 96,000$ and $n = 75$. Comparing the pitches found for the gear and the pinion, it is seen that the gear requires the greater pitch and since they must be alike the 1.32-inch circular pitch must be used. The face width will be $1.32 \times 3 = 3.96$ inches or approximately 4 inches. The nearest stronger diametral pitch is 2.25. On the basis of diametral pitch, the pitch diameter of the pinion will be $\frac{15}{2.25} = 6.67$ inches. The pitch diameter of the gear is $\frac{75}{2.25} = 33.33$ inches. The face width is 4 inches, as previously stated.

When the desired fiber-stress does not follow the curves assumed, the pitch is not quite so readily obtained from the diagrams but may be determined as follows:

Problem 6.—In Problem 1, instead of giving the fiber-stress we will assume that it is required to follow the curve representing Mr. Barth's equation, shown in the diagram Fig. 5, for cast iron. Assuming that one has no idea what the pinion diameter will be, it is better to first find the pitch required as if the allowable fiber-stress varies as $\frac{88{,}000}{\sqrt{v}}$.

$$A = \frac{M\sqrt{N}}{C_2 f} = \frac{5600\sqrt{225}}{C_2 \times 3.25} = 25{,}800.$$

From the diagram Fig. 4, $p_c = 1.45$ inch; and the value of v corresponding to this pitch is:

$$v = \frac{np_cN}{12} = \frac{15 \times 1.45 \times 225}{12} = 408 \text{ or approximately } 400$$

feet per minute.

It will be sufficiently close to assume that the relation between the working fiber-stresses at the actual velocities will approximate that for 400 feet per minute. From the diagram Fig. 5, the fiber-stresses at 400 feet per minute, according to Barth's (light line) and the heavy line curve, are 6000 and 4400 pounds per square inch, respectively. The ratio of these stresses is $\frac{6000}{4400} = 1.36$. In Formula (6) from the diagram Fig. 4, for cast iron:

$$M = Wr = \frac{88{,}000\sqrt{12}}{\sqrt{np_cN}} \times p_c f \times \frac{np_c}{6.28}\left(0.124 - \frac{0.684}{n}\right).$$

If the twisting moment or the horsepower is to remain constant while the fiber-stress, stated in the portion $\frac{88{,}000\sqrt{12}}{\sqrt{np_cN}}$ varies, then p_c must change to preserve the equality. If the ratio of the two fiber-stresses is a, then p_c must vary inversely with the factor $\rho = a^{\frac{2}{3}}$, *i.e.*, the cube-root of its square. To use the diagram, $a^{\frac{2}{3}} = 1.36^{\frac{2}{3}} = 1.23$. The corrected pitch then is $\frac{p_c}{\rho} = \frac{1.45}{1.23} = 1.18$ inch. Had the ratio of the face width to the circular pitch been given, instead of the width of the tooth face in inches, then the factor would have been $\rho = a^{\frac{2}{5}}$, and the diagram Fig. 3 would have been used. Another problem will illustrate the last suggestion.

Problem 7.—Design a pair of gears to transmit 80 horsepower, the pinion to be steel with 18 teeth while the gear will be cast iron with 90 teeth. The ratio of the face width to the circular pitch will be 4 to 1; and the allowable fiber-stress on the pinion shall be that given in the diagram Fig. 5 for steel. For cast iron, Barth's curve shall be used. The pinion runs at 400 revolutions per minute.

For the pinion, $C_1 = 4$ and $C_2 = 2.5$.

$$B = \frac{\text{H. P.}}{C_1 C_2 \sqrt{N}} = \frac{80}{4 \times 2.5\sqrt{400}} = 0.40.$$

Then from the diagram Fig. 3, $p_c = 1.15$ inch. For the gear, $C_1 = 4$ and $C_2 = 1$.

$$B = \frac{\text{H. P.}}{C_1 C_2 \sqrt{N}} = \frac{80}{4 \times 1\sqrt{80}} = 2.23.$$

Then from the diagram Fig. 3 p_c corresponding to $B = 2.23$ for 90 teeth is 1.46 inch. This is the value which must be used, as it is the greater of the two pitches. The velocity at the pitch line of the gear is $\frac{1.46 \times 90 \times 80}{12} = 876$ feet per minute. From the diagram Fig. 5, the allowable fiber-stress given by the two curves is 4000 and 3000 pounds per square inch, respectively. From these values:

$$a = \frac{4000}{3000} = 1.33.$$

$$\rho = a^{\frac{2}{5}} = 1.33^{\frac{2}{5}} = 1.12.$$

Hence the revised circular pitch is $\frac{p_c}{1.12} = \frac{1.46}{1.12} = 1.30$ inch.

The diameter of the pinion is $\frac{1.30 \times 18}{3.14} = 7.45$ inches.

The diameter of the gear is $\frac{1.30 \times 90}{3.14} = 37.24$ inches.

Instead of changing the circular pitch, the working-stress in the teeth might have been increased by reducing the width of the face, as the fiber-stress and the width of the face vary inversely with each other. The gear with 3000 pounds per square inch fiber-stress had $p_c = 1.46$ inch, so that the gear diameter is $\frac{1.46 \times 90}{3.14} = 41.82$ inches, while the pinion diameter is $\frac{1.46 \times 18}{3.14} = 8.37$ inches. The face width is $1.46 \times 4 = 5.84$ inches. Had it been deemed desirable to use a narrower face width, the face could have been made $\frac{3}{4} \times 5.84 = 4.38$ inches; and this would have increased the fiber-stress from 3000 to 4000 pounds per square inch, which is the desired limiting fiber-stress.

Similar diagrams may be used for the design of gears with stub teeth or for other ranges of pitches. The diagrams give the minimum pitches and consequently the smallest diameters for the given conditions. Where the frame conditions require larger gears, owing to the desired distance between the gear centers, the pitch found in the diagrams still gives a good suggestion as to the probable dimensions.

* * *

SCARCITY OF COPPER ALLOYS IN GERMANY

In the issue of July 30, of *Die Werkzeugmaschine*, a letter from the German war department to the Society of German Machine Tool Builders is published. This refers to a request made by the machine tool builders for brass and phosphor-bronze, which metals apparently have been entirely appropriated by the government. The letter states that the release of such quantities of brass and phosphor-bronze as had been requested would be impossible on account of the necessity for safeguarding the supplies necessary for the army for a long time to come. It is stated that while, without question, the elimination of copper alloys in the construction of machine tools would mean greater wear and heavier stresses in many machine details, these evils must be taken into consideration and accepted by the buyer during the war. According to the opinions of experts, however, cast iron can be used, says the war department, for all journal bushings where the revolutions per minute do not exceed 300 to 400. Cast iron, as well as hardened steel, can safely be run in cast-iron bearings. When machine steel is used in cast-iron bearings, the machine steel journal should be casehardened. White metal bearings are also, at the present time, recommended in place of brass and bronze bushings. The lubrication should be suited to the metals used in bearings, ring oiling, forced lubrication, etc., being preferable. Graphite should be used when running-in journals to produce a smooth surface. The letter ends with a further request to the machine tool builders to regard these points in machine tool construction, and to consider it a duty to use the greatest economy in the employment of metals which the government considers it necessary to save.

* * *

The United States government has installed an eight-effect distilling plant for supplying water to a fortification where fresh water is not available. The apparatus, of the Lillie design, is of the reversible type. The hot effects can be made the cool effects, and *vice versa;* the object of reversibility is to reduce the scaling to a minimum. The efficiency obtained is six pounds of distilled water per pound of steam at forty-five pounds gage pressure. The apparatus cost about $16,500 complete with boilers and auxiliaries and has a capacity of 7000 gallons per day of twenty-four hours. The cost per gallon of distilled water when the plant is run twenty-four hours a day, 300 days to the year, is one-quarter cent, coal being charged at $3.50 per ton. This charge includes a depreciation charge of 12 per cent on the investment.

A PROBLEM IN SLOTTING AND INDEXING

BY DONALD A. HAMPSON*

Several interesting points were presented by a certain contract job that was recently handled in our shop, and I have prepared the following description of our method of doing the work with the hope that it may prove of interest to some of MACHINERY'S readers. The part with which this article concerns itself consisted of machining three cast-iron rings, which were 34 inches outside diameter, 23 inches inside diameter and 1 inch in thickness. After machining these castings, it was necessary to cut radial T-slots across their faces. There were twenty slots cut in the first ring, forty in the second and sixty in the third. These slots were ½ inch wide with a total depth of 9/16 inch, and were under-cut for bolt heads ¼ by 1 inch in size. As shown in the accompanying illustrations, some of the slots were widened out at the ends, but this has no particular connection with the way in which the work was handled.

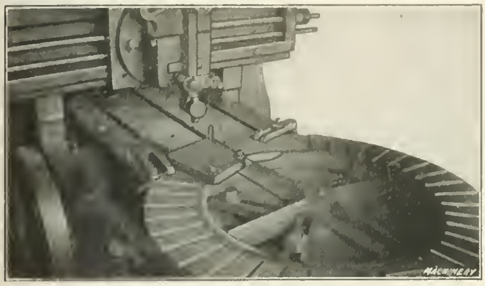


Fig. 1. Set-up for First Operation performed on Planer

Just how to index these slots correctly and still handle the work economically caused considerable speculation, and required some of us to give the problem a good deal of thought. Safety in handling was of primary importance because breaking a ring of these dimensions was an ever-present possibility, and would have involved a serious delay and loss in labor charges. Index centers of the ordinary type could not be employed in this case, and laying out the work would not give the required degree of accuracy. The fixtures that were finally made for handling this job are shown in Figs. 1 and 2, which also show the work in two different stages. The method of procedure consisted in taking stocking cuts of the full ½ inch in width and of nearly the full depth on the planer, then doing the T-slotting with a standard T-slot cutter used in the milling machine. The greatest permissible variation in the spacing was 0.005 inch at the outside of the rings.

The indexing fixtures used on the planer are shown in Fig. 1. They consist of a cast-iron spider 23 inches in diameter, that had a hole bored in the center, and was turned on the outside to the required size; a plug to go in the central hole of the spider; an index plate having holes for twenty, forty and sixty divisions; and an index pin. The center plug was tapped at its lower end and screwed down tightly against the planer table over a bolt placed in the middle T-slot. This plug was reduced to a diameter of ½ inch at its upper end, which was the same as the width of the slots to be cut, and by setting the slotting tools to this plug, the slots were cut exactly on the diameter. The spider was slipped over the plug and clamped securely in place. In making the index plate great care had to be exercised to insure having it of the required accuracy. The position of the plate on the spider was such that the work could be revolved below it; but this arrangement made it necessary for the index plate to be removed every time a fresh ring was put on the spider, and on this account substantial dowel-pins were provided in addition to two ½-inch cap-screws. There were four holes for the index pin, there being one zero hole and one hole for twenty, forty and sixty divisions, respectively, all of the holes being located on a circle 33 inches in diameter. These holes were located by the button method, and bored a close fit for an index pin ⅝ inch in diameter, so that the pin could be flattened on two sides to present a broader and larger wearing surface to the slots in the work. As the flattened sides were slightly tapered, they took care of variations in the width of the slots which might result from wearing of the tool.

Considerable care had to be exercised in setting the spider and index plate, for it will be evident that any error introduced at the start would be cumulative, *i. e.*, while all of the slots indexed would be equally spaced only thirty-nine indexings are required for a forty-slot ring, so that the last space would receive the entire error introduced at the start of the machining operation. This was the chief objection to the method of indexing that was employed, but by taking great care at the two "danger points"—spacing of the plate and setting the work for milling the first slot in the ring—the difficulty was overcome. In handling the work, the ring to be slotted was clamped in place and the first slot cut, the tool having been set central by means of the plug at the middle of the spider. The spider was next unclamped and swung around until the zero hole, which is on the right-hand side, was over the cut slot with the index pin firmly in place. After clamping the spider, the ring was turned to the left until the slot was under the forty hole (assuming a forty-slot ring is being handled), after which the index pin was slipped into this slot. The ring was next clamped and the spider unclamped and revolved until the zero hole once more lined up with the slot, after which the index pin was inserted and the spider permanently fastened. This resulted in locating the zero hole on a diameter exactly 9 degrees from the diameter covered by the slotting tool.

Twenty-, forty- and sixty-hole rings were handled by means of corresponding holes in the index plate, these holes only being used for the first setting, after which only the zero hole was used for successive indexing operations without requiring the spider to be moved. With the zero hole properly placed, the operation resolved itself into one of plain indexing, and the work was done so carefully that the sixty-slot ring showed a total error of 0.004 inch, while the error in the forty- and twenty-slot rings was only 0.006 inch. These results showed the care which was exercised in setting up the work to overcome the weak features of this method of indexing. The tool used for slotting was an Armstrong special planer tool-holder carrying two high-speed steel bits, one of which took the roughing cut and the other the sizing cut. This is shown in detail in Fig. 3. As the slots were planed 0.010 inch less than the required depth, the broken surface which the tools left in the bottom of the slots made no difference. Originally it was intended to make a special tool fixture, but by cutting the slot in the head bolt a little longer, the Armstrong holder answered the purpose required of it. Incidentally, this affords a good example of adapting a standard tool for a special job, as compared with the more expensive method of making up a special tool for the purpose.

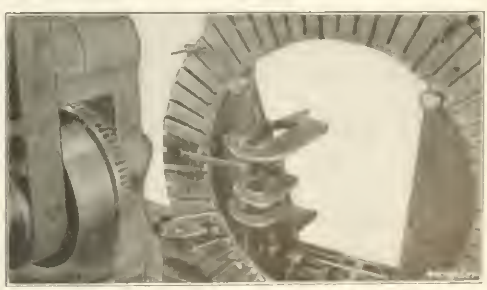


Fig. 2. Set-up for Second Operation done on Milling Machine

After the slots were planed, it was necessary to under-cut them on a plain milling machine, no tools other than the shop's regular equipment being used for this purpose. Two or three points in connection with this part of the work are worthy of special mention. For holding the work, two 24-inch angle plates were bolted to the milling machine table with their surfaces slightly overhanging its edge. This method

* Address: 31 Hanford St., Middletown, N. Y.

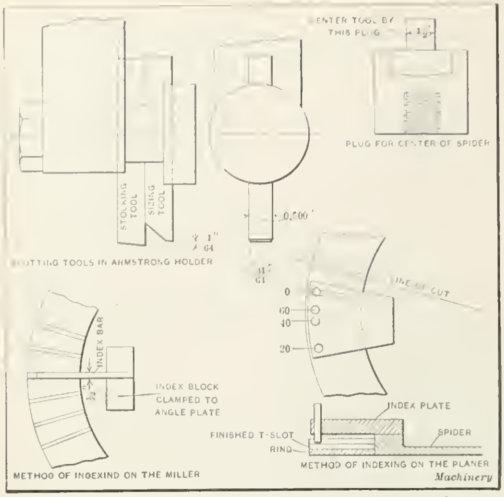


Fig. 3. Details of Tools used for Planing and Milling Operations

was resorted to because the capacity of the machine would not permit of the rings resting on top of the table, but with the angle plates they could be set up to extend about 6 inches below its working surface. As there was no center web to support the ring, the operation of shifting and re-aligning the work for each cut would have been a formidable one had it not been for the provision of two small rollers, which can be seen in Fig. 2 on the inside of the ring near the top. These rollers were mounted on shoulder bolts set in the angle plates, and served the triple purpose of centering the ring, forming anti-friction bearings on which to turn it, and by means of a flange on the inside of each roller, avoiding any chance of a ring slipping off and falling while the C-clamps were loosened for turning the work.

Ordinary T-slot cutters were used for the undercutting operation, and after the first slot was properly aligned and centered with the cutter, the work was located for subsequent operations by direct indexing. A piece of steel had a ½-inch slot cut in it and a second piece of steel ½ inch square was machined to fit snugly in the slot. The ½-inch bar was then laid in the aligned slot in the ring and in the piece of flat steel held against the angle plate. C-clamps fastened the bar in place, thus holding the work in the desired position. The work was then located for subsequent operations by loosening the clamps and turning the ring until the bar dropped into both the slot in the work and the index slot. That this method gave satisfactory results is evidenced by the fact that the entire milling operation was performed at an average rate of 8 minutes per slot, this time including everything except setting up the work ready for the first operation. The rollers on which the work was held on the angle plates made it possible for the milling machine operator to mill the rings without requiring any assistance.

* * *

DRILLING MOTORCYCLE HUBS

The drilling of the spoke holes in the hubs of "Indian" motorcycles at the factory of the Hendee Mfg. Co., Springfield, Mass., is a job worthy of mention. These hubs are made of low carbon steel and the end flanges through which the holes are drilled are one-eighth inch thick. Through each flange sixteen No. 25 holes are drilled at a slight angle so that the direction of the drilling is along the lines of a cone. The distance between the holes is about one-half inch.

The spindles of the multiple spindle drilling machine in which the work is done are guided in their inclination by a steel ring supported from the head of the machine. The jig is of the swiveling type, permitting the holes in one end of the hub to be drilled, after which the work-holding part of the jig is swiveled 180 degrees and the holes in the opposite end are drilled. The drilling is performed by running the head and drills down to the work, which on account of the inclination of the spindles is the only way possible.

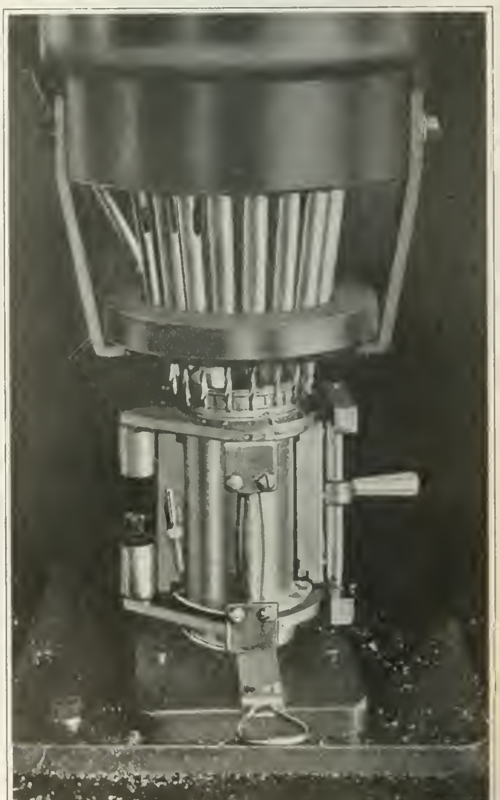
In order that the work may be quickly inserted and removed, the jig is made in halves. As the illustration shows, these halves are hinged at the left and held together for the drilling by a latch that appears at the right of the illustration. The drill bushings are located in the faces of the halves of the jig. After the holes in one flange of the hub have been drilled, the steel plate that takes the thrust is removed from beneath the work. Then by withdrawing the index pin at the left, the working part of the jig can be turned 180 degrees to present the other face of the hub to the drills. The heavy stud on which the jig swivels is directly behind the work and therefore not visible in the illustration. The index pin is inserted, the thrust plate is replaced and the drilling of the hub is completed. The hubs, each having thirty-two holes—sixteen to each end—are drilled at the rate of 300 per ten-hour day. C. L. L.

* * *

CONSUMPTION OF OIL FUEL FOR FORGE FIRES

In order that forge fires may be operated economically, there should not be an abundance of flame passing out of the door openings of the furnace. Greater heat and economy of fuel are secured by so regulating the burners that only a greenish haze about six inches long is visible passing out of the furnace doors when opened. With the correct number of burners properly adjusted for the capacity of the furnace, the average consumption of oil when heating for a 1000-pound steam hammer is 3½ to 4½ gallons per hour. It has been found in one of the foremost forge plants in this country that nineteen pounds of steel can be heated to each gallon of oil consumed. The steel used is chiefly vanadium alloy.

D. T. H



Swiveling Drill Jig for Motorcycle Hubs

PUNCH AND DIE STANDARDS

APPLICATION OF MANUFACTURING METHODS IN TOOLMAKING OPERATIONS

BY EDWARD K. HAMMOND*

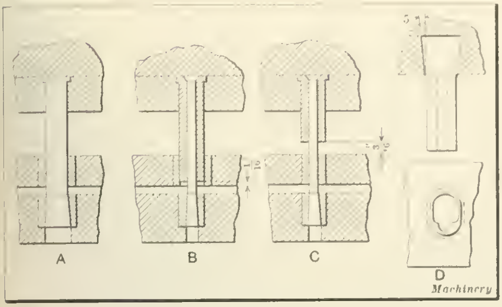


Fig. 1. Standard Methods of supporting Perforating Punches in Punch plates

IN many shops there is still a tendency to regard toolmaking as work on which it is inevitable for the labor charges to be high. Toolmakers who have learned their trade in such an atmosphere may be capable of doing very good work, but it is natural that they should have formed a habit of working slowly. Such men invariably run their machines at the slowest speeds and feeds, and as it is a foregone conclusion that the work will be expensive, no particular effort is made to devise ways and means of increasing the rate of production and making a corresponding reduction in cost. In the up-to-date tool-rooms of progressive manufacturing plants, all precedent is discarded in striving for increased efficiency. Necessarily there is a definite relation between the rate at which the work is produced and the accuracy of the product; but toolmaking methods have been carefully investigated with the view of increasing the output to the maximum that is consistent with the attainment of the required degree of accuracy.

Briefly speaking, this change in toolmaking practice has consisted of the introduction of manufacturing methods in the tool-room wherever such a course seemed feasible. An excellent example of this kind is seen in the system which has been developed by the Western Electric Co. for the production of all sizes of punches and dies which are used in this company's factory at Hawthorne, Ill. For example, in the case of tandem perforating and blanking dies, the use of six standard sizes has been adopted with the view of reducing the cost of production of these tools. Each size is designated by a number, and standard dimensions have been established for the die-block, stripper, die-holder, punch-holder, and punch-plate for each size of punch and die. The punch is made especially at the time that the order for any given punch and die is being filled, and the die-block is left soft ready to have a hole of the required shape cut in it. The use of standard sized hardened and ground dowel-pins, and standard round steel compression springs has also been adopted in punch and die work.

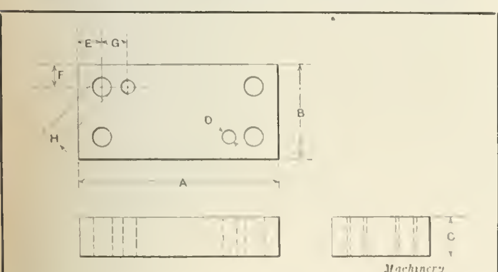
Fig. 2. Detail of Piece to be made

Increased efficiency of production is secured in several directions through the establishment of these punch and die standards. Most important among these is the fact that the adoption of uniform sizes insures the existence of a future demand for parts of the different standard sizes of punches and dies. As a result, these parts can be produced on a manufacturing basis, a series of each of the parts being made and delivered to the stock-room, where they are kept, pending the receipt of requisitions from the tool-room for the necessary number of parts to fill orders for punches and dies to be used in the various manufacturing departments. Needless to say, punches and dies can be produced far more economically in this way than would be possible in making individual parts for a given punch and die at the time the order was issued.

In addition to effecting a saving in the cost of labor for toolmaking, this method is also the means of making a noteworthy saving of labor in the drafting-room. When an order is received to design a punch and die for producing some new part, the draftsman's work is quite simple. All that he has to do is to make a detail drawing of the part to be produced and an assembly drawing of the punch and die to be used for its manufacture. The size-number of the standard punch and die to be employed is specified on the drawing, and the two drawings, when approved, are sent to the tool-room. The tool-room foreman then sends a requisition to the stock-room, calling for the standard parts that are required for producing this punch and die. It will be obvious that the punch must be made especially for the part which is to be produced, and it has already been mentioned that the standard die-block is sent to the stock-room in the annealed

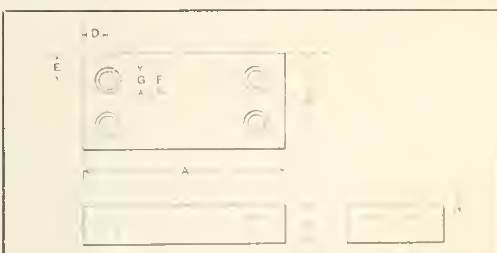
* Associate Editor of MACHINERY.

TABLE I. DESIGN AND DIMENSIONS OF STANDARD DIE-BLOCK



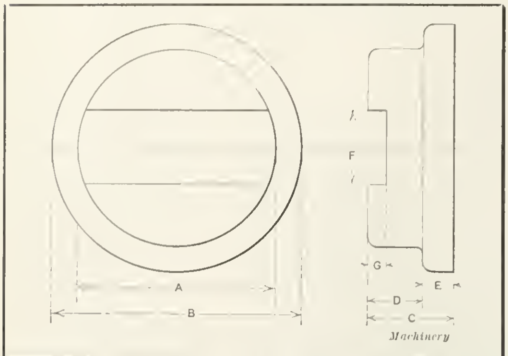
No. of Die-block	A	B	C	D Drill	D Ream	E	F	G	H
4	3	1½"	[illegible]	[illegible]	¼"	[illegible]	[illegible]	[illegible]	[illegible]
5	4	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	5	2½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	7	3¼	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	9	4½	1⅛	[illegible]	½	[illegible]	[illegible]	[illegible]	[illegible]

TABLE II DESIGN AND DIMENSIONS OF STANDARD STRIPPER PLATE



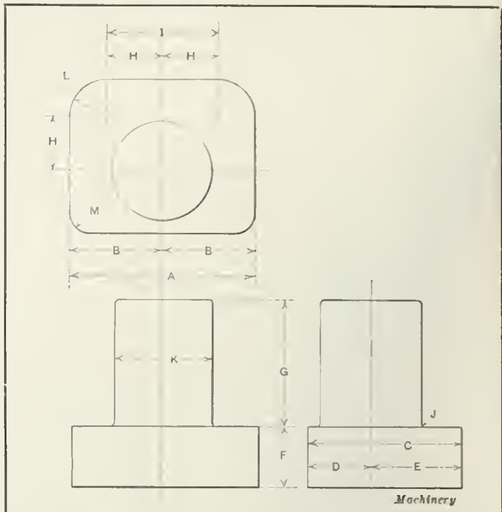
No. of Stripper	A	B	C	D	E	F	G	H
4	3"	1½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	4	2	[illegible]	[illegible]	[illegible]	0.447	[illegible]	[illegible]
6	5	2½	[illegible]	[illegible]	[illegible]	0.510	[illegible]	[illegible]
8	7	3¼	[illegible]	[illegible]	[illegible]	0.572	[illegible]	[illegible]
10	9	4½	[illegible]	[illegible]	[illegible]	0.697	[illegible]	[illegible]

TABLE III. DESIGN AND DIMENSIONS OF STANDARD DIE-HOLDER



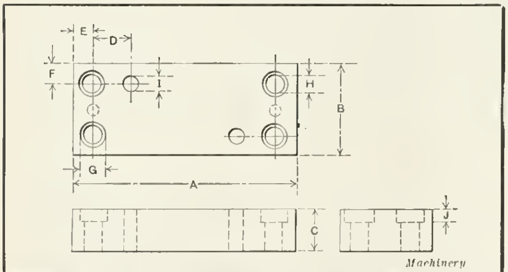
No. of Die-holder	A	B	C	D	E	F	G
4	4"	5"	1¾"	1⅛"	⅝"	1½"	⅜"
5	5	6	1¾	1⅛	⅝	2	⅜
6	6	7	1¾	1⅛	⅝	2½	⅜
8	8	9	2¼	1⅝	⅝	3¼	½
10	10	11	2¼	1⅝	⅝	4½	⅝
12	12	13	2½	1⅞	⅝	..	..

TABLE IV DESIGN AND DIMENSIONS OF STANDARD PUNCH-HOLDER



Holder No. of Punch	A	B	C	D	E	F	G	H	I	J	K	L	M
4	3¾"	1⅞"	3⅛"	1¼"	1⅞"	1"	2½"	1⅛"	2¼"	⅛"	2"	¾"	¼"
5	4½	2¼	3½	1¼	2¼	1	2½	1 7/16	2⅞	⅛	2	13/16	¼
6	5½	2¾	4¼	1½	2¾	1¼	2½	1¾	3½	⅛	2	1	¼
8	7¼	3⅝	5½	1⅞	3⅝	1¼	2½	2⅜	4¾	⅛	2	1¼	¼
10	9	4½	7	2½	4½	1¼	2½	3	6	⅛	2	1½	¼
12	10⅝	5 5/16	8 1/16	2¾	5 5/16	1¼	2½	3½	7	⅛	2	1 13/16	¼

TABLE V. DESIGN AND DIMENSIONS OF STANDARD PUNCH-PLATE



No. of Plate	A	B	C	D	E	F	G	H	I Drill	I Ream	J
4	3"	1¼"	½"	..	¼"	¼"	0.353"	¼"	15/64"	¼"	5/32"
5	4	1¾	½	⅝"	⅜	⅜	0.447	5/16	19/64	5/16	3/16
6	5	2¼	⅝	¾	7/16	7/16	0.510	⅜	23/64	⅜	¼
8	7	3⅛	⅝	1	9/16	9/16	0.572	7/16	27/64	7/16	¼
10	9	4⅛	⅝	1¼	11/16	11/16	0.697	½	31/64	½	5/16

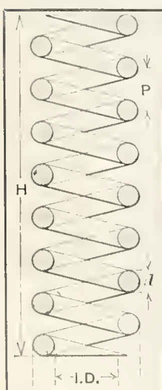
Note.—Dotted circles show dowel-pins in punch-plate No. 4

TABLE VI. DIMENSIONS OF STANDARD DOWEL PINS

No. of Dowel Pin	Diameter	Length	Make from
1	3/16"	⅞"	No. 8 drill rod (0.197 inch)..
2	3/16	1⅜	No. 8 drill rod (0.197 inch)..
3	¼	1	No. G drill rod (0.261 inch).
4	¼	1¾	No. G drill rod (0.261 inch).
5	5/16	1¼	No. P drill rod (0.323 inch).
6	5/16	1¾	No. P drill rod (0.323 inch).
7	⅜	1⅜	No. W drill rod (0.386 inch).
8	⅜	2⅛	No. W drill rod (0.386 inch).
9	7/16	1½	½-inch tool steel........ ....
10	7/16	2⅜	½-inch tool steel.............
11	½	2¾	9/16-inch tool steel...........

Machinery

TABLE VII. STANDARD COMPRESSION SPRINGS FOR USE IN PUNCH AND DIE CONSTRUCTION

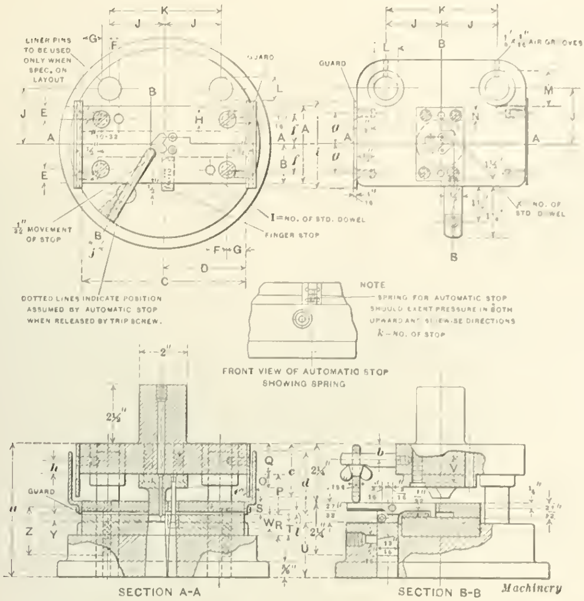


O. D.	I. D.	d	P	H	Max. F per in.	Max. W	F per In. W = 100 Lbs.	W F = 0.1 inch per in.	O. D.	I. D.	d	P	H	Max. F per in.	Max. W	F per In. W = 100 Lbs.	W F = 0.1 inch per in.
In.	In.	In.	In.	In.	In.	Lbs.	In.	Lbs.	In.	In.	In.	In.	In.	In.	Lbs.	In.	Lbs.
7/32	0.153	0.032	0.057	3	0.3995	515	0.25740	0.0137	51/64	0.347	0.225	0.350	1¾	0.0869	626	0.01400	0.0721
¼	0.124	0.063	0.110	36	0.1055	42	0.25182	0.0396	51/64	0.347	0.225	0.350	5⅞	0.0869	626	0.01400	0.0721
⅜	0.135	0.120	0.198	36	0.0576	213	0.02677	0.0370	13/16	0.429	0.192	0.300	2	0.1399	358	0.03906	0.0256
29/64	0.213	0.120	0.198	1¼	0.0980	163	0.06010	0.0166	53/64	0.340	0.244	0.369	1¾	0.0794	781	0.01003	0.0985
½	0.260	0.120	0.198	1¼	0.1273	143	0.08888	0.0113	61/64	0.465	0.244	0.369	6	0.1168	644	0.01816	0.0550
½	0.176	0.162	0.256	36	0.0578	395	0.01445	0.0686	1¼	0.636	0.307	0.463	3½	0.1309	964	0.01361	0.0736
17/32	0.207	0.162	0.256	1½	0.0688	362	0.01914	0.0527	1¼	0.636	0.307	0.463	5	0.1309	964	0.01361	0.0736
9/16	0.266	0.148	0.242	2⅝	0.1004	246	0.04091	0.0244	1¼	0.390	0.430	0.555	3½	0.0589	3046	0.00198	0.5162
⅝	0.385	0.120	0.183	1¼	0.2432	107	0.22723	0.0044	1⅜	0.761	0.307	0.495	6⅝	0.1572	851	0.01838	0.0540
⅝	0.385	0.120	0.183	1¾	0.2432	107	0.22723	0.0044	1 7/16	0.713	0.362	0.550	4½	0.1218	1385	0.00875	0.1139
⅝	0.301	0.162	0.256	1½	0.1082	288	0.03750	0.0266	1½	0.776	0.362	0.550	6	0.1362	1309	0.01036	0.0963
41/64	0.257	0.192	0.286	1¾	0.0766	496	0.01538	0.0646	1⅝	⅝	0.500	0.750	6⅛	0.0707	3491	0.00200	0.4935
11/16	0.237	0.225	0.319	36	0.0624	774	0.00815	0.1241	2 1/32	1 1/32	0.500	0.688	7½	0.1427	2565	0.00552	0.1796
25/32	0.331	0.225	0.319	36	0.0903	643	0.01411	0.0711	3½	2	0.750	1.000	12	0.2111	4820	0.00440	0.2280
..	....	.....	......	....	......	....	....	......	3½	1¾	0.875	1.063	18	0.1551	8018	0.00198	0.5116

Machinery

NOTE: F=compression in spring; W = load on spring; For other notations see diagram.

TABLE VIII. LAYOUT FOR PERFORATING AND BLANKING PUNCH AND DIE



No. of Punch and Die	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
4	1½"	¾"	3"	1½"	⅜"	⅜"	⅜"	¼"-20	4	1⅛"	2¼"	½"	13/16"	10"-32	½"	1½"	1"	⅝"	½"
5	2	1	4	2	7/16	½	½	5/16-18	6	1 7/16	2⅞	⅝	1	12-24	½	1½	1	⅝	½
6	2½	1¼	5	2½	½	⅝	⅝	⅜-16	8	1¾	3½	¾	1⅛	¼-20	⅝	1¾	1¼	¾	⅝
8	3¼	1⅝	7	3½	9/16	¾	¾	7/16-14	10	2⅜	4¾	1	1½	5/16-18	⅝	1¾	1¼	⅞	⅝
10	4½	2¼	9	4½	¾	⅞	⅞	½-13	11	3	6	1¼	1¾	⅜-16	⅝	1¾	1¼	1⅛	⅝
12	..	..	..	..	..	..	..	.....	..	3½	7	1½	2⅛	7/16-14	⅝	..	..	..	..

No. of Punch and Die	T	U	V	W	X	Y	Z	a	b	c	d	e	f	g	h	i	j	k	l
4	⅜"	1¾"	1"	7/16"	1	¼"	1½"	4½"	½"	1¾"	2¼"	13/32"	½"	⅞"	½"	2½"	7/32"	1	¼"
5	⅜	1¾	1	7/16	3	¼	1½	4½	½	1¾	2¼	13/32	¾	⅞	½	2½	7/32	1	¼
6	⅜	1¾	1¼	½	5	5/16	1¾	5⅛	⅝	2⅛	2¾	13/32	1	1⅛	⅝	3	9/32	2	5/16
8	½	2¼	1¼	⅝	7	5/16	2	5⅝	⅝	2⅛	2¾	9/32	1⅜	1½	⅝	3¼	9/32	2	5/16
10	⅝	2¼	1¼	¾	9	⅜	2¼	5⅞	⅝	2⅛	2¾	5/32	2	2⅛	⅝	5	9/32	2	5/16
12	..	2½	..	..	..	..	..	..	..	..	..	..	..	2⅜	⅝	5½	..	..	..

condition, so that it is ready to have the hole machined in it. After this work has been done, the punch and die are hardened and the entire tool may then be assembled.

In connection with the design of perforating punches and dies, standard methods have been adopted for holding the punches in the punch-plate, these standard constructions being shown in Fig. 1. All punches made of larger sections than No. 1 drill rod are strong enough to do without a supporting sleeve, and the standard construction for such punches is shown at *A*. For small punches where a supporting sleeve is required, the standard construction is shown at *B*, where it will be seen that the supporting sleeve slides in a bushing carried in the stripper-plate. In some cases, however, the form of bushing shown at *B* occupies too much space, and where the amount of available room for the bushing in the stripper-plate is limited, the form of construction shown at *C* has been adopted. At *D* is shown the method of holding punches which must be sheared into the die. Reference to the illustration will show that the punch is provided with a 5-degree taper shank which supports it securely in the punch-plate.

As an example of the way in which this system works out, consider the case of making a tandem perforating and blanking punch and die for producing the part, Fig. 2. Ribbon stock is used for this purpose, and the assembly drawing of the punch and die is shown at the top of Table VIII. Reference to this illustration will show that the tool is provided with a pair of perforating punches for piercing the two holes in the work, and a blanking punch for stamping out the finished part from the stock. At each stroke one finished part is produced, while the perforating punches make the two holes in the part which will be stamped out from the stock by the following stroke of the press. It will be seen that the assembly drawing gives the toolmaker complete instructions, and with the standard parts of the punch and die in stock ready for use, the work of making the tool is a matter of simple routine and can be handled very rapidly.

Toolmakers will doubtless be interested in the materials which are specified by the Western Electric Co. for making the standard parts for the type of tandem perforating and blanking dies which has been referred to. The punch-plates are made of machine steel, the carbon content of which must not exceed 0.20 per cent. These parts are completely finished, including the screw and dowel-pin holes. The punch-holders and die-holders are made of cast iron, and they are finished ready for use. The stripper-plates are made of machine steel with a carbon content of not over 0.20 per cent. The screw holes are machined at the time the stripper-plates are made, while the dowel-pin holes are transferred from the die-block at the time the die is made up. The die-blocks are, of course, made of tool steel, with the screw and dowel-pin holes and all surfaces finished ready for use. The stock for making dowel-pins is given in Table VI.

The "suggestion box" idea is used in the Hawthorne shops of the Western Electric Co., with the view of encouraging employes to hand in written suggestions regarding ideas for the improvement of manufacturing methods. One employe suggested making dowel-pins which were 0.001 inch over size for use in cases where the dowel-pin holes in the die-block had been lapped too large. One of the rules in connection with the operation of the "suggestion box" is that a report shall be sent to the employe, either accepting his idea or giving the reason for its rejection. The dowel-pin idea was turned down, because it was felt that the stocking of these over-size dowel-pins would tend to create a spirit of carelessness on the part of the toolmakers, which would be very undesirable. Furthermore, if the plan of carrying special parts of this character in stock were adopted, an excessive amount of storage capacity would be required.

It has been the purpose of this article to describe a principle of toolmaking rather than to give specific information on the making of punches and dies. The tables give the sizes which the Western Electric Co. has found satisfactory for use in making tandem perforating and blanking punches and dies. The Western Electric Co. has also developed standards for sub-press dies and other classes of dies, which enable the same economies to be taken advantage of; but it is not within the scope of this article to give detailed information in regard to the dimensions of the different sizes of tools in these classes. The sizes would necessarily vary with the character of the work, and manufacturers would therefore be able to adopt standards that are best suited to their requirements.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Patent Infringements

(Federal) The making of what is a single part in a patented machine in two pieces does not avoid infringement, where they do the same work as the single piece in substantially the same manner. The United States Circuit Court of Appeals has so held in Stockland v. Russell Grader Mfg. Co. The Russell Grader Co. was the owner of a patent for certain improvements in a road grading machine. Defendant Stockland built a similar machine, but containing more parts to it. The question was whether this second machine infringed the first. The court in holding the Russell Grader Mfg. Co. to be infringed said: "In determining the question of infringement, the court or jury, as the case may be, are not to judge about similarities or differences by the names of things, but are to look at the machines or their several devices or elements in the light of what they do, or what office or function they perform, and how they perform it, and to find that one thing is substantially the same as another, if it performs substantially the same function in substantially the same way to obtain the same result, always bearing in mind that devices in a patented machine are different in the sense of patent law when they perform different functions in a different way, or produce a substantially different result, * * * as it is necessary in every such investigation to look at the mode of operation or the way the device works, and at the result, as well as at the means by which the result is attained. Inquiries of this kind are often attended with difficulty; but if special attention is given to such portions of a given device as really do the work, so as not to give undue importance to other parts of the same which are only used as a convenient mode of constructing the entire device, the difficulty attending the investigation will be greatly diminished, if not entirely overcome." Damages were awarded to the Russell Co. *(Stockland v. Russell Grader Mfg. Co., 222 Fed. 906.)*

Use Not Essential to Maintenance of Patent

(Federal) Machines which, although patented, were not practically operative and were abandoned after slight use, are not anticipations which will invalidate a subsequent patent for an operative and successful machine. In a suit by the Benthall Machine Co. v. National Machine Corporation, the Benthall Co. charged the National Corporation with having made and sold machines for picking peanuts from vines which infringed its patents. The defense of the National Corporation was that the Benthall Co.'s patent was impractical and inoperative and had been discarded after slight use, and that the National Corporation had improved and changed the machine so that it became a machine which was practical and operative. The United States District Court at Norfolk, Va., having jurisdiction of the case, held the National Corporation's machine to be an infringement of the Benthall patent. The court said that non-use of a machine would not affect the legal rights of the patentee to enjoy the monopoly given it by virtue of the patent. *(Benthall Machine Co. v. National Machine Corporation, 222 Fed. 931.)*

Negligent Operation of Machinery

(Pennsylvania) Where, in an employe's action for injuries from being caught in a moving sprocket of a machine which plaintiff was adjusting, it appeared that the guard had been removed from the sprocket to change the machinery, and that before making the adjustment plaintiff had been ordered by the foreman to replace the guard, but had failed to do so, plaintiff was guilty of contributory negligence barring his right to recover. *(Peiper v. Reading Iron Co., 94 A. 745.)*

Defective Appliances

(Pennsylvania) Where, in an employe's action for injuries from the breaking of a machine, causing a load to fall and crush plaintiff's fingers, there was evidence that the broken link had not been properly welded, and that the imperfect welding would have been discovered by a proper inspection, the court properly affirmed a point to the effect that such a defect was a structural defect of which the employer is presumed to have knowledge. *(Case v. Lehigh Coal & Navigation Co., 94 A 253.)*

Merger of Corporations

(New Jersey) Under New Jersey corporation laws providing that any two corporations organized under the laws of the state to carry on any kind of business of the same or a similar nature may merge into a single corporation, which may be either one of them, or into a new corporation, a corporation whose charter authorized it to construct bridges, buildings, machinery, electric works, waterworks, canals, and other means of transportation, and to sell or otherwise dispose of or to maintain and operate the same, and whose specified objects and powers were declared to be in no way limited by reference to or inference from the terms of any other clause of the certificate, in some of its objects was not similar to any of those of a corporation chartered with the primary object of manufacturing, selling, leasing, and dealing in machinery of every kind, and especially shoe machinery, so that the two could not be merged. *(Copeland v. United Shoe Machinery Co., 94 A. 405.)*

Remedy of Sellers

(Connecticut) Where a contract for the sale of a machine contained a written promise by the buyer to pay therefor within 30 days, and a printed clause reserving title in the seller until payment was made, and providing that in case of rejection the property should be returned within 30 days or the objection thereto would be waived, the printed clause, when construed in harmony with the buyer's promise to pay, gives him only the right to reject for good cause, not to reject at will. A contract of sale which provides that in case of failure to pay in installments the whole contract price shall become due and payable and the seller shall have the right to retake the property and retain it or resell it, gives the seller an option to retake the property or to recover the price. *(United Machinery Co. v. Metzel & Sons, 94 A 355.)*

The Return of Defective Machinery

(Kentucky) If a purchaser of machinery, upon ascertaining that it fails to fulfill the conditions of the contract as to amount and quality of work it can turn out, wishes to cancel the contract or hold the seller liable for breach thereof, he must, within a reasonable time, offer to return the machinery and rescind the contract.

The time within which a purchaser of machinery found to be defective must return it and rescind the contract of sale may be extended by promises on the part of the seller to repair, and by its insistence that the purchaser keep the machinery and give him an opportunity to make it do the agreed work. What is a reasonable time for a purchaser of machinery to return it and rescind the contract for defects in the machinery depends upon the facts of the particular case. *(Meek Coal Co. v. George D. Whitcomb Co., 176 S. W. 354.)*

Unguarded Machinery

(Missouri) The operator of a wood-working machine, while attempting to adjust a defective and rapidly revolving drill, reached around the saw on the same shaft in order to pick up a screwdriver with which to throw off the belt. His hand was caught by the saw, which was not guarded as required by Kansas law. Held, that plaintiff was not guilty of contributory negligence as a matter of law, either by placing the screwdriver where he did, or in attempting to adjust the drill without stopping the machinery. *(Hughes v. D. E. Marshall Contracting & Mfg. Co., 176 S. W. 534.)*

WHAT'S THE MATTER WITH THE FOUNDRIES?

BY J P BROPHY*

Undoubtedly, thousands of people who have more or less to do with foundries will claim that there is nothing the matter with them, but from experience—and some of it really costly—I must say that there is much the matter with many of the foundries in this country at this time, and there has been right along. I maintain that as far as the quality of castings is concerned the foundries are not one particle better than they were twenty or more years ago. There is just as much uncertainty now as to what you might expect from your patterns from so-called first-class foundries as there was a quarter of a century ago. Many will perhaps take exception to this positive statement, but it is based on bitter experience.

Poor castings are detrimental in two ways. The one who receives them and does more or less work on them perhaps discovers in the last operation that there is a blow-hole or a dirty spot in some section, and the consequence is that he generally loses the labor expended. More than this, in many instances it sets back the producing power of his plant, because a number of inferior castings coming in quantities, of which you perhaps have none in stock, means that all the operations of setting up and machining are wasted.

The foundry likewise suffers a loss of the castings, and in some cases inferior castings are charged back to them, and any one would think that the foundries would try to find out, scientifically or otherwise, what is the matter and why so many poor castings are returned to them every day.

All lines of manufacturing have advanced wonderfully until at present in many large plants the loss from poor work is a minimum. Much has been written about the great strides foundries have made in producing castings. Nevertheless, they are slow to grasp or slow to be able to improve to the extent of being able to anywhere nearly guarantee that if you order fifty castings from one pound to one thousand pounds they will be practically all the same and usable.

The foundry business seems to be a somewhat mysterious proposition. The pattern is placed in the sand, all the work performed to complete the mold, the iron is poured in and no one knows for a certainty what the result will be. I don't pretend by any means to understand the foundry business, but there is negligence somewhere that certainly should be rectified.

The producing of small castings by the use of machinery and otherwise has perhaps reached the maximum in the foundry, but when it comes to quality, uncertainty prevails in all directions. If it is because of inferior sand being used or inferior ramming of the mold, or inferior venting or anything inferior in the labor in preparing the flask for the metal to be poured, why is it that with all the experience the foundrymen have had for a generation they have not been able to discover where the trouble lies and are not able to say for a certainty what the results are going to be?

When returning inferior castings to the foundries, either before or after work has been performed on them, they take it as a matter of course and seem to expect a considerable portion of their castings to be returned. If you send in a complaint, there is a possibility that the foundry foreman will visit you and talk matters over, but from past experience you feel almost certain that all this talk is a waste of time, for the reason that they do not seem to be able to improve in producing their product.

If a pattern is sent to a foundry today (and it makes no difference what foundry it might be) which is cored considerably, you can feel quite certain that the cores will either be set in the wrong position or something will happen to this casting—perhaps two or three times—before you finally obtain the results that can be obtained after a great many have been made. In any other line of business it is not expected that anything like this will occur. For this reason it might well be asked: "What's the matter with the foundries?"

Many large foundries would be ahead thousands of dollars a year in net earnings if the castings they produced came anywhere near a fair percentage in soundness. It is a common occurrence to find a large blow-hole hidden in a casting that does not show up in the manufacturing, but under strains after it has left your plant and reached the customer breakage takes place and you are condemned, whereas it is impossible for you to discover this particular blow-hole or weakness in your own plant.

Is it possible that the foundries are careless in mixing their iron before placing it in their cupola? Is it not possible that the iron is not brought to the proper temperature before being poured? Is it not possible that the gates where the metal travels to its destination are in the wrong position—too small or too large—is there something wrong with this part of the foundry business?

Many foundries are exceptionally negligent in their mixture of iron—there is no question about this. Many times you pay for what you don't get. Cast iron should be of a standard tensile strength, at least in the machine tool business, and when 20 per cent steel is used there should be a standard for this also. The writer has known of cases where 20 per cent steel was asked for, and in analyzing no steel could be discovered at all, but an inferior grade of ordinary cast iron. This shows that some foundries are exceptionally careless, or else wilfully accept money that doesn't belong to them. To be anywhere nearly sure of what you are receiving, it seems necessary to analyze each lot of castings to determine their quality.

Up to this point this talk has been on ordinary gray iron. The same might be said of steel castings. No dependence can be placed on steel castings. You never know what you are getting. The writer has attempted to use steel castings for cams and spur gears and obtained these castings from various foundries. In the rough they look fairly good, but after being machined they show up their weaknesses. There is no question but that the steel casting business is just as far behind as it was twenty years ago.

We read considerable about this line of business also, and according to articles about same it has reached the highest pinnacle of perfection. This argument might be considered O. K. if you used rough castings and the patterns were large enough to stand for weaknesses here and there owing to inferior metal, but when the casting must be machined then you will discover that the steel casting business seems to be only in its infancy, and that the producers are not thoroughly posted as to what they are capable of doing. This may appear to be a somewhat severe criticism but there is no guesswork on the part of the writer. Experience has been the teacher in this case.

Consider malleable iron also. We do not seem to have any improvement on this line of goods. It seems to be made in the same old way. There is no telling, for a certainty, what you are going to receive. If tested for tensile strength you will discover that it varies in all directions. I have known of many cases where the foundries wanted greater length of time to produce castings. They explained that they required to dry their molds out thoroughly, but even after this was done the results were just the same as explained in this article—a real game of chance.

Another source of considerable trouble is the fact that you never know when you have a fair size casting made weighing say 1000 to 1500 pounds, and your pattern is [illegible] inch thick, whether your casting will be 1/2 inch or 3/4 inch thick. You certainly cannot depend upon the foundries to produce castings of the same thickness as your patterns. This is either carelessness in rapping the pattern before removing it from the mold, or in giving you over-weight castings. Many times when a casting should actually weigh 1000 pounds it will come 1200 or 1300 pounds. This is inexcusable, but it seems almost impossible to defend yourself against it.

Regardless of the kind of castings being made, large or small, the metal in many cases is poured from one cupola, and you take what you get and let it go at that. In the writer's estimation it seems that any good foundry should have a number of cupolas with various mixtures to suit the requirements of the various castings they are producing.

* Vice-president and general manager, Cleveland Automatic Machine Co., Cleveland, Ohio.

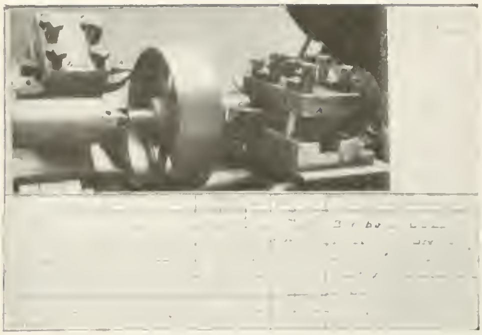


Fig. 1. Shop Operation Sheet for rough-turning a Pulley

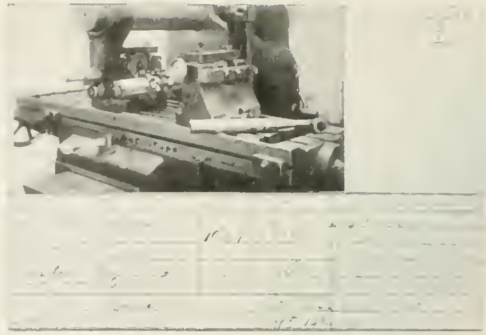


Fig. 2. Shop Operation Sheet for Milling Machine Job

PHOTOGRAPHIC SHOP OPERATION SHEETS

The accompanying illustrations show a method for making shop operation sheets used by the Jones & Lamson Machine Co., Springfield, Vt. Figs. 1 and 2 show the photographs and instructions mounted on cardboard, as given to the machine operator, while Figs. 3 and 4 show the shop operation sheets or records retained by the efficiency department and filed away for future reference. As shown, the machine operator is given a photograph of the proposed method of setting up the machine for a given job, and on the same sheet instructions are given as to the speed and feed to use and the time required for the job. The object of the photograph is to record accurately the tools to be used, how they are used, what clamps and holding-down screws are used, and to show clearly all special arbors and fixtures. The photograph is superior to a drawing, especially when used by more or less unskilled operators. In general, it is far easier for the shop man to set up work in a machine from a photograph than from a drawing.

In order to determine the proper speeds and feeds and the time required, the work is first done in a special department, which determines what methods are to be used. The job is started at a speed which experience has shown to be as rapid as possible for the work in hand. Ten pieces are made and the operations timed. No time of less than a second is considered, and usually on a job of several minutes duration, the time is taken to the nearest multiple of five seconds. Apart from this brief explanation, the shop operation sheets speak for themselves. Sometimes reference letters are marked with ink on the photographs, in order to more clearly indicate the requirements to the operator. The illustrations shown have been furnished through the courtesy of F. E. Lockwood, in charge of the efficiency department of the Jones & Lamson Machine Co.

* * *

Elimination of waste and saving labor are cardinal principles of efficiency; they make for greater comfort and higher standards of living for all. Some of our institutions have applied the principle of eliminating waste and saving with remarkable results. A well-known Cleveland hotel provides ice water on draft in the guest rooms besides hot and cold water. The annoyance of summoning a bell-boy to fetch it is avoided. An automatic switch extinguishes the electric light when a guest leaves his room, the action of locking the door on the outside actuating the switch. The same action is reversed when the door is unlocked, the lights going on as the door is opened. Thus the guest has the comfort of going into a fully lighted room but the management is not burdened by the waste of electricity uselessly consumed while the guest is not occupying his room.

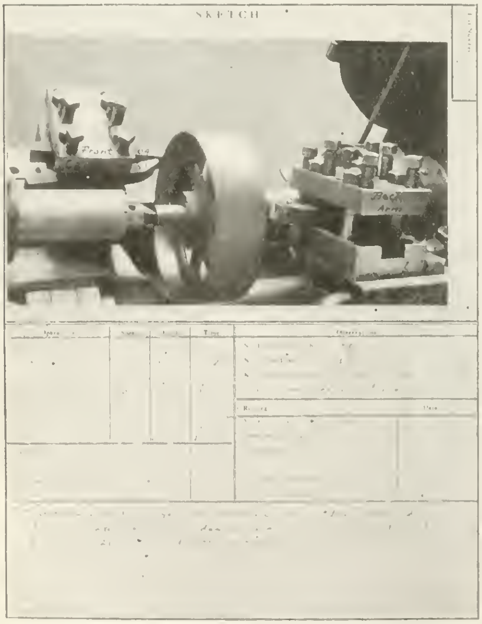


Fig. 3. Efficiency Department Record of Operation Sheet Fig. 1

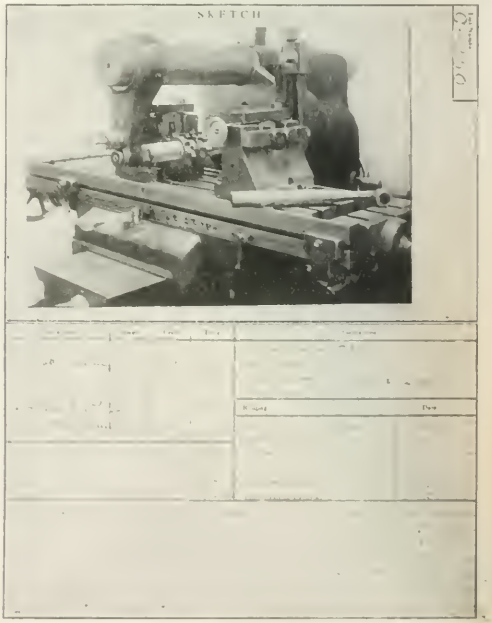


Fig. 4. Record preserved of Operation in Fig. 2

CHECKING DRAWINGS—HOW AND WHY

BY CHARLES F. SCRIBNER*

When the activity of your drafting room has increased so that you employ ten times as many men as heretofore, unless your chief draftsman has organized his department in a systematic manner for the handling of the increased volume of work, his hair will soon turn grey with worry and deep furrows will line his once placid brow. If his system of checking has been such that each man has been required to check his own work, the new order of things will mean not ten times the previous number of errors—in some cases it will mean ten times ten. It is a hard matter to make such an enlargement to a drafting room without getting a certain percentage of unskilled and careless men, especially when all your competitors are making the same change.

Under these conditions a factory that was recently called upon to make such additions to its normally small force of men in the drafting room, decided to adopt a system of checking all drawings that would eliminate, as far as possible, the chances of errors being passed along to the factory; and that would enable the responsibility for errors found in the shop to be placed upon the proper employes. Several men who had been employed for some time in the drafting room were chosen to act as checkers, and were supplied with blueprint copies of the following checking list. This list had been typed on thin bond paper, using a sheet of carbon paper reversed against its back, so that good clear prints were obtained. The checkers were also supplied with complete lists of "standards," as were all draftsmen, and they had access to the pattern index files so that stock patterns would be used wherever possible. In checking, items were taken up according to number, so as to avoid skipping any item which might later give trouble. The checking list follows:

Standard Instruction Sheet No. 84.

March 22, 1915.

From: Engineer-In-Charge,
To: Checkers, Drafting Room.
Subject: CHECKING DRAWINGS.

Beginning today, all drawings will be checked for errors in accordance with the following list. Check the drawing for Item 1, then for Item 2, etc. Don't skip around—by so doing, you may make a costly mistake.

1. Is the size of sheet correct?
2. Is the title, scale, drawing number, model, number required, etc., correctly given?
3. Is there a sufficient number of views to correctly show the piece?
4. Are all views detailed in third-angle projection?
5. Are full and dotted lines shown in their proper places?
6. Are dimensions properly located?
7. Are views shown correctly as to right and left hand? Are even numbers used for right-hand patterns and odd numbers for left-hand?
8. Is the design correct in principle?
9. Is it what is needed and can nothing better be suggested? Can it be made cheaper?
10. Is the drawing correct to scale, and are those dimensions not scaling correctly underlined?
11. Are arrow-heads neatly and properly shown?
12. Is all necessary information given, and are all dimensions "tied up"?
13. Are all dimensions given in decimals, except where fractions are necessary?
14. Are tapped holes shown correctly?
15. Are "f" marks shown where needed?
16. Is the proper draft provided for all patterns and forging dies?
17. Are all corners provided with rounds or fillets?
18. Is a note given in regard to counterboring or other finish for screw heads?
19. Are all bosses large enough?
20. Are all parts of proper strength?
21. Are detail notes provided regarding heat-treatment, polishing, electro-plating, etc.? Are such notes correct?
22. Are parts marked "grind," where needed?
23. Are all given dimensions correctly figured?
24. Will the piece properly fit parts with which it is to be assembled, and will it work without interference?
25. Is clearance provided for wrenches and screw-drivers?
26. Is there clearance provided to allow for all variations and tolerances?
27. Are proper oil-holes provided, and is there a sufficient number of them?
28. Are all parts provided with a sufficient number of threads of proper pitch for the material used?
29. Is the allowance for driving and running fits expressed in thousandths of an inch, and are the parts marked with their plus and minus limits?
30. Are developed lengths of parts shown?
31. Are all parts "necked" to provide clearance for the wheel when grinding?
32. Is provision made on all drill jigs, fixtures, etc., for the removal of burrs and chips?
33. Constructive changes: Note position, relation, diameter, length, thickness, width and bearing on prior effective changes.
34. Has proper consideration been given to the subsequent attachment of other parts?
35. Is the material cross-sectioned according to standards?
36. Has the following information been given regarding springs: Temper, gage number and decimal diameter of wire, number of coils, initial tension, inside diameter and length in compression?
37. Is it shown on dies where they are to be ground?
38. Is relief provided on the corners in casement fits?
39. Is clearance provided for the leaf swing on jigs and fixtures?
40. Can the bosses shown be drawn from the sand?
41. If two dowel pins are used, is one shorter than the other so that one can enter before the other?
42. Are all male fillets from 1/16 to 1 inch provided with a plus radius of 1/16 inch and from 1 to 2 inches with a plus radius of 1/8 inch?
43. Are you willing to stand responsible for any errors noted above, if this drawing is sent into the factory?
44. Have you signed this drawing as "checked?"

* Address: P. O. Box 556, Hartford, Conn.

• • •

THE SWEDISH ENGINEERING CONVENTION IN THE UNITED STATES

The first Swedish Engineering Convention in the United States was held at the La Salle Hotel, Chicago, September 9, 10, and 11, and was attended by over two hundred engineers of Swedish extraction, both from Sweden and from all parts of the United States. Owing to the disturbed conditions in Europe, the delegation from Sweden was very much smaller than had been originally expected, only fifteen engineers from that country having braved the present dangers of the sea to come to the United States. Papers were read by J. Körner, of Vesteras, Sweden, on "The Industries of Sweden and their Forms of Organization;" by F. Sandelin, of Sandviken, Sweden, on "The Natural Resources and Future Industrial Possibilities of Sweden;" by A. G. Witting, of the Indiana Steel Co., Gary, Ind., on "The Uses of the By-products of the Steel Industry;" and by A. Engblom, of Shelton, Conn., on "Scientific Management and its Practical Applications." Excursions were made to the Gary Steel Works, the Pullman Car Works, the Western Electric Co., and the Union Stock Yards. The convention was very successful as regards the exchange of ideas of an engineering nature and also from a social point of view in that it brought together a great number of engineers who had known each other in the past years but who have been scattered all over the United States. It was proposed to make the convention organization a permanent one and to hold similar conventions at certain intervals in the future, alternately in Sweden and in the United States. The holding of a convention of this kind, at this time, is especially significant, as the United States and Sweden are at present the only two nations of any industrial importance that are at peace with each other and the rest of the world.

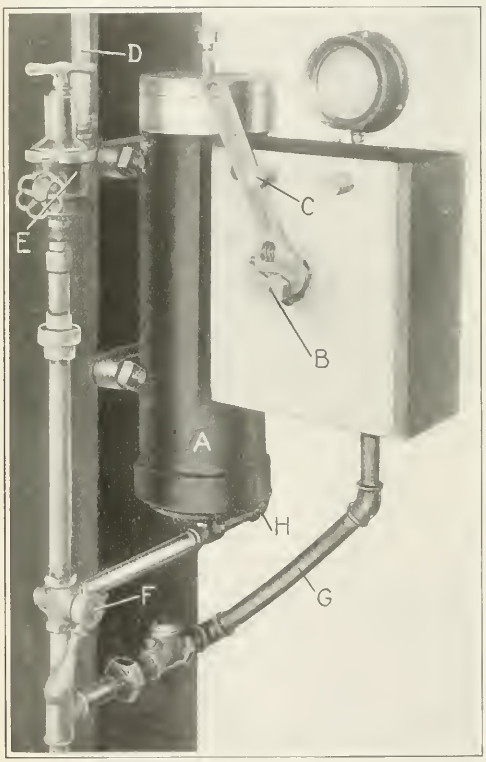
• • •

The first calculating machine invented was made by Pascal, the eminent French mathematician, about 1641. He was not only one of the foremost mathematicians in his day but also excelled in mechanics. The next notable production in this field was made by Leibnitz, about 1671. He made several multiplying and dividing machines, and one constructed about 1700 is still in existence. In some of its features, this machine resembled the Thomas machine which was built and marketed one hundred and twenty years later, improved types of which are still in use.

A HYDRAULIC WRENCH TESTING DEVICE

At the factory of the Crescent Tool Co., Jamestown, N. Y., manufacturer of wrenches and similar tools, there is in operation an apparatus for wrench testing that is of interest because few tool manufacturers subject wrenches to an actual gage test before being sent into service. This apparatus is shown in the accompanying illustration, and the principle upon which it operates includes the engaging of the wrench jaws by a central stud that is turned by hydraulic pressure until a predetermined pressure has been applied to the wrench.

The apparatus is mounted upon a post, and consists of a cast-iron cylinder *A*, within which is a piston carrying a rack that meshes with a spur gear keyed to stud *B* over which the wrench jaws fit. As the handle of the wrench is prevented from turning through contact with a pin *C*, it



How "Crescent" Wrenches are tested

is obvious that the continued rising of the piston and consequent turning of stud *B* places the same strain upon the wrench that it would receive in actual service. The piston is hydraulically operated, and the supply pipe through which water pressure enters is shown at *D*. The water passes through a reducing valve *E*, that can be set to different pressures for the different sized wrenches, so that only enough pressure will be turned on to test the particular type of wrench that is going through. At *F* is a three-way valve. When this valve is open the pressure through the supply pipe comes down and around into the cylinder, forces the piston up, and through the rack and pinion, causes the stud to turn and thus places a strain on the wrench. Drain pipe *H* allows the water in the cylinder to be let out after the testing action has taken place and the plunger is free to return to its normal position. A continuation of the supply pipe turns the corner at *G* and runs up to the pressure gage shown above the testing block. This indicates at all times the amount of pressure being applied to the wrench. Valve *E* may be set so that this pressure will not exceed a predetermined amount. In drain pipe *G* is a check valve whose function it is to keep the back pressure from entering the apparatus.

With this apparatus the Crescent Tool Co. is enabled to test various sized wrenches with a surety that the tools that leave the factory have passed a test as severe as any they will receive in service. C. L. L.

* * *

GIVE AND TAKE

Modern manufacturing methods have in many cases reduced the cost of products so low that further reductions seem hardly worth striving for, unless corresponding reductions in selling costs can be effected. The great problem of the day is to secure more efficient means of distribution. Improved machinery is offered for sale to all alike, and concerns in competing lines using standard machinery are brought to an even footing as regards facilities for manufacturing, provided their capital is sufficient to provide for the equipment needs. Plant management, first-class material and selling efficiency are what count in the game of competition.

The modern manager is keenly alive to the importance of keeping up to date by reading the technical journals in his field, and some subscribe to these publications for their foremen. In view of this eager desire for knowledge and keen appreciation of that gained from other sources it seems unwisely selfish to maintain a semi-closed shop policy, but many do. An editor visiting one of these plants may be courteously received and shown through, but he must promise not to print anything about what he saw. Knowledge is broadening and the technical editor gladly avails himself of every opportunity to see what is going on in all shops within his field, but he also wishes to make such excursions profitable to the larger circle of his readers.

The funny part is that visiting courtesies are often extended to men, who, unknown to the proprietor, have connections with competitors. They get the details in a more or less accurate way and use them to their own advantage, when their own factory practice is behind the times. The ostrich who hides his head in the sand, thinking thereby he is safe from annoyance, is not more self-deceived than many of the smartest men acting in the capacities of general managers of industrial plants.

* * *

CHEMICAL ENGINEERING DEPARTMENT OF COLUMBIA UNIVERSITY

Columbia University has established a separate department of chemical engineering upon the same plane of importance as mining, civil, electrical and mechanical engineering in recognition of the tremendous development of our chemical industries that is bound to take place because of the European war. The sudden demand for products previously secured from Europe has greatly stimulated activity among chemical manufacturers. In many cases, it is necessary first to develop the raw material supplies, as for example in the manufacture of coal tar dyes, where large quantities of benzol, phenol, toluol, etc. are required. The demand for these materials is being met by the installation of large plants for the recovery from coke oven gases of these heretofore waste products. Such concerns as the Lackawanna Steel Co., United States Steel Co. and other large coke producers, both in the United States and Canada, are now recovering these products. Similar activity has developed in other fields, the large demand for explosives having enormously increased the production of sulphuric and nitric acids. Entirely aside from these abnormal developments, forced upon us by the war, it should be noted that important chemical processes are being established in other fields. Recently, two enormous installations, one at the Anaconda Smelter and another at Chuquicamata, Chile, have been started for the extraction of copper by chemical methods. Plants for the production of sulphuric acid from the roasting of sulphide ores have also been established.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

WHAT IS VANADIUM STEEL?

Some time ago a concern in which the writer is interested placed an order with a steel foundry located somewhat less than 100 miles from the Chicago postoffice for the following:

> Six tray lips, pattern A-1044. These lips are to be of vanadium cast steel 0.35 to 0.45 carbon, annealed. Care should be taken that the metal in the cutting edges is solid and of the best quality.

These castings were shipped direct to a coal dock where they were to be used. Some of them broke within a few hours and all within a comparatively short time after being put into service, and did not last as long as some ordinary open-hearth steel tray lips which had previously been used. Payment of the bills was refused and the steel foundry brought suit in which the following testimony was developed.

The superintendent of the steel foundry testified that 6½ pounds vanadium (alloy about one-third pure) was used in each pot of 1600 pounds steel, which would amount to 0.15 to 0.16 per cent (calculation shows 0.1354 per cent) and in reply to a question regarding standard vanadium stated that vanadium *put in* castings varies from 0.05 to 0.15 per cent—sometimes higher if it is ordered higher; also that the amount of ferro-vanadium lost in the melt varies a good deal with the temperature of the steel, from *nothing up to one-half of one per cent.*

A chemist testifying for the defendant stated that he found the vanadium content of the castings, defendant's exhibits 1 and 2, to be 0.03 and 0.04 per cent; carbon content 0.375 and 0.384 per cent.

A metallurgist of twenty-eight years active experience, the last six years devoted especially to vanadium alloys, testifying for the defendant, stated that if 6½ pounds of ferro-vanadium (33 1/3 per cent vanadium) were added to 1600 pounds of steel, it would be equivalent in round numbers to 0.14 per cent vanadium, and that there would be at least 20 per cent and possibly 30 per cent of that lost. The result would be about 0.10 per cent in round numbers of vanadium remaining in the steel. He further stated *that there is a recognized standard vanadium steel*, containing not less than 0.15 per cent vanadium, and that castings containing only 0.03 and 0.04 per cent would not be castings of standard vanadium steel, and that the two castings—defendant's exhibits 1 and 2—showed numerous gas cavities and blow-holes.

Three other witnesses testifying for the defendant stated that after the castings were broken they observed numerous holes, variously designated by them as air-holes, blow-holes, sand-holes, etc., and specified various sizes up to an inch—a little larger—a little smaller.

The attorney for the plaintiff stated verbally, "When you specified vanadium as you did in the contract, *you left it entirely to us*, to our judgment, as to the amount of vanadium to be put in," and, in his brief stated, "We submit that if there is a 'standard,' under the contract the plaintiff was not required to furnish it, and that if it was required to do so, it did furnish steel substantially complying with the alleged standard specifications as disclosed by the record." (R. W. Hunt & Co.'s analysis as testified to above shows vanadium 0.03 to 0.04 per cent.)

The Encyclopaedia Britannica, Vol. 14, page 812 says, "Vanadium in small quantities (0.15 or 0.20 per cent) is said to improve steel greatly, especially in increasing its resistance to shock and to oft-repeated stresses."

Notwithstanding the above testimony as to vanadium content and defects in castings, a decision was given for the plaintiff.

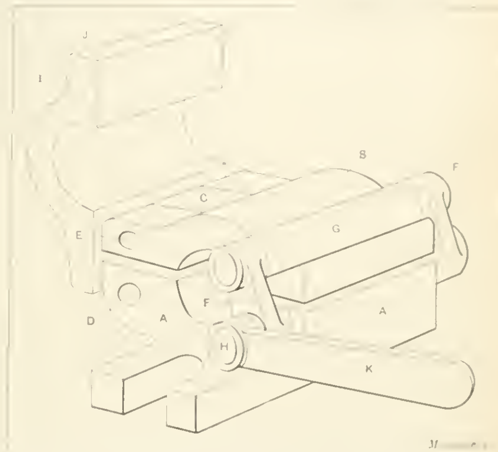
The question now comes up, which interests all purchasers of steel castings of special alloy or otherwise: "Is there a standard vanadium steel casting, and to what extent must full and complete specifications, chemical as well as physical, be given in a simple order when not covered by a term contract in which these elements are covered?"

Let the steel foundries come forward and declare themselves. Would all of them make the claim put forward by the attorney for the plaintiff in the above case, and would they, under the circumstances, claim that these were merchantable castings? What is the opinion of the trade on this subject?

Chicago, Ill. D. J. EVANS

ECONOMICAL FIXTURE DESIGN

When laying out jigs or fixtures for handling a variety of similar classes of work, it is economical to design the parts in such a way that many of them can be made in duplicate. This allows the same patterns to be employed and enables the machining operations to be conducted more efficiently.

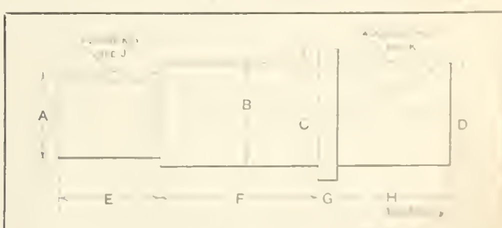


Design of Standard Fixture for Use in milling Keyseats in Spindles of the Dimensions shown in the Table

For example, let us assume that the spindle shown at the top of the accompanying table is to be made in three standard sizes, the dimensions of the different sizes being given in the table. In designing a spindle-clamping fixture for holding this work for milling the keyways, a little study would enable many of the parts of the fixture to be standardized, thus reducing the cost of producing them to a minimum.

A fixture that may be used for holding the spindle for milling the keyways is shown in the accompanying illustration.

DIMENSIONS OF STUD USED IN KEYSEAT MILLING FIXTURE



A	B	C	D	E	F	G	H	J	K
1	1¼	[illegible]	[illegible]	1¼	2¼	[illegible]	[illegible]	[illegible]	[illegible]
1¼	[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]	2	[illegible]	[illegible]
[illegible]	[illegible]	2¼	[illegible]	[illegible]	[illegible]	[illegible]	2¼	[illegible]	[illegible]

Machinery

This may be briefly described as follows: The base *A* of the fixture, which is bolted to the milling machine table, has a cap *B* connected to it by means of a link *C* and bearing pins *D* and *E*, the arrangement being such that the cap *B* may be swung up to provide for removing finished work from the fixture. The ends of the pin *H* are eccentric to that portion of the pin which has a bearing in the base of the fixture, the amount of eccentricity being sufficient to allow the clamping bar *G* to swing out of the groove *I* and over the curved section *J* as the handle *K* is raised to a vertical position. This allows the cap *B* to be raised to the position shown by the dotted lines, to provide for setting up the work.

To make this fixture so that it will accommodate the three sizes of spindles dimensioned in the table, to enable the parts to be manufactured in duplicate and simplify the pattern work, is what may properly be termed "economical tool desigu." It has been found possible to make in duplicate the link *C*, link pins *D* and *E*, links *F*, clamping bar *G*, eccentric *H*, and handle *K*. In laying out the base *A* and cap *B*, the length of the bearings should not be more than 2 1/4 inches, which is the minimum dimension *F* in the table. The diameter of the bore for the three sizes of spindles would be 1 1/4, 1 9/16 and 1 7/8 inch, respectively. This requires that the thickness of the metal shall be sufficient to provide strength for holding the spindle of 1 7/8 inch diameter, and also that the core shall be small enough for the spindle of 1 1/4 inch diameter. Care given to these details will not only save money in making the fixtures, but it will also result in a saving of the space required for storing and listing duplicate tool patterns.

Brookline, Mass. ARTHUR B. BABBITT

A USE FOR AN OLD SLIDE-RULE

Many men have an old slide-rule that is so worn or warped that it is no longer useful for its original purpose. In almost every drafting room there are one or more such slide-rules knocking about. The scales on these rules can be used to excellent advantage as logarithmic scales for use in making graphical analysis of problems in machine design, and for many other purposes. This is done by simply taking the rule apart and beveling the edges of the wood under the scales, as shown in Fig. 1. With an ordinary Mannheim slide-rule the writer prefers to bevel the under side of the *A* scale, where large work is to be handled; while in the case of small diagrams, the *C* scale is very satisfactory. As these rules are generally made of straight grained wood, it is an easy matter to bevel the edges with a small plane or even with a pocket knife.

Another use that these scales can often be put to is in preparing tables or diagrams of weights of certain parts of complete machines. An example is shown in Fig. 2, where one curve of a diagram of the weights of cast-iron pulleys of a given diameter and of various face widths, is presented. Of course, the complete diagram shows a large number of curves for pulleys of different diameters, but for the sake of simplifying the chart for reproduction, the curve for only one of these diameters is shown. In this case, it was desired to illustrate the weight of these pulleys within a small percentage of the actual weight, this percentage of error being the same for all sizes of pulleys. A table covering all sizes of pulleys which can be shown on such a chart would have filled several pages of a salesman's book, and such tables would have required a lot of time to calculate. By making a rough sketch of a pulley and calculating the necessary dimensions for the allowable stresses for each of four widths for each diameter, it was possible to draw curves through the four points so determined. The weights of the remaining twelve pulleys of each diameter could then be found on these curves, as accurately as the commercial practice requires.

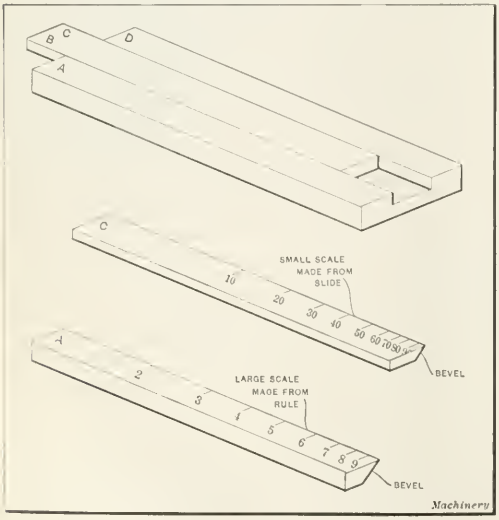


Fig. 1. Logarithmic Scales made from Worn-out Slide-rule

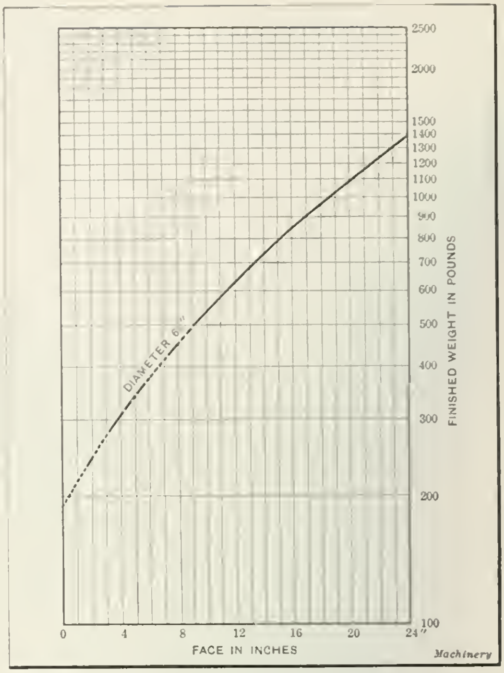


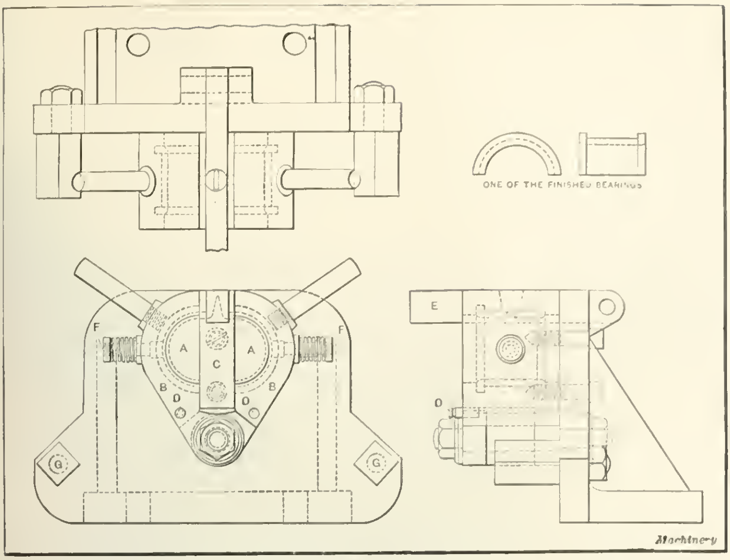
Fig. 2. An Example of Use of Logarithmic Scales shown in Fig. 1

Birmingham, Ala. FREDERICK W. SALMON

BABBITT BEARING MOLD

In the December and March numbers of MACHINERY, descriptions were published of molds for making babbitt bearing bushings. After reading these descriptions, the writer is inclined to believe that the mold which forms the subject of the present article is more efficient than either of the two previously described. The first cost is no greater and it appears that this mold could be operated more rapidly and that it would be longer lived.

Referring to the accompanying illustration, it will be seen that the main casting or frame consists of an angle block on which the cores or half-arbors *A* are mounted. The molds *B* are made of cast iron and are pivoted on a shoulder bolt at the bottom of the steel center piece *C*. The molds are operated by the handles at the top and are held against the center piece by a spring which extends across between the pins *D*. When the mold is open, this spring passes below the center of the hinge pin and serves to hold



Improved Type of Mold for Use in casting Babbitt Bearing Bushings, and One of the Finished Bushings

the two halves of the mold apart. The pouring is done through a hole in the center piece E which is hinged at the back of the angle block; and a tapered pouring hole connects with the molds through two small holes in the center piece C.

After the bushings have been poured, the center piece E is driven up with a light lead hammer, and in so doing cuts off the babbitt sprues extending into the holes in the center piece C. At the same time this jars the bushings loose. The piece of babbitt which is left in the center piece E drops out due to the tapered opening. The mold is then opened by means of the two handles, and the ejecting pins F strike the posts G. The movement of the ejecting pins is limited by collars on the stems, being just sufficient to force the bushings out of the molds. There is, of course, a small projection of babbitt left on one side of each bushing, but this is easily removed on the disk grinder or by filing. When the mold is again closed, the springs on the ejector pins push them back to their proper positions. When the mold is open, the halves are in a nearly horizontal position so that they are easily inspected or cleaned. The entire apparatus is bolted to a bench when in use.

D. S. Mann

SHALL WE USE WIDE OR NARROW GUIDES?

The accompanying illustration shows the saddle of a machine tool sliding on the guiding surfaces S and propelled by a force F which overcomes the resistance R due to the tool carried on the saddle, etc. To simplify the following discussion, the propelling force F and the external resistance R have both been shown in a plane passing through the center line of the guiding surfaces S. Assuming the surfaces T to be frictionless and that the normal pressure N is concentrated at the ends of the saddle, we have:

$$Nf = G$$

where f = coefficient of friction;

G = frictional resistance at the ends of the saddle where they slide upon the surfaces S.

The total moment M about the line of action of the propelling force F due to the resistance overcome is as follows:

$$M = NfA + NfD + RB \qquad (1)$$

In order to have the mechanism in equilibrium, the moment of the reaction of the guiding surfaces S must equal M. Hence we have:

$$M = NL \qquad (2)$$

By equating Formulas (1) and (2) we obtain the following expression:

$$N = \frac{RB}{L - fA - fD} \qquad (3)$$

As the propelling force must equal the resistance overcome, we have:

$$F = R + 2Nf \qquad (4)$$

Solving Formula (4) for the value of N, we obtain:

$$N = \frac{F - R}{2f} \qquad (5)$$

Then by equating Formulas (3) and (5) we find the following value of F:

$$F = R + \frac{RB}{\dfrac{L}{2f} - \dfrac{A + D}{2}} \qquad (6)$$

By an inspection of the illustration we find that the distance C from the line of action of the force F to the center line between the guiding surfaces S has a value of $\dfrac{A + D}{2}$. Substituting this value in Equation (6), we have:

$$F = R + \frac{RB}{\dfrac{L}{2f} - C} \qquad (7)$$

$$F = R \left[1 + \frac{B}{\dfrac{L}{2f} - C} \right] \qquad (8)$$

By an inspection of Formula (8), bearing in mind that the surfaces T have been considered frictionless, and also that the inertia due to the weight of the saddle has been neglected, we reach the following conclusions: First, as the width of the guides does not enter into the equation, it does not affect the force required to propel the saddle over the guides. Second, other conditions being fixed, the value of the propelling force F is a minimum: (1) When the distance C is zero; (2) When the distance B is zero; (3) When the distance L is infinite; (4) When the value of f is zero. Third, other conditions being fixed, the value of the propelling force F is infinite, or in other words the guide is self-locking, when the distance C is equal to $L \div 2f$.

Kenmore, N. Y. Sherwood C. Bliss

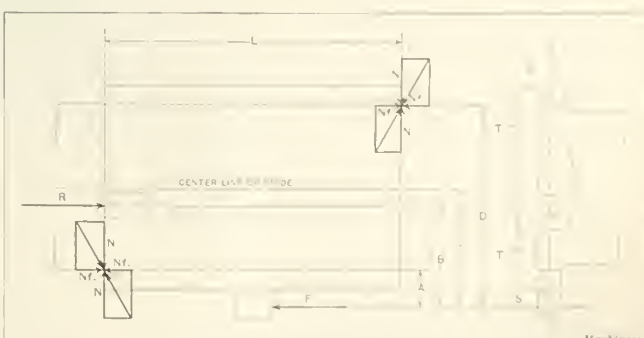


Diagram showing Principal Forces acting on Saddle and Guides of Machine Tool

DRAFTING-ROOM KINKS WHICH ELIMINATE SHOP ERRORS

A drawing is the best and clearest method of conveying an idea to a workman, but it is highly important for all drawings to be made so explicit that they cannot be misunderstood. It is the purpose of this article to explain one or two simple "kinks" which have been found useful in eliminating certain mistakes that are sometimes made by the mechanic who has not had a great deal of experience in "reading drawings."

Fig. 1 is a reproduction of a drawing of a small machine steel block on which the surfaces which are to be finished by grinding are marked with a letter G. As these surfaces are not too clearly indicated, it is not uncommon for the grinding operation to be omitted. Another somewhat common error on this job is for the man who orders the stock to use his own judgment when ordering material instead of following

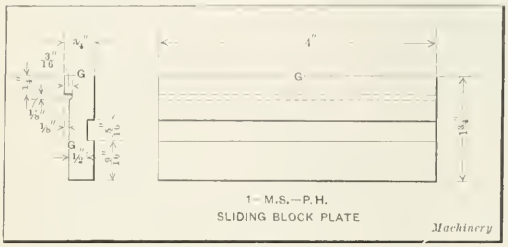


Fig. 1. Shop Drawing of a Machine Steel Block to be finished by Grinding

the drawing. Fig. 2 shows the same drawing in which these two items of the shop instructions are brought forcibly to the mechanic's attention by employing arrows as "tell-tales" which call attention to the notes concerning the method of finishing the work and the material to use.

Another source of annoyance for which there is no real necessity is the obscure way in which the identification numbers are often placed on drawings. As the number is the point looked for in locating a given drawing, it should be made quite conspicuous, and this is done in Figs. 3 and 4 by putting the number in the upper right-hand corner where it is readily seen. A similar source of trouble arises when the arrow points indicating the termination of dimension lines on drawings are so faint on blueprints that they are not readily discernible. Where the dimension lines are made continuous, as shown in Fig. 3, it is sometimes very hard to tell from what points they extend. By staggering them, as shown in Fig. 4, much of the trouble from this source is overcome.

F. Server

CONFLICT OF ONE-HALF-INCH THREAD PITCHES

Does it not seem strange that in these days of efficiency systems and all the rest of the modern requirements tending toward high-speed production, two pitches of thread for the half-inch diameter screw should be tolerated? The U. S. standard pitch for the half-inch screw is thirteen threads per

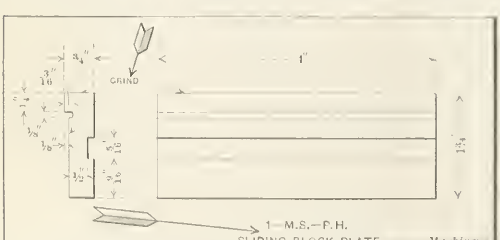


Fig. 2. Drawing of Part shown in Fig. 1 with Arrows to emphasize Material and Finish Notations

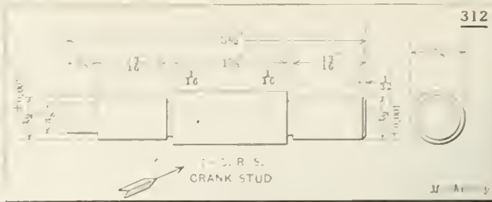


Fig. 3. Continuous Dimension Lines which sometimes give Trouble on Indistinct Blueprints

inch, and yet the market is supplied with screws having both twelve and thirteen threads per inch. In the shops where the writer is employed, the half-inch machine bolts and headless set-screws used have thirteen threads per inch while cap-screws and common set-screws have twelve threads. In case it is desired to change from one kind of set-screw to the other after a hole has been threaded, the thread has to be practically ruined to effect the change.

Other standard screw sizes show no such conflict of pitches, and there seems to be no good reason why there should be two pitches in common use for the half-inch screw. Of course, if the purchasing agent specifies when ordering that all bolts, cap-screws, studs, set-screws and nuts, should be of a certain pitch, he would probably be supplied with what he orders, and so confusion in that particular shop would be prevented. But what does the average purchasing agent know about such things? The proper ones to remedy the fault would seem to be the manufacturers; they should adhere to the established standard pitch for the half-inch screw as they do for all others. This matter would seem to be of sufficient importance to require attention and action—the sooner the better.

Los Angeles, Cal. John A. Wood.

[The condition described by Mr. Wood is one that has long existed, and it has caused endless trouble and confusion. It is true that thirteen threads to the inch is the Sellers or U. S. standard, but perhaps the founders of this standard made a mistake in using thirteen threads to the inch instead of twelve. The standard boiler thread is twelve threads per inch for all sizes, and of course a half-inch boiler stud or cap-screw is not an exception to the rule. Perhaps it would

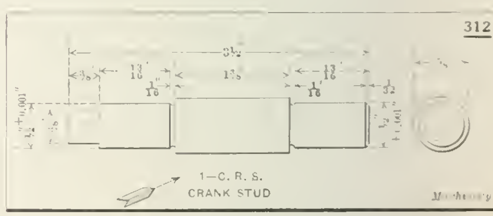


Fig. 4. By staggering Dimension Lines as shown in this Illustration, they stand out more clearly

have been wiser on the part of those who formulated the Sellers standard to have sacrificed an ideal number of threads in the case of the half-inch screw and made it the same as the boiler standard which had long been in use. Some of the largest manufacturers have clung to the half-inch twelve threads standard, notably the Westinghouse Air Brake Co. Notwithstanding the fact that the railroads generally have adopted the U. S. standard system, the Westinghouse Air Brake Co. has continued to make its half-inch studs and cap-screws with twelve threads per inch. The trouble incident to this double standard in railroad shops is typical of the condition generally existing where the two standards are used side by side.—Editor.]

* * *

Reinforced concrete is so rapidly coming into general use that figures relating to bridges of this construction are of unusual interest. The Walnut Lane Bridge has a span of 233 feet; at Grafton, New Zealand, there is a bridge with a span of 320 feet; over the Tiber, at Rome, 328 feet; and at Largweiz, Switzerland, 330 feet.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

NATIONAL-ACME SINGLE AND MULTIPLE DRILLING MACHINES

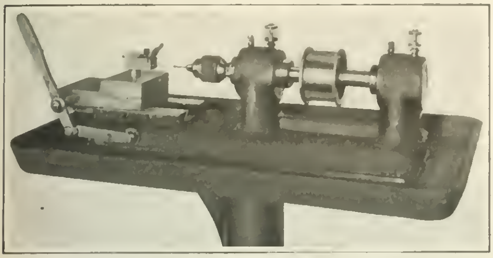


Fig. 1. National-Acme Style D Single-spindle Drilling Machine

The following description explains the essential features of a line of machines developed for performing such second operations as drilling, facing and counterboring on automatic screw machine product. It will be seen from the illustrations that the first two machines are of essentially the same design, with the exception that one has a single spindle while the other has two opposed spindles. These machines are for use in drilling one piece of work at a time. The third machine of the line is equipped with four spindles and a three-faced turret, so that four pieces of work can be drilled at a time; and the product can be removed from the fixtures and fresh blanks set up in place on two faces of the turret while the drilling operation is being performed on the work held in fixtures of the third turret face. The fourth machine is provided with six spindles and a compound slide on which the work-holding fixtures are carried. This slide enables either of the six alternate fixtures to be brought into line with the spindles so that the drilling operation can be performed on the work held in these six fixtures; and at the same time, the product can be removed from the other six fixtures and fresh blanks set up in place for the next drilling operation.

In the manufacture of screw machine parts in large quantities, the expeditious performance of such second operations as drilling, facing and counterboring is of vital importance. For handling such operations on the product after it has left the automatic screw machine, the National-Acme Mfg. Co., Cleveland, Ohio, has developed a complete line of single- and multiple-spindle drilling machines, the design of which includes some particularly interesting features. One of these machines of the single-spindle type, which is known as Style D, is shown in Fig. 1. It has a maximum capacity for driving drills up to 1/4 inch in diameter and is suitable for such work as light drilling, counterboring and the removal of burrs; and the rate of production is said to be very satisfactory. Reference to Fig. 1 will show that the machine is of simple construction. The driving shaft or drill spindle is carried by a ball thrust bearing which enables the spindle to run smoothly at the highest speeds required. The fixture mounted on the slide shown in the accompanying illustration is not part of the regular equipment; but was furnished to meet the requirements of a particular class of work. This slide is operated by a single lever, and the work is carried by a suitable fixture secured to the top face of the slide. An adjustable stop governs the depth to which the hole is drilled. The opposed-spindle drilling machine shown in Fig. 2 is constructed along the same lines as the single-spindle machine shown in Fig. 1. The capacity of this machine is also for drills up to 1/4 inch in diameter.

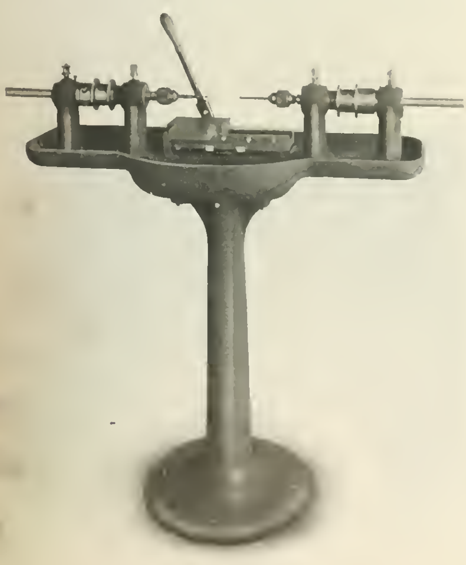


Fig. 2. National-Acme Style D Double-spindle Drilling Machine

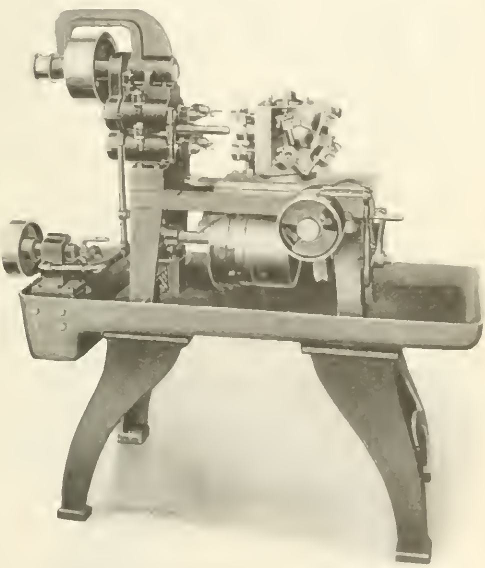


Fig. 3. National-Acme No. 4 Four-spindle Drilling Machine

The multiple-spindle drilling machine shown in Fig. 3 is semi-automatic in operation. It is known as the No. 4 multiple-spindle drilling machine and is equipped with four drilling spindles and a three-sided turret on which the work is carried. The capacity is for driving drills up to 3/16 inch in diameter when working in steel, and for drills up to 5/16 inch in diameter when working in brass. The machine is particularly adapted for the drilling of pins or holes in screws and similar parts, in addition to performing general drilling operations. In operation, it is customary to employ fixtures which provide for holding four pieces of work on each face of the turret, and in order to increase the rigidity of the turret as the work is fed forward to the drills, the turret is engaged by a pilot which enters the bushing in its face, thus maintaining precise alignment. As the turret

RATE OF PRODUCTION AND CHANGE-GEARS FOR NATIONAL-ACME NO. 4 FOUR-SPINDLE DRILLING MACHINE

Pieces Per Ten Hours	Gears on Worm Shaft		Gears on Stud		R.P. 10 hours of Cam-shaft
10035	50	41	26	35	2508
9265	53	41	32	44	2316
8720	53	41	26	38	2180
8440	50	35	41	56	2110
7850	50	35	32	47	1962
7600	50	35	29	44	1900
7310	50	35	26	41	1828
6965	50	32	35	53	1741
6710	53	35	29	47	1678
6230	50	32	26	44	1557
5770	50	29	32	53	1412
5285	50	29	26	47	1321
4685	50	26	29	53	1171
4185	53	26	29	56	1046
3945	56	26	32	62	996
3760	56	26	29	59	939
3575	59	26	32	65	893
3395	59	26	29	62	848
3080	62	26	29	65	770
2810	65	26	29	68	702
2570	68	26	29	71	642
2210	71	26	26	71	552
1880	71	24	24	71	470

Machinery

slide is drawn back, the turret is automatically indexed through one-third revolution, after which it is once more advanced to drill four more holes in the work. While the drilling is being done on the work clamped to the first face of the turret, the operator removes the finished product on the second face and sets up fresh blanks in the fixture carried by the third face of the turret. It will be evident from this description that the operation of the machine is quite rapid.

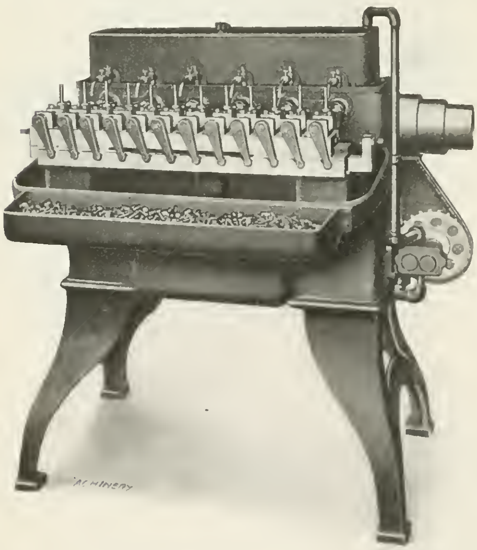


Fig. 4. National-Acme Six-spindle Bolt Drilling Machine

The drive is provided by two main belts, one of which drives the drill spindles and provides power for operating the oil pump by means of an auxiliary belt. The second main belt provides power for traversing the triangular work-turret to and from the spindles, the movement being effected by means of cams; and this belt also provides power for indexing and locking the turret for successive drilling operations. Change-gears, which are applied similarly to those on the regular National-Acme multiple-spindle automatic screw machines, are provided for varying the cutting speeds; and the cam-shafts are automatically accelerated during the idle motion by means of an intermittent drive. The approximate productive capacity of this machine and the proper gears to use under different operating conditions are given in the accompanying table. The figures showing production are only approximate, but will serve as a guide when calculating the maximum output which can be expected under various working conditions. The saving of time resulting from the employment of the three-sided work-turret with which this machine is equipped has been found to materially increase the rate of production on certain classes of work as compared with the output obtained from machines where production stops while removing the finished product and setting up fresh blanks. On certain classes of work one man can easily look after two of these National-Acme multiple-spindle drilling machines.

Fig. 4 shows a general view, and Fig. 5 a close view, of the mechanism of a drilling machine which differs considerably from the machines shown in Figs. 1, 2 and 3. This machine is designed for use in drilling transverse holes in six bolts

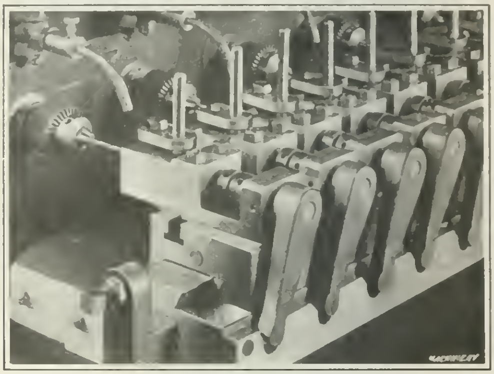


Fig. 5. Close View of Drill Spindles and Fixtures of National-Acme Six-spindle Drilling Machine

at a time. The high rate of production secured by drilling bolts simultaneously is further increased by the fact that provision is made for setting up six blanks in the fixture while the holes are being drilled in six other bolts, the total capacity of the fixture being for twelve bolts, as shown in Figs. 4 and 5. The machine is equipped with a compound slide, the lower slide being for the purpose of moving the work toward or away from the drills, while the upper slide provides the necessary lateral movement for bringing either series of six bolts opposite the drills. Both slides are controlled by levers which are operated by individual cams mounted on a drum and disk, and the same system of change-

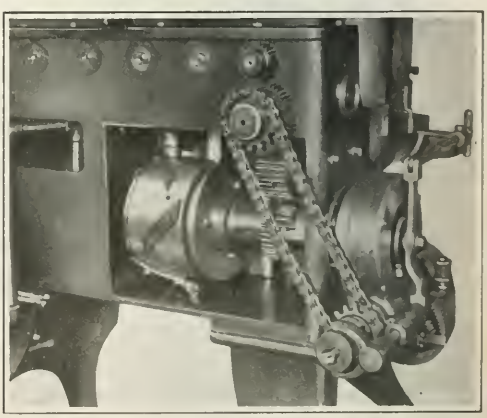


Fig. 6. View of Cam-shaft and Drive to Pump on Machine shown in Fig. 4

gears is employed for varying the speed of the cam-shaft as that which is used on other machines made by the National-Acme Mfg. Co. The change-gears and cams are shown in detail in Fig. 6.

Twelve jigs of suitable design to hold the work to be drilled, are mounted on the top slide; six of these jigs are in line with the drill spindles and hold the work that is to be drilled, while the finished product is being removed from the other six jigs and fresh blanks set up in its place. The jigs in line with the drills are advanced for the drilling operation by means of a compound lever and are returned to the starting point by means of the cam on the disk. As soon as the return motion of the lower slide has been completed, the upper slide is shifted laterally to bring the fresh blanks into line with the drills. The fixtures which hold the finished work are automatically released by the lateral movement of the slide, and the same movement automatically clamps the fresh blanks in the other six fixtures. The machine is particularly adapted for handling small work, and it will be evident from the preceding description that the rate of production will be quite satisfactory. Correct speeds for the drill spindles are secured through a three-step cone pulley which is shown at the right-hand side of the machine in Fig. 4, and a clutch lever gives the operator complete control of the drive. At the top of the machine there is a reservoir for the cutting fluid, and each drill is supplied with lubricant from individual pipes, the supply being adequate for the maximum requirements. The pump, and chain and sprocket which drive it will be seen at the right-hand side of the machine, and in detail in Fig. 6.

IMPROVED WAHLSTROM DRILL CHUCKS

In the May, 1914, and October, 1912, numbers of MACHINERY, descriptions were published of Wahlstrom automatic drill chucks for holding straight and taper shank drills. At the time these articles were published, the Wahlstrom Tool Co., 346 Carroll St., Brooklyn, N. Y., had just taken up the manufacture of drill chucks; and although the service which these tools have been giving during the past three years has been satisfactory, experience has suggested certain improvements in the design. These will be best understood by referring to Figs. 1 and 2, which show the old and improved styles.

In order to explain the improvements which have been made in the design, it will be desirable to describe the operation of the old style chuck for the benefit of those who are not familiar with the construction of this tool. Referring to the end view Fig. 1, the chuck body is shown at *A*, and *B* is a

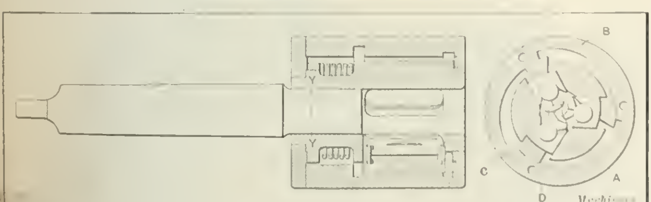


Fig. 1. Early Type of Wahlstrom Automatic Drill Chuck

shell in which three cam surfaces are machined. Between the chuck jaws *C* and the cam surfaces there are extension pieces *D*. The outside of the shell *B* is knurled to provide a good grip for the hand, and by holding this shell back against the rotation of the drill spindle the extension pieces *D* run on their respective cam surfaces, which results in opening the jaws. When the drill is inserted and the shell *B* released, a spring causes the shell to rotate, with the result that the cam surfaces force the jaws into contact with the shank of the drill. The grip secured in this way is sufficient to start the tool cutting, after which the resistance of the cut sets up a torque which causes the eccentric inner jaws to bind against the shank of the drill, the grip obtained being in direct proportion to the amount of power which is required. Fig. 1 shows the chuck jaws in the extreme closed position. When the shell *B* is held back against the rotation of the drill spindle, the extension pieces *D* run on their cam surfaces until engagement is made with the shoulders which separate adjacent cams. At this point the jaws run off the extension pieces into direct contact with the cam surfaces, and the motion is continued until the jaws come up against the side of the next extension piece which abuts against the shoulder at the end of the cam. This is the maximum opening.

The chief objection to the original form of construction lay in the fact that there was a possibility for the extension pieces to be tilted out of alignment with the chuck jaws, due to the introduction of dirt or chips into the chuck. When this condition occurred, the chuck jaws would fail to grip the drill properly and efficient operation of the chuck was

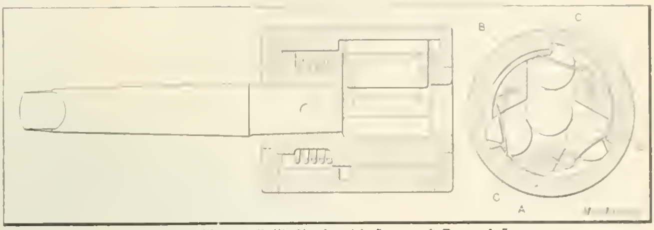


Fig. 2. Wahlstrom Drill Chuck with Improved Type of Jaws

impossible. This difficulty has now been obviated by the employment of an improved form of jaws shown in the end view Fig. 2, which does away with the use of extension pieces, the jaws being in direct contact with the cam surfaces at all times. The method of operation is essentially the same as that described for the old style of chuck, and the end view Fig. 2 shows the chuck in the extreme open position. But in the case of the improved Wahlstrom chuck, each jaw engages only one of the cam surfaces. When the shell of the chuck is held against the rotation of the drill spindle, the jaws run over the cam surfaces until they come into contact with the shoulders at the ends of the cams. After this point is reached, the jaws are rocked over so that the shoulders on the cams enter the spaces provided by the segments which are cut out from the jaws. This is the position shown in Fig. 2. The largest size of drill for which the chuck is adapted can now be slipped up into the chuck, after which the shell is released and the spring causes it to snap back, with the result that the cams force the jaws into contact with the shank of the drill. The jaws are eccentric, and when the drill begins to cut, the resistance causes them to rock around so that their eccentric form makes them bind on the shank of the drill. This principle is the same as that of the original form of Wahlstrom chucks, and as in the earlier type, the grip obtained is in direct proportion to the cutting power required of the drill.

The improved Wahlstrom chucks are made for holding both straight and taper shank drills. The chucks for straight shank drills are made in three different sizes which have capacities for drills from No. 1 to 1/2 inch, from 3/8 to 3/4 inch, and from 17/32 to 1 inch, respectively. The 1/2-inch chuck has either a No. 1 or 2 Morse taper shank, the 3/4-inch chuck either a No. 2, 3 or 4 Morse taper shank, and the 1-inch chuck either a No. 3 or 4 Morse taper shank. Special shanks can be provided to order. The taper shank chucks are made in one size only, and are adapted for holding drills with No. 1, 2 or 3 Morse taper shanks; and the chucks are furnished with either No. 3 or 4 Morse taper shanks. The operation of these chucks is the same as that of the straight shank chucks, and as the jaws grip directly on the shank of the drill, the drive is not in any way dependent upon the tang. No collets are used. As a result, there is no loss of drills from broken tangs where the Wahlstrom chuck is used, and drills which have accumulated in the shop with the tangs twisted off can be made use of.

GLEASON BEVEL GEAR PLANING GENERATOR

The manner in which the generating motion is obtained on this machine represents a departure from the crown gear and segment construction employed on other Gleason bevel gear generators. In the present design, the cradle carrying the tools and the spindle carrying the work are rolled by means of a reversing mechanism, a geared connection being used to transmit the drive to each member. The correct relative roll is secured by means of compound change-gears and a scale is provided to enable the operator to check up the accuracy of the roll at any time. On flat gears of 8 to 1 ratio, the capacity of the machine is for gears up to 32 inches in diameter; and miter gears up to 25 inches in diameter can be handled. The range of pitches is from the finest up to 1½ diametral pitch; and the maximum face width of gears which can be cut is 5 inches.

To meet the requirements of automobile truck builders and other manufacturers who are in need of machines for cutting quiet running bevel gears and pinions, the Gleason Works, Rochester, N. Y., have added to their line a 25-inch bevel gear planing generator of the two-tool type. The capacity of this machine is for flat bevel gears up to 32 inches in diameter for an 8 to 1 ratio; and gears of 45-degree face angle, *i. e.*, the so-called "miter-gears," can be cut in diameters up to 25 inches. The range of pitches for which the machine is adapted is from the finest up to 1½ diametral pitch; and the maximum length of the tool stroke is 6 inches, which provides for cutting gears with a face width of 5 inches.

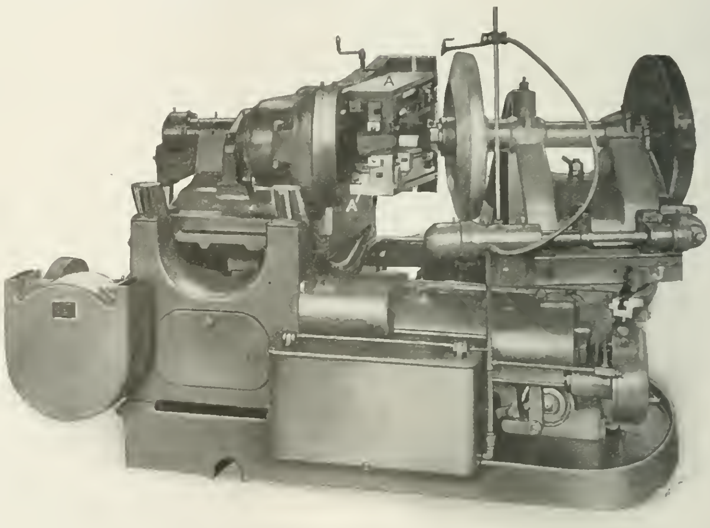


Fig. 1. Gleason 25-inch Bevel Gear Planing Generator

Provision is made for planing gears with a long hub at the back by allowing enough space so that the end of the work-spindle can be set 20 inches from the tools. To adapt the machine for planing pinions which are an integral part of a long stem, the work-spindle is made hollow so that pinions of this character can be set up with the stem carried inside of the hollow spindle. The time required for finishing one tooth ranges from 30 seconds to 2 minutes 50 seconds, according to the material and the size of the gear which is being cut. The floor space occupied is relatively small in comparison to the size of work which can be handled on the machine, the extreme dimensions being 8 feet 2 inches long by 6 feet 4 inches wide. The net weight of the machine is 11,000 pounds.

The machine works on the generating principle and is fully automatic in operation. The tools are mounted in clapper-blocks which are carried by long slides operating in arms shown at *A* in Fig. 1; and the setting is made for any required length of stroke by adjusting the graduated crank-plate *B*, Fig. 2. The slides are fully protected from chips and dirt, and the arms may be set for any tooth angle by means of a turnbuckle *C*, Fig. 3, and graduations *D*, Fig. 4. After the arms have been set in the required positions, they are securely fastened to the carriage *E*, Fig. 5; the carriage holds the

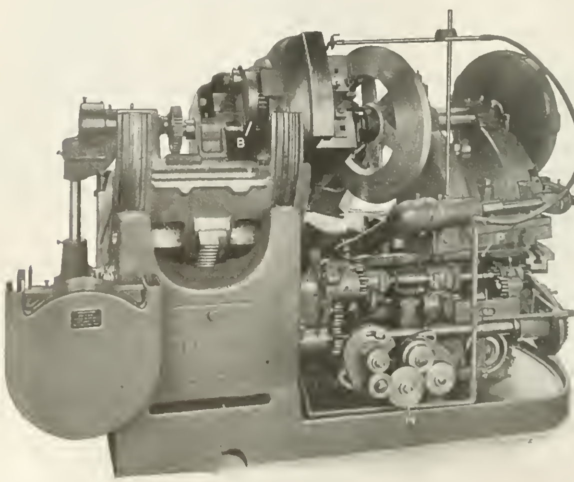


Fig. 2. Covers removed to show Graduated Crank-plate B, Change-gears H and Oil Tubes P

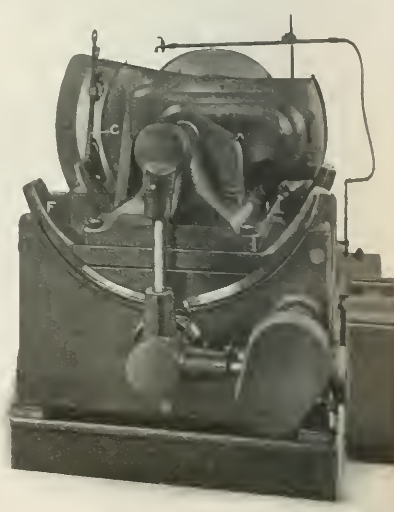


Fig. 3. View of Machine from End on which Tool-cradle is mounted

mechanism for driving the tool-slides and is solidly bolted to a cradle *F*, Fig. 3. The speed of the tool-slide can be varied by means of change-gears *G*, Fig. 5. The cradle *F* has circular V-ways which are designed with liberal bearing surfaces and provided with forced lubrication.

The generating motion employed on this machine represents a departure from the regular Gleason crown gear and segment method. In the present design, the cradle which carries the tools and the spindle which carries the work are rolled by means of a reversing mechanism, and a geared connection is used to transmit the drive to each member. The final pair of gears in each train is a worm and worm-wheel which are made of suitable pitch to insure accurate control. The correct relative rolling motion of the cradle and work-spindle is secured by means of compound change-gears, shown at *H* in Fig. 2; and the graduations *I*, Fig. 4, allow the operator to check up the accuracy of the rolling motion. The indexing mechanism is positively driven and operates by one turn of a stop-plate. This motion is joined with the drive for the generating roll of the work by means of a differential mechanism, and a single train of driving members carries the combined motions to a worm-wheel on the spindle. This arrangement permits of employing a very compact design which does away with the swinging bracket construction used on earlier types of Gleason bevel gear generating machines, thereby saving a considerable amount of floor space.

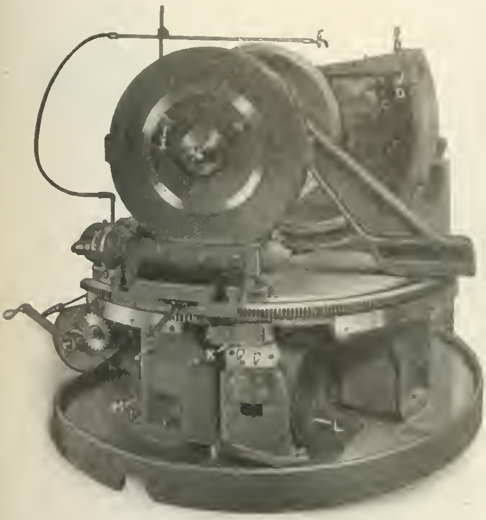


Fig. 4. View of Machine seen from Work-spindle End

The head is carried on a swinging base *J*, Fig. 1, which carries the work to the tools; and the proper depth of cut is obtained by adjusting the graduated lever *K*, Fig. 4. The base *J* is driven by cam *L* and the cam, in turn, receives its motion from a worm and worm-wheel which run in an oil bath *M*. The tools are of the rack tooth type, and can be made to 14½-, 20-degree or any other pressure angle which may be required. The cutter is made of high-speed steel and mounted on a carbon steel holder, as shown in Fig. 6, where it will be seen that the cutter is positively located on the holder by means of a double tongue and groove joint. Owing to the present cost of high-speed steel, this type of tool is far more economical than a solid tool, and aside from the saving in cost the arrangement has the further advantage of enabling the cutters to be quickly interchanged when they require regrinding or when gears of some other pitch are to be cut.

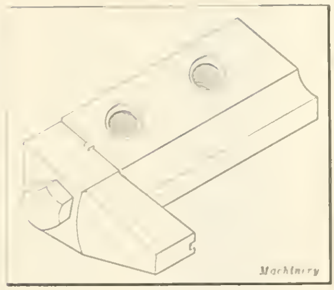


Fig. 6. Form of Tool-holder used

The oiling of all worm-wheels, cradle-ways, heavy-duty gears and cutting tools is effected by a system of forced lubrication which receives oil from two pumps that are located inside of the cradle base at *O*, Fig. 5, where they are accessible at all times. Aside from the saving of space which is secured by this arrangement, there is the further advantage of having all gears and driving chains fully guarded. All other oil tubes on the machine are grouped in convenient places as shown at *P* in Fig. 2, so that the operator is not likely to overlook any of them. All gears on the machine, with the exception of the change-gears, are made of steel and casehardened to make them durable. The tools are easily and accurately set by means of gages which may be tested at any time with a proof plug; and the gear blank to be cut can also be quickly set up on the work-spindle by means of a cone distance gage. These provisions which are made for the rapid adjustment of the machine in connection with the features of the design which afford rapid and automatic operation, make the rate of production very satisfactory.

ROCKFORD 17-INCH ENGINE LATHE

In the October, 1914, number of MACHINERY a description was published of the 13-inch "Economy" engine lathe manufactured by the Rockford Lathe & Drill Co., Rockford, Ill. Since the appearance of the article referred to, this concern has added to its line a 17-inch engine lathe, the design of which is essentially the same as that of the smaller sized machine. It is built in two types, one of which is equipped with a quick change-gear mechanism and the other with what is styled as a "semi-quick" change-gear device. In the former type of machine the feed-box is of simple and powerful construction; all gears are cut from solid steel and thirty-two changes are obtained through sliding gears and hardened steel clutches that are

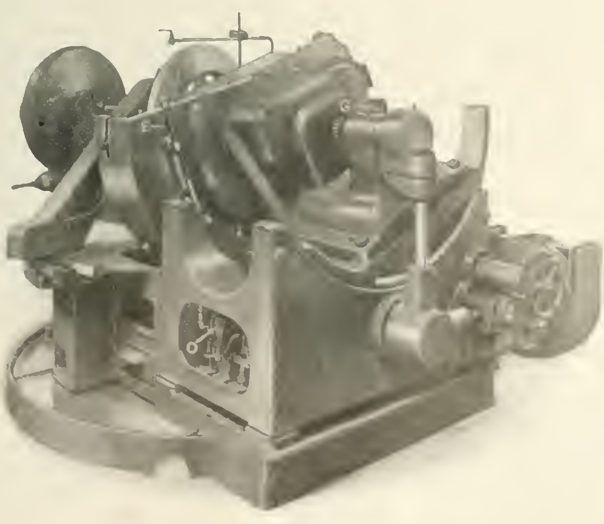


Fig. 5. Opposite Side of Machine from that shown in Figs. 1 and 2

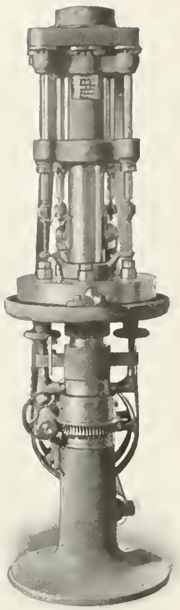


Fig. 1. Front View of Bemis Four-spindle Semi-automatic Drill

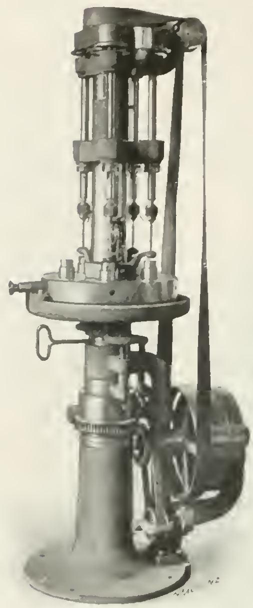


Fig. 2. Side View of Bemis Drill

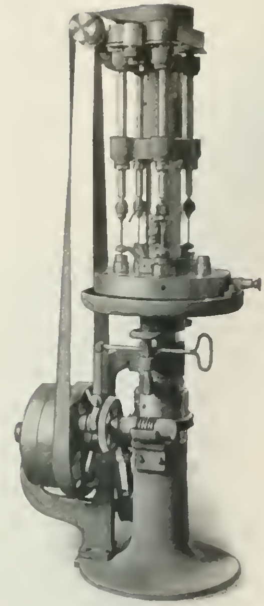


Fig. 3. Opposite View of Machine shown in Fig. 2

controlled by two handles. The lead-screw and feed-shaft operate independently, and either the screw or shaft is engaged by operating a knob at the front of the gear-box. In the lathe with the semi-quick change-gear box, three changes of feed are obtainable for each change of gearing through sliding steel gears and hardened steel clutches which afford a powerful drive. This gear-box simplifies thread cutting operations, as all pitches are obtainable without the necessity of compounding gears. These new lathes swing 18½ inches over the ways and 11¾ inches over the carriage; the distance between centers on a lathe with a 6-foot bed is 27 inches. The ratios of the double back-gears are 3.5 to 1 and 11.13 to 1, respectively. The machine is built with 6-, 8-, and 10-foot beds.

BEMIS FOUR-SPINDLE DRILL

The semi-automatic four-spindle ball bearing drill shown in the illustrations presented in connection with the following description, was developed by Edgar W. Bemis, Worcester, Mass., for use in drilling clearance holes in threading dies and for similar work. The table is equipped with five chucks so that the finished work may be removed from one chuck and a fresh blank placed in position while the drills are working on the pieces held in the other four chucks. The general arrangement of the machine will be readily understood by reference to the front, rear and side views shown in Figs. 1, 2 and 3; and from Figs. 4 and 5, which show the index mechanism and method of driving. In operation, the piece to be drilled is set up in the chuck at the front of the machine, the lock-pin is withdrawn and the table revolved to bring the work under the first spindle. While the table is being raised to feed the work to the drill, the operator places another piece in the second chuck and continues setting up work until all of the chucks have been filled. After the operation has once been started in this way, it is merely necessary for the operator to remove the finished piece and set up a fresh blank in each successive chuck as it comes to the idle position at the front of the machine.

The work-table is supported on ball bearings on the lifting table which is moved up and down to feed the work to the drills and withdraw it after the operation has been completed. The work-spindles have gears keyed to them which mesh with a gear carried by the hub of the lifting table. As the work-table is indexed to bring the work-spindles into successive positions under the four drill spindles, the gears just referred to index the work to the proper positions for drilling. The feeding of the work-table to and from the drills is effected by means of rolls carried on the lifting rods; these rolls run on cams fastened to a worm-gear which re-

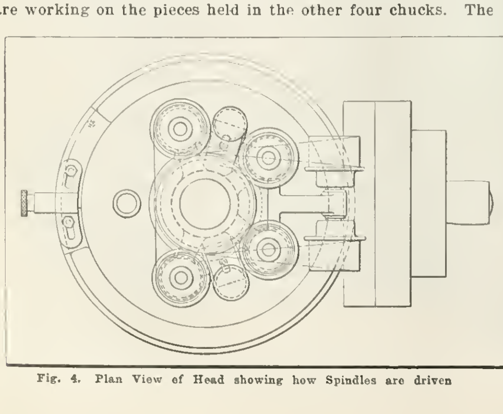


Fig. 4. Plan View of Head showing how Spindles are driven

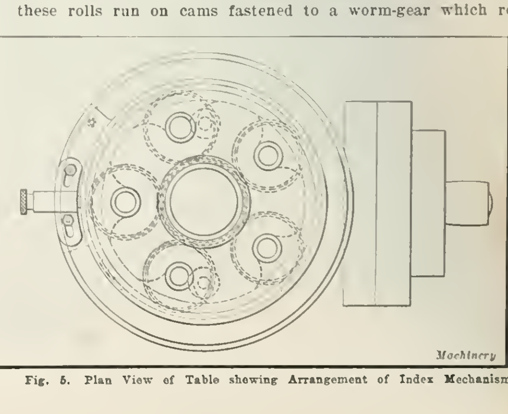
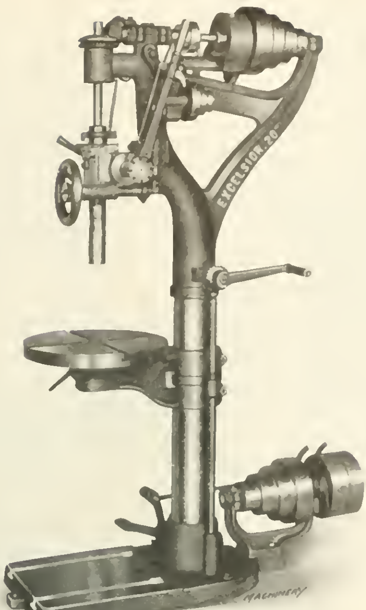


Fig. 5. Plan View of Table showing Arrangement of Index Mechanism

volves around the post and is driven by the gears on the main driving shaft. A stud at the top of the post supports a cone pulley, the top step of which receives the belt which runs over idler pulleys from the main driving pulley. An endless belt runs around the four pulleys on the drill spindles, and the desired tension of this belt is maintained by means of idler pulleys.

The locking-pin which locks the work-table to the lifting table is adjustable to allow the center of the chucks on the work-table to be moved from the centers of the drills, thus enabling four holes to be drilled on any circle up to 3½ inches in diameter. A convenient handle located at the side of the machine operates a sliding clutch on the worm-shaft to provide for stopping or starting the feed. The worm-gear which carries the lifting cams rests on ½-inch falls, thus reducing the frictional resistance. The lifting cams fastened to the worm-gear may be adjusted to provide for drilling to any required depth which comes within the range of the machine. The lifting rods on each side of the machine are threaded for a part of their length, and the rods pass through handwheels that are used to adjust the position of the table relative to the drills. The shank of the chuck is drilled half way through its length so that long drills can be put up in the shank and then drawn down to any required position. An oil chamber is cored around the head of the drill behind the spindle bearings, and valves are tapped into this chamber to make connection with pipes which carry oil to each of the drills. A pump driven from the main shaft keeps the chamber full of oil. The capacity of this machine is for drilling holes through 1800 pieces of 5/16-inch stock per day.



Royersford Improved 20-inch Double Back-geared Drill

WHITNEY HAND-OPERATED PUNCHES

The accompanying illustrations show three hand-operated punches which constitute recent additions to the line of punches and shears made by the Whitney Metal Tool Co., Rockford, Ill. In addition to punching metal, these tools may also be employed for setting the heads of rivets, in which service they give very satisfactory results.

Fig. 1 shows the No. 15 ball bearing punch which has a capacity for punching holes up to 5/16 inch in diameter through iron 5/16 inch in thickness. The tool will reach to the center of a 7¾-inch disk, and the height of the gap is ¾ inch. One-half turn serves to drive the punch through ¼ inch of metal. The weight of the tool complete is 21 pounds. The No. 20 ball bearing punch shown in Fig. 2 is made of chrome-nickel steel, heat-treated to obtain the required properties. The capacity of this tool is for punching holes up to ½ inch in diameter through iron ½ inch in thickness. The depth of the throat is 2 inches, the height of the throat 1¾ inch, and the weight of the tool 20 pounds.

Fig. 3 shows a No. 40 ball bearing punch which, like the No. 15 punch shown in Fig. 1, is equipped with a ratchet head and socket handle. The capacity of this tool is for punching holes up to ¾ inch in diameter in iron ¾ inch in thickness; the depth of the throat is 3 inches, the height of the throat 2 inches, and the weight of the tool 51 pounds. The No. 15 tool requires a pressure of 15,300 pounds to punch a hole 5/16 inch in diameter through iron 5/16 inch in thickness. The No. 20 tool requires 39,300 pounds pressure to punch a hole ½ inch in diameter through iron ½ inch in thickness. The No. 40 tool requires a pressure of 88,400 pounds to punch a hole ¾ inch in diameter through iron ¾ inch in thickness.

ROYERSFORD DOUBLE BACK-GEARED DRILL

The design of the improved 20-inch double back-geared drill which has recently been placed on the market by the Royersford Foundry & Machine Co., Royersford, Pennsylvania, combines the features of simplicity, strength and rigidity with speed and accuracy of production. The capacity is for drilling holes up to 1½ inch in diameter. All the gears are machine cut, and the bearings are liberally proportioned; the change from direct to double back-geared drive or *vice versa* is instantly obtained by simply sliding the gears in to or out of mesh. It will be seen from the illustration that the drill is made with a square base.

Eight changes of speed are provided, and the feed may be obtained by power, by hand through a feed wheel, or by means of a feed lever. The spindle is counterbalanced by a

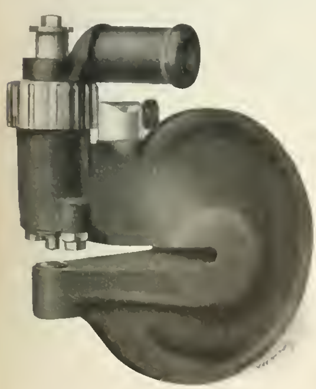


Fig. 1. Whitney No. 15 Ball Bearing Punch for Sheet Iron up to 5/16 Inch in Thickness

Fig. 2. Whitney No. 20 Ball Bearing Punch for Sheet Iron up to ½ Inch in Thickness

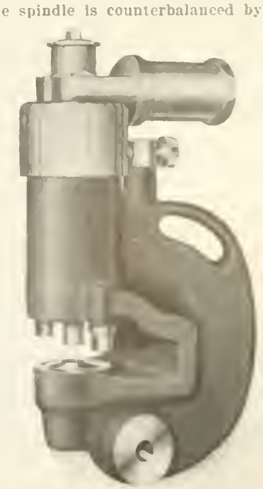


Fig. 3. Whitney No. 40 Ball Bearing Punch for Sheet Iron up to ¾ Inch in Thickness

weight inside the column and is provided with an automatic stop and quick return. There is a quick-acting screw for raising or lowering the table. The principal dimensions of the machine are as follows: maximum distance between table and spindle, 36 inches; maximum distance between base and spindle, 45 inches; distance from column to center of spindle, $10\frac{1}{4}$ inches; diameter of column, $5\frac{1}{4}$ inches; traverse of spindle, 9 inches; traverse of table on column, $21\frac{1}{2}$ inches; diameter of table, 18 inches; floor space occupied, 23 by 50 inches; horsepower required to drive drill, 1; and net weight of machine, 800 pounds.

"MODERN" COLLAPSIBLE TAP

The collapsible adjustable tap illustrated and described herewith is a recent product of the Modern Tool Co., Erie, Pa. This tool is designed for use in machining shrapnel and high-explosive shells, and it is said that it is constructed along such rigid lines that it possesses practically the same strength as a solid tap. The design of the mechanism is extremely simple, yet it governs the operation of the tool in such a way that the collapse of the tap is insured at any predetermined point, thus permitting the quick withdrawal of the tool without injury to the work. In addition to the collapsing feature, the construction provides for making adjustments for producing tight and loose threads.

The cutting members consist of but two parts, being identical with a solid tap split through the center. Each blade has two or more flutes as in the case of a solid tap—and the shank of the blades terminates in a square base which is inserted in a correspondingly shaped hole in one of the two slides in which the blades are fastened by set-screws. These two slides are secured in a T-shaped groove in the head, and are movable transversely to enable the blades to slide past each other. In this way the diameter of the cutting tools is reduced or increased as required. Each sliding block terminates on the outer end in a curved surface which is operated upon by cam surfaces on the inside of a ring which encircles the blocks. These cams are of sufficient depth to force the sliding blocks to move in opposite directions through a distance sufficient to bring about the collapse of the tap, so that it is clear of the work and may be rapidly withdrawn when the tapping is completed.

The head which carries the sliding blocks and cam ring is mounted on a shank that is clamped in the chuck or turret head in the usual manner. The shank may be made integral with the head or provided with longitudinal float as desired. It will be evident from the description and illustrations that, in designing this tap, the Modern Tool Co. has utilized the same principles and practically the same construction as employed in the Modern self-opening and adjustable die-head.

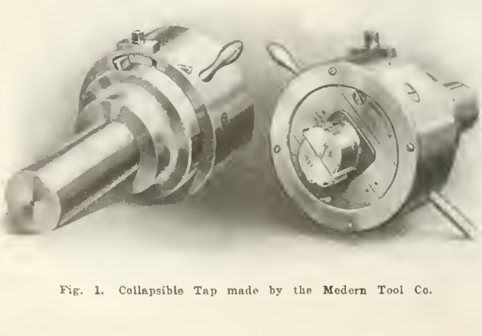


Fig. 1. Collapsible Tap made by the Modern Tool Co.

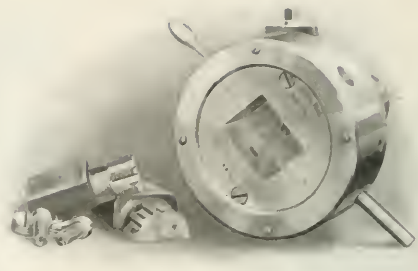


Fig. 2. Parts of Modern Tool Co.'s New Tap

The chief points of difference are that the slides have been reduced to two in the case of the tap, and that the cutters are made for cutting internal threads instead of external threads. As the operation of the tool is controlled by cams and springs which are independent of the cutting members, and as there are no delicate parts inside the tap, work of exceptionally small diameters may be threaded. This tap is made in four sizes ranging from $\frac{1}{2}$ to 3 inches in diameter.

HECO ELECTRIC TEMPERING OVEN

The enviable reputation which is enjoyed by English toolsmiths was built up in the days when the equipment available for hardening tool steel consisted of a coke fire. After the tools had been hardened, the method of tempering consisted of heating a large block of steel to a cherry red, and then placing the hardened tools on this block until their temperature had been raised to the desired degree as indicated by the color, which ranged from straw to a dark blue. Although the results obtained by this method were of such a high quality that the reputation established by the old English toolsmiths has been held to the present day, the method of tempering referred to is not adapted to the requirements of modern manufacturing. To provide for handling work more rapidly, the general method of tempering in American manufacturing plants consists of immersing the hardened parts in a bath of oil, the temperature of which has been raised to the proper degree. There are, however, certain undesirable features connected with this process, such as the difficulty of handling the work, the untidy appearance of the tempering room, which is unavoidable, and the fact that the best grades of tempering oil cannot be heated above 600 degrees F., so that the method is not adaptable for tempering many classes of high-speed steel which require the application of higher temperatures.

Heco Electric Tempering Oven for which H. B. Eaton & Co. have the Selling Agency

With the view of developing a method of tempering which would obviate the objectionable features of the oil tempering bath, and enable work of the high quality produced by the old English toolsmiths with their heated steel blocks to be turned out at a rate that could meet modern conditions of competition, the Heco Mfg. Co., Boston, Mass., has developed the electric tempering oven shown in the accompanying illustration, for which H. B. Eaton & Co., Inc., 144 Pearl St., Boston, Mass., have the eastern sales agency. The advantages of the method of "dry" tempering may be briefly outlined as follows: The metal can be brought to a uniform condition from the outer surface to the center of the work; and with the Heco electric oven, the work can be handled even more rapidly than in the case of the oil bath. Any desired temperature is available up to 800 degrees F., the control being maintained by a rheostat. The heating units are placed at

the bottom of the oven and are located in parallel rows from front to back, so that every part of the oven receives an absolutely uniform heat, with the result that the temper of all parts is drawn uniformly. The ovens are provided with 4-inch heat retaining walls, and it is stated that with a maximum temperature of 800 degrees F. the exterior remains cool.

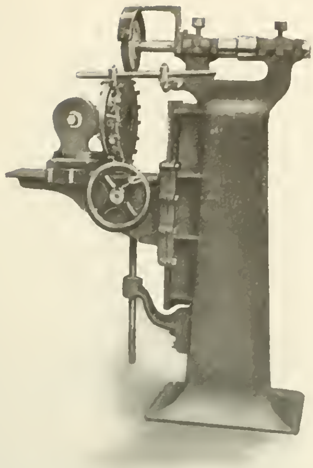


Fig. 1. Grinding an Inserted-tooth Milling Cutter

With intelligent use, the ovens should last for years, but the heating units require renewing after approximately 3000 hours of service. The Heco electric tempering ovens are made in three stock sizes, known as Nos. 1, 2 and 3. The No. 1 oven is 12 inches wide by 12 inches deep by 8 inches high, and the approximate consumption of electric power is 1000 watts per hour. The No. 2 oven is 18 inches wide by 18 inches deep by 8 inches high and the approximate consumption of electric power is 1500 watts per hour. The No. 3 is 24 inches wide by 24 inches deep by 8 inches high and the approximate consumption of electric power is 2000 watts per hour. All sizes of ovens are made for various voltages and for use on alternating or direct current.

KANE & ROACH GRINDER

The grinding machine which forms the subject of this article is a recent product of Kane & Roach, Niagara and Shonnard Sts., Syracuse, N. Y., and is adapted for grinding all kinds of milling cutters. The illustrations show the machine set up for four typical operations, which will give the reader an idea of its range. This machine has been in use in the manufacturers' shops for a considerable time, during which it has been employed on a great variety of cutter grinding work, and the experience gained has enabled weak features to be eliminated. All the attachments used on the machine are graduated in degrees so that they can be swiveled or tilted to any angle that may be required by the work. Also, the head can be moved in or out, and the table can be raised or lowered into any desired position. The result is that the grinding machine is adapted for a wide range of work.

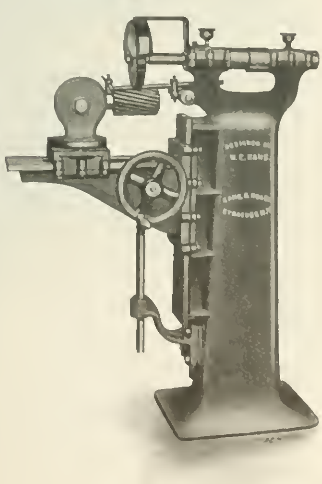


Fig. 3. Cutter held on Mandrel in Horizontal Position

The countershaft is furnished with the machine and the cone pulley provides two changes of speed. The different grinding wheels used on the machine are carried by taper shank mandrels. The swinging or swivel sleeves which carry the work are made to fit bushings for the various forms of straight or tapered shanks on the cutters or mandrels. These bushings and mandrels are not furnished with the machine, as it is necessary for the user to make the attachments to suit his own particular work. The swivel head, which is ready to receive the work-holding bushings, constitutes part of the regular equipment of the machine, and the same is true of the countershaft. The floor space occupied is approximately 3½ feet by 1 foot 8 inches, and the complete height is 3½ feet.

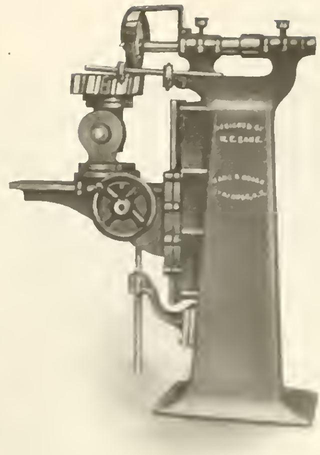


Fig. 2. Cutter held on Mandrel in Vertical Position

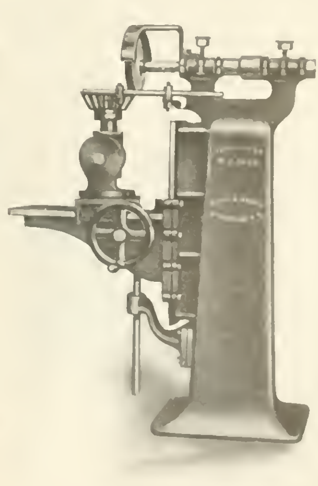


Fig. 4. Grinding a Tapered Milling Cutter

ANDERSON DIE FORMING MACHINE

The machine shown by the illustrations presented in connection with the following description is built by the Anderson Die Machine Co., 590 Water St., Bridgeport, Conn., and is especially adapted for finishing blanking dies and similar work after the hole has been roughed out in the usual way. It is driven by a motor that can be attached to an ordinary lamp socket. It will be evident from the illustrations that the machine is equipped with a special cutter which is shaped like a file but operates more on the principle of a milling cutter. The cutting edge is one continuous spiral, and the cutter is driven by a rotating spindle. The die is fed up to the cutter by hand. The following advantages are claimed for the machine: First, that it cuts very rapidly and without interruption; second, that it is unnecessary to change the cutter for every variation in contour of the surface being operated upon; third, that the work-table is always set at right angles to the spindle so that the cutter, which has the same taper as the clearance required in the die, always produces a uniform clearance regardless of how the work is presented to the cutter. The result is that when the die is ground to renew its cutting edge, the opening is uniformly enlarged without distortion.

The motor is connected to the horizontal driving shaft on the machine by means of a semi-flexible

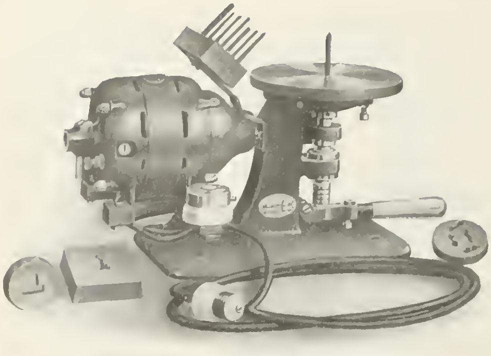


Fig. 1. Control Side of Anderson Die Forming Machine

coupling, and connection between the driving shaft and vertical spindle is by means of a pair of spiral gears. It will be seen that the driving mechanism is completely enclosed with the exception of a small opening at the bottom of the case, which provides ventilation to prevent heating of the electrical parts. The design of the motor windings has been worked out with particular reference to the intermittent loads to which the Anderson die forming machine is subjected.

The cutter is carried in the machine by means of a hardened and ground collet which is held in the closed position by a powerful spring at the lower end of the spindle. When it is desired to remove the cutter from the spindle, the collet is opened by raising the hand lever. The spindle is hardened and ground, and runs in phosphor-bronze bearings; the upper bearing is of the double angle type and the lower bearing of the straight type. An adjustable thrust collar is provided to engage the lower face of the upper bearing, thus reducing to a minimum the changes in adjustment resulting from variations of temperature. A knurled ring is provided on the end of the spindle which prevents chips or dust from finding their way into the bearings. The centrifugal force due to the rapid rotation of the spindle largely prevents the lodging of chips or dust in the collet, but should the collet require cleaning, the table can be tilted back to make it easily accessible, this position being shown in Fig. 2. A switch is located on the base of the machine for starting or stopping the motor.

The cutters used on this machine are so designed that the use of feed-screws, slides or vises is unnecessary for holding the work and feeding it up to the cutter. The work is held by hand and guided up to the cutter in any direction, so that either straight or irregular lines can be followed. The cutting is the result of a continuous shearing action of the tool, which not only removes the excess stock from the die but also serves to hold the die-block down on the table. As all chips are carried down, no trouble is experienced from the obscuring of the outline laid out on the die-block. The cutting edge of the tool is not subjected to any appreciable shock while in operation, and so it will be evident that the life of the tools is quite satisfactory. Cutters for die work can be furnished to produce any desired degree of clearance, and they can be made to leave the die straight for ¼ or 3/16 inch, after which the clearance is of the usual form. All sizes of cutters are made with shanks ¼ inch in diameter so that it is unnecessary to change the collet in the machine when a change of cutters is necessary.

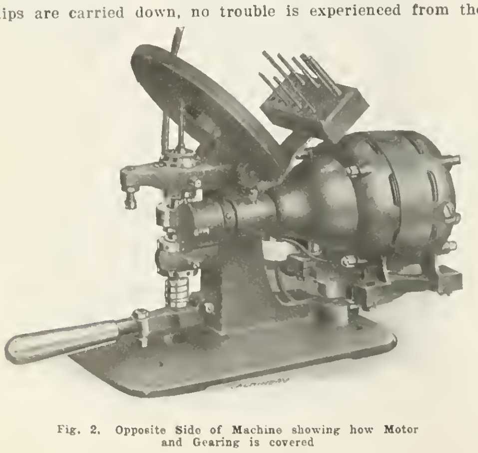


Fig. 2. Opposite Side of Machine showing how Motor and Gearing is covered

The cutting actión of the tool is such that wooden patterns can be formed to give the required draft and there is no danger of splitting the wood, no matter what direction the grain runs in. The finish produced is very smooth and the pattern will require very little, if any, hand work to be done on it after leaving the machine. The draft on the pattern will be uniform on all sides because the amount of draft is controlled by the taper of the cutter. Suitable cutters are made to produce any required degree of draft for wooden or metal patterns. The regular equipment furnished with the machine includes the driving motor, a heavy flexible cord and attachment plug, a fixed or portable tool rack, and a

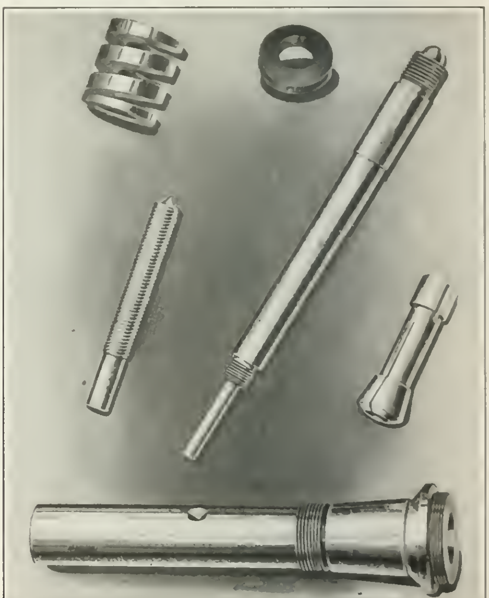


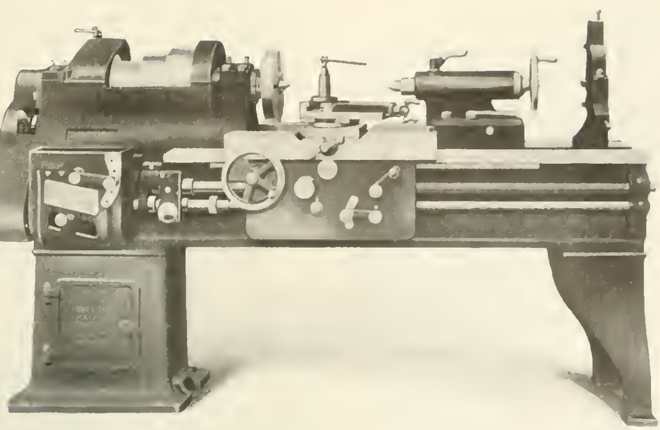
Fig. 3. Close View of Cutting Tool, Collet and Spindle

set of twelve cutters of any form that may be desired. In addition to its application for finishing blanking dies, the machine will be found useful in making irregular-shaped drawing dies, templets, small sheet metal model parts, formers for profiling gages, irregular-shaped gages, formers for cams, metal patterns, and small wooden patterns. The principal dimensions of the machine are as follows: Capacity, for finishing dies up to 1½ inch in thickness; size of cutters used, ⅛ to 5/16 inch in diameter; size of table, 7 inches in diameter; height of table from bench, 10¼ inches; bench space occupied, 9 by 18 inches; and weight, including motor, 551 pounds.

"SUPERIOR" ENGINE LATHE

The unusual demand which now exists for many types of machine tools makes the question of prompt delivery of great importance to many prospective purchasers. This is particularly true of lathes which are being used in great quantities both in this country and Europe for the turning of shrapnel and high-explosive shells. The Superior Machine Tool Co., Kokomo, Ind., has recently added to its line an 18-inch engine lathe which is shown in the accompanying illustration, and

this concern announces that it is in a position to make early deliveries on orders. It will be seen that the design of the machine follows closely established practice in the construction of modern engine lathes, and the features of the machine will be evident from the illustration without requiring a detailed description.



Engine Lathe manufactured by the Superior Machine Tool Co.

The principal dimensions of the machine are as follows: Swing over bed, 18½ inches; swing over carriage, 11½ inches; size of front spindle bearing, 3⅛ by 5 5/16 inches; size of rear spindle bearing, 2 7/16 by 4½ inches; diameter of hole through spindle, 1 9/16 inch; diameter of spindle nose, 2 11/16 inches; width of belt for machine with four-step cone pulley, 3½ inches; width of belt for machine with three-step cone pulley, 3¾ inches; size of cutting tool, ⅝ by 1¼ inch; diameter of tailstock spindle, 2¼ inches; length of carriage bearing on bed, 27 inches; ratio of back-gears, 3.27 to 1 and 10.5 to 1; size of countershaft pulleys, 12 by 4 inches; speed of countershaft, 225 to 400 R. P. M.; lengths of beds furnished on machine, 6 to 16 feet; distance between centers for machine with 8-foot bed, 56 inches; net weight of machine with 8-foot bed, 3600 pounds; and additional weight per foot of bed, 145 pounds.

NEWTON WORM-WHEEL HOBBING MACHINE

In a worm-wheel hobbing machine which has recently been added to the line of the Newton Machine Tool Works, Inc., Philadelphia, Pa., provision is made for generating the teeth with either a tapered hob or fly-cutter. The generating tool has the general form of a tap and is set in the same position as that occupied by the worm when in mesh with the wheel, i. e., at the same distance from the axis and at the same angle with the plane of the wheel. The general practice in hobbing is to cut the wheel teeth to a gradually increasing depth by feeding the cutter in a radial direction toward the center of the wheel. On the Newton hobbing machine this practice is not followed; in the present case the cutter is fed along a tangent to the wheel. As a result, the smallest diameter of the tapered hob starts cutting, and as the hob is fed across the wheel, the taper causes the teeth to cut to steadily increasing depths. The largest diameter of the hob cuts the teeth to the required depth. Fig. 1 shows the machine generating a worm-wheel with one of the special tapered hobs, and Fig. 2 shows the teeth of a large worm-wheel being generated by a fly-cutter. In the latter case the worm-wheel has 92 teeth of 2 pitch and triple lead; the outside diameter of the wheel is 47½ inches and the face width 5½ inches. The cutting of the teeth in this wheel was completed in ten hours

Fig. 1. Newton Worm-wheel Hobbing Machine equipped with One of the Special Tapered Hobs

Fig. 2. Generating Worm-wheel with Fly-cutter

BICKNELL-THOMAS TAPPING CHUCK

The distinctive features of the friction-driven tapping chuck which has been added to the line of the Bicknell-Thomas Co., Greenfield, Mass., are the simplicity of the design and the compact form of construction which has been developed. The latter feature makes the chuck suitable for use on many machines where some types of tapping chucks are too cumbersome, a case in point being on certain types of multiple-spindle drills or tapping machines where the center distance between the holes is relatively small. The friction drive is adjustable so that sufficient power can be provided to drive the tap under normal working conditions; but if a hard

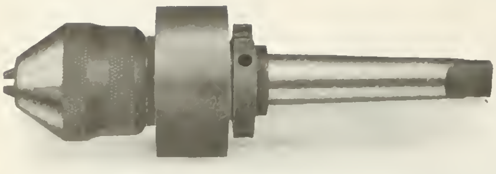


Fig. 1. Bicknell-Thomas Friction-driven Tapping Chuck

spot in the work is encountered or some other abnormal condition arises, the friction will slip before sufficient strain develops to break the tap. Another class of work on which this adjustable friction drive is of value is in setting up a machine for tapping blind holes. In such cases an error in judgment on the part of the operator is likely to result in driving the tap to the bottom of the hole and breaking it. With the Bicknell-Thomas tapping chuck such accidents are virtually impossible.

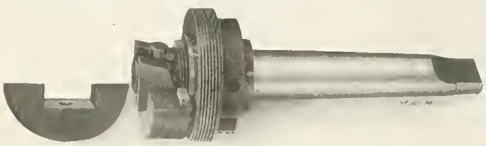


Fig. 2. Driving Mechanism of Bicknell-Thomas Chuck

Fig. 2 shows the driving mechanism of the Bicknell-Thomas chuck, from which it will be seen that the friction drive is provided by a split fiber disk which fits around a beveled center piece. A cylindrical member located under the jaws of the chuck fits over the split disk, and the two halves of the disk are forced against the inner surface of this part by drawing the beveled center piece down into the shank of the chuck. Thus provision is made for adjusting the radial position of the halves of the driving disk to give the necessary power for the size of tap being used. The adjustment of the frictions is made by turning the locking-nut at the back of the chuck. It will be evident from Fig. 3 that the chuck jaws are designed in such a way that they grip both the round shank of the tap and the squared portion at the end of the shank. These chucks are made in five different sizes known as Nos. 952 to 956, and the capacities of these tools are 1/8 to 1/4 inch, 3/16 to 3/8 inch, 1/4 to 1/2 inch, 5/16 to 3/4 inch, and 9/16 to 1 inch, respectively. They are made with an assortment of Morse taper shanks or straight shanks of various diameters to meet the requirements of different machines on which this tapping chuck can be used.

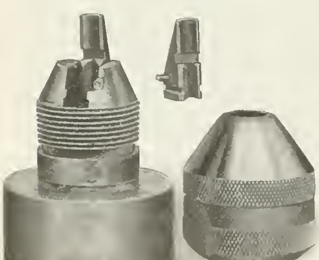
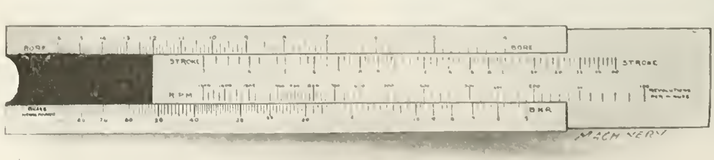


Fig. 3. Jaws of Chuck showing Provision for holding on both Round Shank and Squared End of Tap

BARRETT "GASPOWRULE"

The accompanying illustration shows a slide-rule known as a "gaspowrule" which has been developed by D. O. Barrett, 802 S. McDonald St., Lima, Ohio, for use in determining the approximate horsepower developed by four-cycle gas and gasoline engines. The rule also gives quite satisfactory results for two-cycle semi-Diesel oil engines. This rule has been developed from data obtained in making a great number of engine tests, and while it is not claimed that the results are absolutely accurate, it affords a means of rapidly comparing the results obtained from various sizes of engines.



Barrett "Gaspowrule" for calculating Power developed by Four-cycle Gas and Gasoline Engines

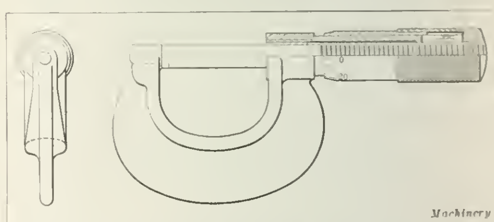
E. G. SMITH POCKET LEVEL

The No. 2 pocket level which forms the subject of this description is known as the "Tampa" which-way level, and is a recent product of E. G. Smith, 315 West Park Ave., Tampa, Fla. This tool consists of a circular vial which is fastened in a steel casing 1 inch in diameter by 3/8 inch high. There are three 1/8-inch holes in the base of the casing for fastening the level to a larger surface. Levels of this type may be provided with a polished brass base either 1 1/2 inch or 2 1/2 inches in diameter. These bases are graduated at 50 to 100 spaces respectively, to facilitate pointing out in which direction the work is out of level; and the levels are carefully finished and nickelplated, so that to use the phrase of the manufacturer "they are attractive enough for a watch charm."

E. G. Smith No. 2 Which-way Level

REED & PRINCE MICROMETER

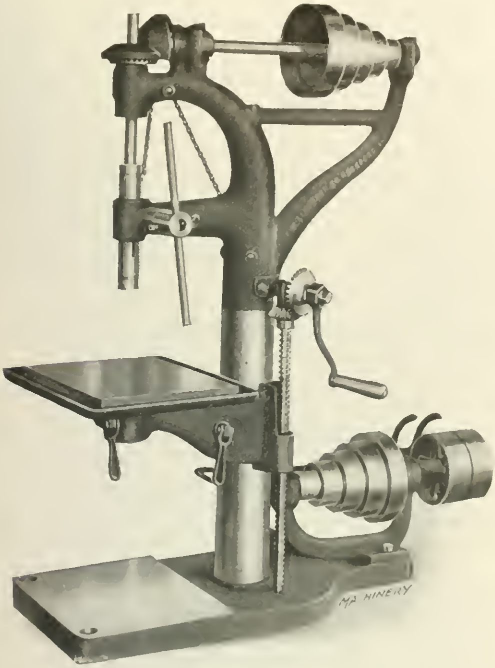
The micrometer caliper which has recently been placed on the market by the Reed & Prince Mfg. Co., Worcester, Mass., follows the general lines of the micrometer calipers which have been manufactured by this concern for the past five years; but the new tool comprises several noteworthy improvements. The anvil is fixed instead of being adjustable, and this change has made it possible to reduce the depth of the frame at the anvil so that the micrometer can be used in narrower places. Adjustment for wear is made by means of a two-part thimble; the knurled part of this thimble is permanently attached to the spindle and the sleeve or plain part can be rotated, while the spindle and anvil are in contact with each other, until the zero mark on the thimble corresponds with the zero graduation on the barrel. The two parts of the thimble are a friction fit, and when assembled together they are locked in such a way that the spanner wrench provided for this purpose must be used when making the adjustment. There is no danger of the setting being accidentally changed. This extremely simple adjustment is easily and accurately made and the same spanner wrench that is used for adjusting the sleeve is also employed for regulating the tension nut. A hardened bushing is pressed into the frame to guide the spindle; and this bushing is ground and lapped to the required size. The spindle is taper-threaded and locked into the thimble in such a way as to secure a rigid joint, the end being riveted over to give additional strength.



Improved Reed & Prince Micrometer

LINDGREN HIGH-SPEED BENCH DRILL

The F. W. Lindgren Co., Rockford, Ill., has recently placed on the market a 13-inch high-speed bench drill which is suitable for all kinds of light drilling and is particularly adapted for tool and die work. To provide for operation at high speed, all the bearings are bronze bushed and equipped with ring oilers, which provide constant lubrication;



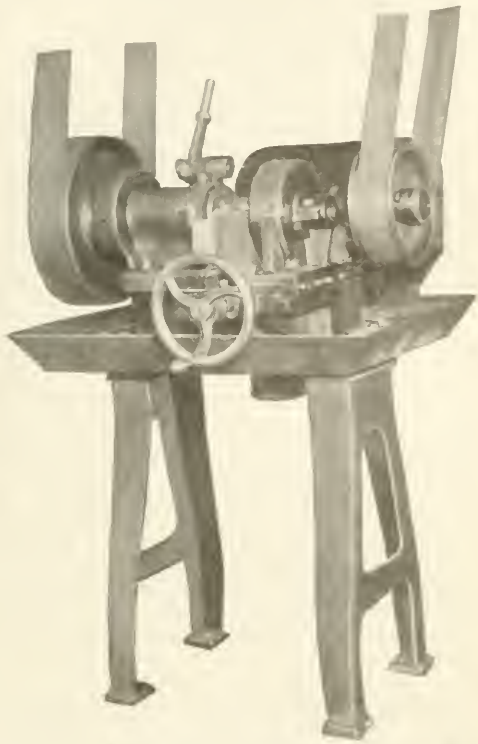
F. W. Lindgren 13-inch High-speed Bench Drill

when worn, the bushings can be readily replaced. The crown gear is fitted with a thrust bearing at the end of the hub, and a fiber washer prevents the escape of oil. The spindle is equipped with ball thrust bearings, and the sleeve is graduated in inches. The capacity of the machine is for drills up to 5/8 inch.

The principal dimensions of this drill are as follows: Height, 37 3/4 inches; maximum distance from spindle to base, 21 inches; maximum distance from spindle to table, 15 inches; diameter of column, 3 1/2 inches; size of table, 9 by 11 inches; hole in spindle, No. 1 Morse taper; width of belt on cone pulleys, 1 3/4 inch; width of belt on tight and loose pulleys, 1 1/2 inch; floor space occupied, 32 by 12 inches; and net weight of machine, 155 pounds.

HOLDEN-MORGAN PLUG MILLER

The Holden-Morgan Co., Toronto, Canada, has recently added to its line a machine for use in turning the gas check plug and milling the thread for high-explosive shells. In addition to the two operations referred to, the machine also providea for facing the plugs. The entire operation is performed at a single chucking of the work, and the time re-



Holden-Morgan Machine for turning and milling Thread on Gas Check Plugs for High-explosive Shells

quired to completely mill a plug is from two to three minutes. The machine is equipped with an oil pump, quick-acting collet and automatic stops for all the feed movements. The method of operation is so simple that satisfactory results can be obtained with unskilled labor. The A. R. Williams Machinery Co., Ltd., 64-66 Front St., West, Toronto, Canada, has the exclusive sales agency for the machine.

AMERICAN HIGH-SPEED SILENT CHAIN

The characteristic feature of the high-speed silent chains manufactured by the American High Speed Chain Co., Indianapolis, Ind., is the simplicity of the design. These chains are

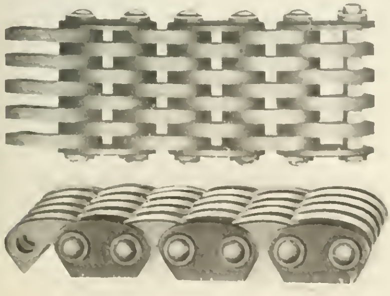


Fig. 1. American Silent Chain—note the Three-part Construction

Fig. 2. Application of the American Silent Chain

composed of three parts, namely, the links, connecting pins and washers, which are made of chrome-nickel steel having a tensile strength of 170,000 pounds per square inch. The links are of sufficient thickness to enable them to be casehardened to provide greater strength and durability, and at the same time allow the metal in the interior portion of each part to be left in its natural condition of toughness, with the result that the chain possesses the desirable property of flexibility. The pins and washers are also casehardened, and are said to be practically indestructible. The pins are not held stationary; they are free to rotate, and, therefore, distribute the wear around the entire surface.

The links are accurately machined in relation to the pinholes and pitch-line, and the angle of the links is 60 degrees, which experience has shown to be well suited for maintaining the proper relation between the links and the sprockets over which they run. The links are fitted perfectly against the sprocket teeth and make contact without friction, so that noise is virtually eliminated. This correct meshing of the chains and sprockets, and the distribution of the load over a large number of teeth, is constant, regardless of the wear which may have developed from long usage. This condition is effected by an automatic adjustment which provides for assuming a correspondingly large pitch diameter of the wheels as the teeth or bearings wear and the chain stretches.

W. A. WHITNEY CHANNEL IRON PUNCH

The W. A. Whitney Mfg. Co., Rockford, Ill., has recently added to its line of hand-operated metal punches a portable channel iron punch of the same general construction as the No. 2 punch manufactured by this company. All parts of the new channel iron punch are interchangeable with the standard No. 2 punch, which enables shops to interchange punches, dies, etc., between the two tools. The capacity of the channel iron punch is for holes up to 1/4 inch in diameter through iron 1/4 inch in thickness; and it is capable of reaching to the center of a 4-inch channel iron with 1 1/2-inch flanges. This is said to be the only portable channel iron punch on the market

NEW MACHINERY AND TOOLS NOTES

Portable Magnetic Separator: Cutler-Hammer Clutch Co., Milwaukee, Wis. A portable outfit for use in various departments of a factory for removing particles of iron from brass scrap.

Hanger Insert for Concrete: Diamond Expansion Bolt Co., 90 West St., New York City. Two forms of bolts for use in concrete buildings, to provide for securing pipe hangers and other supports to the walls, ceiling or floor.

Engine Lathe: McCoy-Brandt Machinery Co., House Building, Pittsburg, Pa. Heavy-duty engine lathe intended for use in machining shrapnel shells. The machine is built with a swing of 18 inches and an 8-foot bed. There are six changes of speed. The carriage is equipped with a six-hole turret or a compound rest as desired.

Screwdriver with Rubber Covered Handle: H. D. Smith & Co., Plantsville, Conn. A screwdriver which has a handle covered with hard rubber so that a very firm grip is secured. In addition, the rubber cover constitutes a safety feature when the screwdriver is used on electrical apparatus. The tool measures 11 1/4 inches in length.

Shell-Band Turning Lathe: Jenckes Machine Co., Sherbrooke, Canada. A machine particularly adapted for turning the copper rifling bands for use on the larger sizes of high explosive shells. The turning operation is performed by roughing and finishing tools which are carried at the front and back of the cross-slide, respectively.

Concrete Drill: Diamond Expansion Bolt Co., 90 West St., New York City. An improved form of drill for use in brick or concrete. This is an improved design of the drill formerly manufactured by this company, the chief improvement consisting of the provision of an adjusting screw for regulating the power of the blow delivered to the drill.

Bar Bending Machine: Wallace Supplies Mfg. Co., Chicago, Ill. A machine adapted for heavy bending operations such as bending 1 1/4-inch twisted reinforcing bars to any desired angle or to a U-shape. The machine is also suitable for bending ordinary square, round or flat iron bars; and can be arranged for bending channels, T-irons, etc.

Moving Picture Outfit: The Optigraph Co., Chicago, Ill. A portable moving picture projector which is particularly adapted for industrial purposes, such as showing prospective purchasers the operation of machine tools in which they are interested. The apparatus can be operated from an ordinary electric light socket and uses standard sized films and slides.

Work Cabinets: Berger Mfg. Co., Canton, Ohio. A line of pressed steel work cabinets developed for the purpose of providing secure and convenient storage facilities for dies, tools, blueprints, etc. The cabinets are substantially constructed of pressed sheet steel, and equipped with a heavy top which can be used as a bench for laying out work.

Special Punching Machine: Cleveland Punch & Shear Works Co., Cleveland, Ohio. A special punching machine of unusual size, which was designed and built for the Bethlehem Steel Co. for use in performing all punching operations involved in the fabrication of heavy steel sections. The machine has a capacity for punching eight 1-inch holes in 1-inch material.

Multiple Spindle Drill: Gem City Machine Co., Dayton, Ohio. A 44-spindle machine built for the purpose of drilling and countersinking holes in aluminum automobile retaining strips. Each of the spindles is equipped with a combination drill and countersink, and the machine is constructed in such a way that any number of spindles up to the full capacity may be used.

Multiple-spindle Drilling Machine: National Automatic Tool Co., Richmond, Ind. A ten-spindle drill which is known as the standard No. 13 machine of the line manufactured by this company. The same type of drill is also made with various numbers of spindles according to the requirements of different users. Both the table and drill head are adjustable on the column.

Tapping and Countersinking Machine: Poese Machinery & Mfg. Co., Cleveland, Ohio. An automatic machine designed for tapping either "blind" or through holes up to 1/4 inch in diameter. The machine taps the hole to the required depth, reverses and backs out the tool without requiring the operation of a hand lever or foot treadle. The weight of the machine is 125 pounds.

Saw Setting Device: Hunter Saw & Machine Co., Pittsburg, Pa. A device for setting the teeth of inserted-tooth saws. It is a generally known fact that in order to obtain the best results with saws of this type, the teeth must be set at exactly the same height. With the device developed by the Hunter Saw & Machine Co., all teeth can be set to an accuracy of 0.001 inch.

Slitting Machine: Charles Leffler & Co., 61 Clymer St., Brooklyn, N. Y. A machine for slitting metal sheets into strips. It is furnished with automatic power feed and a grinding attachment for sharpening the cutters. The cutters are 6 3/4 inches in diameter and double edged. The machine represents an improved design of the slitting machine formerly manufactured by this concern.

Sheet Metal Forming Machine: C. L. Frost & Son, Grand Rapids, Mich. A rolling machine for use in forming strips of sheet metal into various shapes. The capacity of the machine is for forming from 4000 to 4500 feet of strip metal per hour. The coil of material to be formed is placed on a reel at one end of the machine, from which it is drawn between the forming rolls as required.

Countershaft: Cincinnati Tool Co., Norwood, Cincinnati, Ohio. A "single-pull" countershaft in which the oscillating lever to which the cord is attached is kept in position by a compression spring which locks the shifter bar at the end of each stroke. A single pull of the cord stops or starts the machine; and, of course, the height of the ceiling does not affect the operation of the countershaft.

Sanitary Water Cooler: L. G. Stebbins, New London, Conn. A drinking water cooler particularly suited for shop use. The ice is placed in a separate compartment at the top of the cooler and the water melted from it runs down through a pipe into a false bottom, from which it is drawn off. The ice chamber is surrounded by an air-tight compartment which prevents the ice melting too rapidly.

Shrapnel Shell Grinding Fixture: Ransom Mfg. Co., Oshkosh, Wis. A fixture designed for use in removing the center bosses from shrapnel shells by grinding. This fixture is used in connection with a Ransom disk grinding machine, and enables this work to be done very rapidly and accurately. In finishing shells in this way, the work is placed in a V-block and does not require to be clamped.

Belt Shifter: Diamond Clamp & Flask Co., Richmond, Ind. This belt shifter has been developed to reduce the possibility of accidents in shifting belts. It is applicable to any type of countershaft which has a tight and loose pulley; but it cannot be used on a countershaft that has a reverse pulley. This shifter is made in five different sizes for handling belts ranging from 1 1/4 to 6 inches in width.

Autogenous Welding Table: Cave Welding & Mfg. Co., Springfield, Mass. A universal table designed to facilitate repair welding and manufacturing operations in which weld-

ing has to be done. The table is particularly suitable for use where it is desirable to strap the work down, and then alter the position of the table, as may be required, without loosening the straps until the welding is finished.

Heavy Wire Drawing Machine: Morgan Construction Co., Worcester, Mass. A machine developed for use in drawing large wire of round, square or hexagon sections. The accuracy of the product turned out in this way enables the stock to be handled in the gripping dies of automatic forming machines which require a smooth, clean bar of accurate size. The capacity of the machine is for drawing wire in sizes up to 1¼ inch in diameter.

Saw Tooth Grinding Machine: Huther Bros. Saw Mfg. Co., 1108 University Ave., Rochester, N. Y. A special type of grinding machine for use in sharpening saws of the inserted-tooth type which are used for cutting off bar stock and structural material. The grinding wheel can be set for various tooth angles. In operation, the saw is mounted on an adjustable table which is carried by the base on which the grinding wheel is mounted.

Multiple-spindle Drill: National Automatic Tool Co., Richmond, Ind. A No. 12 machine which is equipped with the company's regular type of attachment for throwing in or disengaging the power feed, and for making other adjustments. Two changes of power feed are provided, and there are four changes of speed ranging from 350 to 1020 revolutions per minute. The machine is equipped with a tapping attachment. Its weight is 2000 pounds.

Annealing Boxes: Pittsburg Annealing Box Co., Pittsburg, Pa. Reinforced boxes designed to withstand the intense heat employed in annealing furnaces. For this purpose forged supports or pedestals are provided which are riveted to the bottom and edges of the annealing boxes at the points subjected to the greatest strains. The pedestals support the boxes at a sufficient height from the floor of the furnace to permit a complete circulation of the hot gases all around the boxes.

Filing Machine: Robinson Tool Works, Inc., Waterbury, Conn. A No. 2½ machine which has been developed to meet the demand for a filing machine of larger capacity than has formerly been made by this company. Either regular files or special files with ¼-inch shanks can be used in the machine. The table is adjustable for any angle of clearance in the die which is to be filed, and has a working surface 8 inches square. The machine makes 600 strokes per minute and weighs 50 pounds.

Shell Banding Press: Chapman Double Ball Bearing Co. of Canada, Ltd., Toronto, Canada. A machine for use in compressing the copper rifling bands onto shrapnel shells. This press is of about the standard design; it has an 8-inch ram, a stroke of 8 inches, and a pressure capacity of 75 tons. The die is made with eight wedge-shaped fingers which are forced against the copper band when the ram is raised, by means of tapered surfaces on the outside of the wedges which engage a hardened steel ring secured to the top of the press.

Plain Turning Lathe: Earle Gear & Machine Co., Stenton and Wyoming Aves., Philadelphia, Pa. A heavy-duty, plain turning lathe built especially to meet the requirements of machining shrapnel and high explosive shells. The design has been developed along extremely simple lines and particular attention has been paid to securing a very rigid machine. The bed is 7 feet long and is cast integral with the headstock. Eight spindle speeds are available and there are twenty-four combinations of feed and speed.. The machine is made in three sizes of 18, 20, and 24 inches.

Precision Computer: Computer Mfg. Co., 25 California St., San Francisco, Cal. A circular slide-rule which has been developed by Louis Ross, and which is manufactured by the company referred to. The instrument consists of a graduated dial which rotates under a slotted cover, a floating guide, and a slide mounted beside the slot. The operation of the dial gives results to an accuracy of five significant figures. The slide carries a miniature of the dial and may be used separately to obtain an accuracy of three figures; it is used in connection with the dial to check the result obtained and to locate the decimal point.

* * *

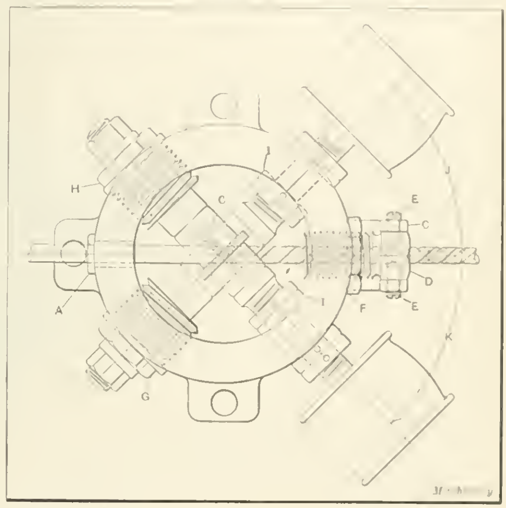
Years ago builders of transmission machinery turned shafting for their customers, but now the manufacture of turned shafting is no longer a profitable part of the business. Power transmission machinery concerns make hangers, couplings, clutches, pulleys, sheaves, etc., and furnish turned or cold-rolled shafting that is bought from the regular shaft making concerns. Turning shafting is somewhat like steel mill production, being a tonnage proposition. The power transmission concerns generally buy their shafting and sell it at a small profit to their customers when filling orders for power transmission equipment.

MACHINE FOR MILLING SPIRAL GROOVES

BY GEORGE WERNER, JR.*

We recently received an order which required two spiral grooves 1/16 inch deep by ⅛ inch wide, with a lead of 1 inch, to be milled in rods ⅜ inch in diameter. This work did not have to be very accurate, a tolerance of 0.005 inch being allowed. We used the milling machine and dividing head for cutting the grooves in the first lot of rods, but this method required a separate cut to be made for each of the two grooves in the rod, and consequently took considerable time. To enable the work to be handled more rapidly, I designed a special machine for milling the two spiral grooves simultaneously, thus greatly increasing the rate of production.

When using this machine it is first necessary to make a pilot or "leader" from a piece of rod 6 or 8 inches long and of the same diameter as the work. This leader has two spiral grooves cut in it of the same lead that it is required to mill, and is threaded on one end to enter a tapped hole in the end of the work. In assembling the machine, the leader is passed through the guide bushing *A* and moved past the milling cutters *B* to engage the nut *C* on the machine, which controls the lead of the spiral grooves that are milled in



Special Milling Machine for cutting Two Spiral Grooves in ⅜-inch Rods

the work. The leader is now set so that the rod to be milled will come into contact with the cutters; this rod is then screwed onto the leader and a clamp is attached to a rod at a point beyond the machine, so that it can be turned by hand, very little effort being required.

It will be evident that as the rod is turned, it is also drawn past the cutters through the connection of the threaded leader in the nut *C*; and that after the pilot has passed through the nut the grooved rod enters the nut and acts as its own leader. When pushed to its full capacity, the machine will cut the spiral grooves at the rate of 6 inches of rod per minute, but under ordinary operating conditions the rate of production is about 3 inches of rod per minute. The machine is so simple that any boy of average intelligence can be taught to run it. When the milling of the spiral groove in the rod is completed, the rod is cut up into pieces of the required length ready for use.

Having referred to the work done by the machine, a brief description will now be given of its design and construction. The arrangement of the guide bushing *A*, milling cutters *B*, and lead nut *C* have already been referred to. It will be seen that the nut *C* is carried at the end of threaded bushings *D*. The lead nut is formed by means of set-screws *E* which have pilots at their ends that are of the proper size

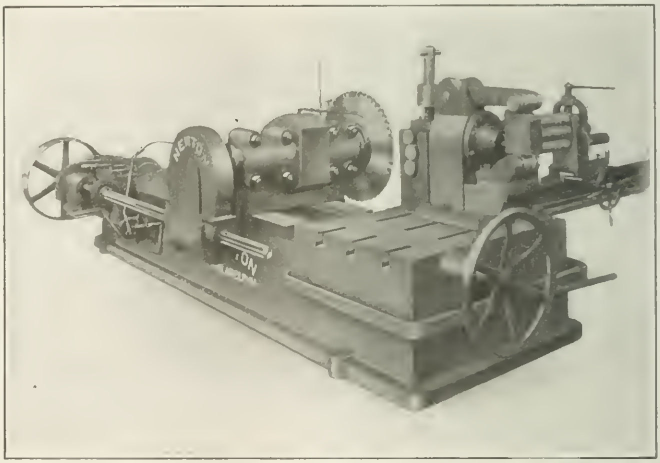
* Address: [illegible] S. 10th St., Newark, N. J.

to engage the grooves in the rod without any lost motion. The set-screws E are provided with lock-nuts, as shown; and a lock-nut F is also provided to hold the threaded bushing D in the required position. The outboard bearings G and H in which the spindles are carried are threaded into the frame of the machine so that they can be readily removed when it is necessary to change the cutters. It will also be noticed that adjusting collars I are provided at the pulley ends of the spindles. The angles J and K are equal to the spiral angles of the grooves being milled.

* * *

CUTTING OFF SHRAPNEL BLANKS ON NEWTON COLD SAWS

The demand which has been created by the manufacture of shrapnel and high-explosive shells in this country for machines to cut off short lengths from bar stock ranging from 3 to 9 inches in diameter, led the Newton Machine Tool Works, Inc., Philadelphia, Pa., to make a special study of the requirements which are imposed upon machines employed for this purpose. Investigations were conducted in plants of American and Canadian manufacturers and special tests were run off in the Newton Works. The data gathered from these sources has made possible the standardization of equipment for cutting off one, two, three, five and any other number of bars at a single operation. The machine shown in the accompanying illustration is arranged for cutting off three blanks from three bars 3⅝ inches in diameter at a time; and although much higher feeds are possible for demonstration purposes or even for continuous operations over considerable periods of time, the rate of feed recommended for regular work is 2 inches per minute when cutting three bars simultaneously, and 2½ inches per minute when cutting one bar at a time.



Newton Cold Saw equipped with Multiple Work-holding Fixture for cutting off Shrapnel Shell Blanks

In order to increase the rate of production by decreasing the loss of time which formerly occurred in setting up work in the machine, the use of a stock feeding trolley is recommended. Such an equipment acting in connection with the Newton air-controlled clamp with which the machine is provided, saves a considerable amount of time which would otherwise be lost between cutting operations, and also reduces the number of operators required to run the multiple machines. The rates of feed which have been previously referred to are calculated for constant service during twenty-four hours per day; and in determining these rates, consideration has been given to the cost of maintenance—especially in regard to saw blades. In the Newton cold saws, all bearings are bronze bushed, the driving worm-wheel is made of phosphor-bronze, and the worm is of hardened steel with a roller bearing to receive the thrust. The machine is provided with a lubricant pump and piping, and all gears are covered to conform with the most stringent safety laws.

* * *

Proper heat-treatment makes possible the use of gears of less heavy sections than would otherwise be required, and while this may not be necessary to save weight, it may be desirable to economize in space. The greatest advantage of heat-treated gears, however, is their long life, which means the elimination of repairs and replacements.

NEW IDEAS IN MECHANICAL EDUCATION

A number of new ideas in engineering and trade education have been inaugurated during the last few years, many of which give promise of considerable success. The most important of these is the "cooperative" engineering course at the University of Cincinnati. In order to give the student of engineering a theoretical and at the same time a practical training, a course of six years' study has been adopted. During this period the students work alternate weeks in the shops of the city and in the class-rooms of the university. The students are arranged in pairs, so that when one of them works in the shop, the other receives class-room instruction. The next week the two students will change places. In this way, the practical and theoretical training is carried on simultaneously, with very satisfactory results. During the summer months the students work the entire time in the shops. A system of this type, of course, can be instituted only in large industrial centers, where there are great numbers of shops, each of which is willing to take one or more pairs of students for training. Possibly there is not another city in the United States so well fitted for this type of engineering education as is Cincinnati. Nevertheless, the method must be considered as showing the most advanced idea in engineering education at the present time.

A similar plan adapted to mechanical trade education has been adopted by the high schools of Fitchburg, Mass., the idea having been patterned after the Cincinnati plan. In this case, the boys who wish to be apprenticed in the shops of the city are given an opportunity to acquire training in the shops at the same time that they receive a high school education. The course here is four years, the first of which is spent entirely in the school, while the next three years are spent one week in the shop and one week at the high school, the boys being arranged in pairs for this purpose and alternating with each other.

In Worcester, Mass., a distinct step toward better trade education also has been taken. The Worcester Trade School, the first building of which was opened in the early part of 1910, is intended to give a complete trade training to boys and young men between fourteen and twenty-five years of age. Instruction is offered in machine work, toolmaking, pattern making, power plant engineering, and a number of other trades. Each course comprises four years, and the hope is that when a boy has finished his course in this trade school, he will be able to obtain work in his trade at journeyman's wages. A complete shop equipment is maintained for this purpose, and the work, so far as possible, is conducted along commercial lines. It has been stated by Worcester manufacturers that, if anything, the boys who have been trained for four years in the trade school are worth more at the end of that time, than those who have been regularly apprenticed in the shop. This, of course, is due to the fact that when apprenticed in the shop, the boy is often kept on the same class of work for long periods of time, whereas in the trade school he is given an opportunity to broaden his knowledge, on account of the greater diversity of the work which he is called upon to do.

A new idea in engineering laboratories has also been developed recently. The old method of equipping an engineering laboratory at a school of technology was to buy, or to obtain as gifts, a variety of machines, equip the plant and testing room, and give the students year after year the same stereotyped course of practice and study. That was a convenient and simple method, as the instructor met few new problems, but after a few years the equipment became obsolete, and the students seldom obtained a knowledge of the latest practice. The new idea is exemplified in the Mason Laboratory of the Sheffield Scientific School at Yale University, and aims at a constant rotation of the equipment. No machines are bought—in fact, they are not even accepted as gifts, a radical departure in the practice of an endowed college or university; but Prof. Breckenridge, who is in charge of the mechanical engineering department, accepts with appreciation the *loan* of any machines—from electrical machinery and steam engines to machine tools and motorcycles—for experimental purposes, in order to carry out—by their aid—a number of tests, covering a period of several months. Then the machines are returned to the manufacturers in perfect condition, and other tools and machines take their place.

It is easy to see how great are the advantages of this system over the old permanent equipment system. In the first place, the students have an opportunity to familiarize themselves with a much greater variety of machinery during their term at college. They constantly see new things; their interest is increased; they do not get an opportunity to look upon their education as a fixed quantity—they become more aware of their limitations—a most important thing for a college student; and, last but not least, their whole education is more complete, and more in harmony with conditions in the outside world.

There is also another important aspect to the system of constantly changing the equipment. The effects upon the professors and instructors themselves must be very valuable. They are in this way enabled to obtain first-hand knowledge of new developments, and they are forced to keep pace with the progress of actual practice. The system increases their interest in their work, as it eliminates much of the set routine of the same tests being made over and over again, and the same machines—often old—being used constantly for demonstration purposes. It presents to them new problems which must be solved—thus preventing them from getting into a rut. Briefly, it ties the school and practical engineering closely together, and it is to be expected that the plan will be adopted by many more engineering educational institutions in the future.

* * *

In investigations to determine the effect of relative humidity on oak-tanned leather belts, made by Prof. William W. Bird and Francis W. Roys, of Worcester, Mass., as reported in a paper before the American Society of Mechanical Engineers, the general conclusions arrived at are as follows:

1. If a belt be set up at low relative humidity, slipping will probably occur if the humidity increases to any great extent, especially if accompanied by a rise in temperature.
2. If a belt be set up at high relative humidity, excessive pressure on the bearings and stretching of the belt will result from a decided decrease in humidity, especially if accompanied by a fall in temperature.
3. If a belt be set up at a medium relative humidity, the tensions will not be excessive at lower humidities, nor will there be any great danger of slipping at higher humidities, unless accompanied by excessive temperature changes; in other words, the factor of safety in the ordinary belt rules is sufficient to take care of the effect of changes in the relative humidity if the set-up be made at a medium per cent of relative humidity.
4. If a belt be set up at any relative humidity with a spring or gravity tightener, a load 50 per cent greater than the standard can be transmitted at either high or low humidity without danger of stretching the belt, slipping or excessive pressure on the bearings.

THE ELECTRIC INCANDESCENT LAMP

October 21 will be commemorated as the thirty-sixth anniversary of the invention of the electric incandescent lamp by Thomas A. Edison. Carbonized cotton thread and narrow paper strips were used first for the filaments, but were too fragile and short-lived to be commercially used. A search for grasses and fibers throughout the world resulted in the discovery of the value of Japanese bamboo for the purpose, and carbonized bamboo was the only substance used for about ten years. This was followed by the "squirted" filament, employing carbonized cellulose in one form or another, next the metallized carbon filament, then the pressed tungsten filament and finally the special form of drawn tungsten wire used in the modern Mazda lamps. Working down from a consumption of four or five watts of electrical energy per candlepower in the carbon filament lamps to the standard a few years ago of 3.10 watts per candlepower, the Mazda lamp has brought this down in about five years to about one watt. In the larger sizes of Mazda gas-filled lamps, the reduction in current consumption has reached the low level of nearly a half-watt per candlepower. And no one can forecast the marvels that are yet to be unfolded in electric lamps and methods of lighting. Light without heat is the ideal, but that is still far off. The electric incandescent lamp of today contains the cheapest form of filament that has ever been produced, but some day it will be better and cheaper still.

* * *

An interesting paper has been read before the Academy of Sciences, in Paris, describing experiments undertaken to determine the velocity of the waves used in wireless telegraphy. These experiments were undertaken first between Paris and Toulon in France, and finally between Paris and Washington. The methods employed to measure the time enabled the measurement precisely of an interval of 0.00001 second. It was found that the wireless telegraphy waves are carried along the surface of the earth with a velocity slightly less than that of light.

* * *

PERSONALS

H. C. Elliott, vice-president of the Marshall & Huschart Machinery Co., Chicago, resigned, his resignation taking effect September 1.

R. S. Bryant, for many years consulting engineer of the Standard Welding Co., Cleveland, Ohio, has been appointed factory manager in charge of all manufacturing.

H. L. Wittstein, efficiency engineer with the Knox Motors Co., Springfield, Mass., has resigned to take the position of assistant to the management of the Standard Fuse Corporation of Paulsboro, N. J.

L. F. Hamilton, advertising manager of the National Tube Co., Pittsburg, Pa., was awarded a gold medal for planning the exhibits of the National Tube Co. at the Panama-Pacific International Exposition in San Francisco.

L. S. Neuschul, engineer and director of M. Mett Engineering Co., Petrograd, Russia, is making a trip through the Middle West for the purpose of obtaining a representation for a few more lines of machine tools in Russia.

B. J. Morrison, mechanical engineer and general manager of the National Supply & Equipment Co. of Philadelphia, Pa., is in Europe on a three to five months' business trip, acting as consulting engineer for some American concerns.

A. B. Hazzard, president of the Falcon Motor Truck Co of Detroit, Mich., has been appointed general works manager of the Hall Switch & Signal Co., Garwood, N J. Mr Hazzard was for ten years general manager of the J. Morton Poole Co., Wilmington, Del.

W. S. Hardy, for the past eleven years connected with the Diamond Rubber Co. and the B. F Goodrich Co., and lately in charge of the sales of their mechanical rubber goods division, has been appointed sales manager of the Boston Belting Co., Boston, Mass., manufacturer of mechanical rubber goods.

A. B. Howard, for many years connected with the New York office of the American Express Co., 65 Broadway, has sailed for Buenos Aires to establish the initial South American office of the American Express Co., where Mr. Howard, as manager of the South American department, will make his headquarters.

John J Eberhardt, foreman with the Simonds Mfg., Co., has been promoted to the position of superintendent of the Fitch-

Simple Control—

For Easy Operation

That's characteristic Brown & Sharpe design—simplifying and centralizing the control so that operation is easy and natural. Every handwheel and lever is located where an operator can get at it without reaching. Speeds and feeds are quickly controlled from a *single point.* Through this mechanism an almost universal range of independent speeds and feeds can be instantly secured. The two levers around the dial at the left of the machine marked "Head" and "Table" control the speed of the respective parts.

For Fast Production

This mechanism is an important factor. To begin with, the *most productive* combination of speed and feed can *always* be obtained, and obtained quickly too. Then the long lever behind the dial controls the entire machine, independent of the grinding wheel. By pressing down on this lever the table and headstock are *instantly* stopped—*one* simple motion does it. The work can be quickly removed, another piece put in, the lever pulled back, and the machine is again in operation. Non-productive time between grinding is thus reduced to a minimum.

For Uniform Results

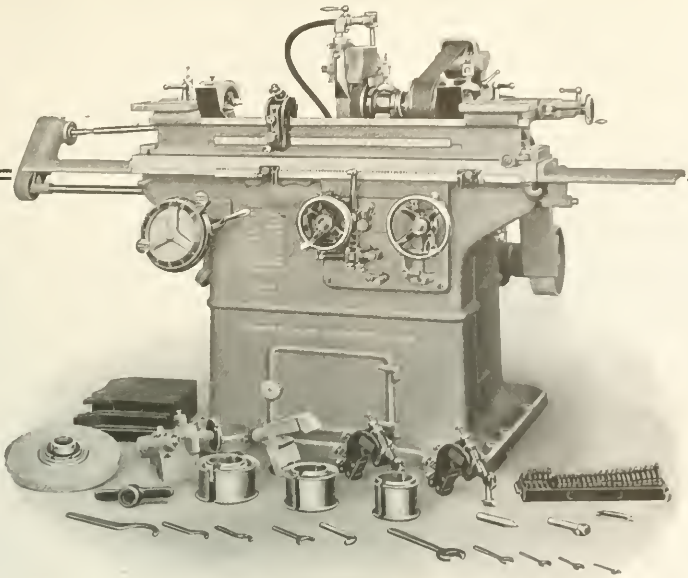
in the quality of work and cost of production you have exactly the required features in Brown & Sharpe machines. When a job is done under conditions that give satisfactory production the natural thing to do when that job comes in again is to duplicate those conditions.

That's very easy with our variable speed mechanism. If slight variations are necessary to meet some new condition the combination of speed and feed can be varied to suit. The best working conditions are always available, keeping costs low and uniform.

Brown & Sharpe Mfg. Co.

OFFICES: 20 Vesey St., New York; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.



No. 11 Plain Grinding Machine

This representative of our line, shown above, in addition to being equipped with the feature just described is entirely self-contained, resulting in a more efficient drive, the practical elimination of overhead works, and adaptability to motor drive.

A high degree of accuracy in the work produced is assured by the true, carefully made alignments and the solid support and rigid construction which insure the maintenance of the original accuracy through years of service. And production—well, it's a very unreasonable demand in this direction that this machine cannot meet. In fact on some work the productive capacity of the machine is limited to the speed of the operator in handling the work. In this connection there's an advantage that cannot be over-emphasized. This machine is so handy, efficient, and smooth-running that an operator has no difficulty in maintaining maximum and uniform production throughout the day. There's no afternoon fatigue attendant upon the operation of these machines. Your operators will like them. So will your production men.

If your shop is not equipped with any of these handy machines get in touch with us and we will show you where we can reduce your grinding costs and keep them uniform. Descriptive literature free on request, also our booklet, "Points About Grinding Wheels and Their Selection."

Providence, R. I., U. S. A.

CANADIAN AGENTS: The Canadian Fairbanks Morse Co., Ltd., Montreal, Toronto, W[illegible]ipeg, Calgary, Vancouver, St. John.

FOREIGN AOENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheff[illegible], Glasgow [illegible] Fra[illegible]rt a M. Germany, V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; [illegible] Petrograd, R[illegible] Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; The F. W. Horne Co. [illegible] L. A. Va[illegible] Me[illegible] Austra[illegible], F. L. Strong, Manila, P. I.

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burg, Mass. shops of that company, succeeding Gifford K. Simonds. Mr. Eberhardt has been connected with the company for the past six years, having served as foreman in several departments. He was previously with the Iver Johnson Arms & Cycle Works of Fitchburg.

Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Mfg. Co., has been named a member of the Naval Advisory Board by Secretary of the Navy Daniels. Mr. Lamme is a graduate of the Ohio State University. He entered the employ of the Westinghouse Electric & Mfg. Co. in the testing department in 1889; in 1900 he was made assistant chief engineer, and succeeded to the position of chief engineer in 1903.

J. A. Massel, special agent of the Department of Commerce, has been making a tour of American cities for the purpose of ascertaining the general interest in South American trade. He found lively interest in the subject, manufacturers generally expressing willingness to expend reasonable sums to lay the foundations for substantial trade relations in the South American field. Mr. Massel's headquarters are Room 409, Custom House, New York City.

Leo. T. Neidow and Frank G. Payson have opened offices in the Madison Terminal Bldg., 9 S. Clinton St., Chicago, Ill., under the name of Neidow & Payson, where they will conduct a general machinery agency. Mr. Neidow has been with the Niles-Bement-Pond Co. for the past eighteen years in the Chicago office. Mr. Payson was formerly with the Niles-Bement-Pond Co., and for the past four years was western representative of the Union Petroleum Co., Philadelphia, Pa., mineral lard oil department.

* * *

OBITUARIES

John C. Wood, for more than fifty years connected with the U. S. Government Armory at Springfield, Mass., died at his home in Springfield, September 10, aged eighty-eight years.

Edward W. Moore, formerly United States commissioner of patents and an expert in patent law, died at his home in Washington, D. C., September 6, aged sixty-three years. Mr. Moore was commissioner of patents from 1907 until 1913.

Samuel T. Davis, Jr., president of the Locomobile Co. of America, Bridgeport, Conn., died at his summer home at Fairfield, Conn., September 1, aged forty-two years. Mr. Davis was a founder and the first president of the National Association of Automobile Manufacturers which later became the Automobile Chamber of Commerce, of which he was a director He was a pioneer in automobile manufacturing.

COMING EVENTS

October 28-29.—Annual convention of the National Machine Tool Builders Association, Hotel Astor, New York City. Charles E. Hildreth, general manager, Worcester, Mass.

December 7-10.—Annual meeting of the American Society of Mechanical Engineers, New York City; Engineering Societies Bldg., headquarters. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

University of South Carolina, Columbia, S. C. Catalogue 1915-1916, containing the calendar for the sessions 1914-1915 and 1915-1916, as well as an outline of the courses included in the curriculum of the university.

School of Mines and Metallurgy, University of Missouri, Rolla, Mo. Bulletin for March, 1915, from catalogue 1914-1915, giving the calendar for 1915-1916, and information on the courses in mine engineering, metallurgy, civil engineering and general science that this university offers.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of evening technical courses, 1915-1916. The courses comprise chemistry, civil engineering, electrical engineering and physics, mechanical engineering, mathematics, English, French, German, Spanish, history, economics and physical training.

Columbia University, New York City, has established a separate department of chemical engineering upon the same plane of importance in the Columbia graduate engineering school as mining, civil, electrical and mechanical engineering. The head of the new department will be Prof. M. C. Whitaker, who has been professor of chemical engineering at Columbia University for the past five years.

Wentworth Institute, Huntington Ave. and Ruggles St., Boston, Mass. Catalogue of the Wentworth Institute for 1915-1916. Two new courses have been added, the first being a one-year day trade course in forging, hardening and tempering, and the second a one-year day trade preparatory course intended for young men who wish to enter some one of the manufacturing industries. The Institute also offers for the first time the second year of its course in architectural construction. This course is for training building superintendents, specification men and constructionists for architects and building contractors.

NEW BOOKS AND PAMPHLETS

The Testing of Rubber Goods. 89 pages, 7 by 10 inches. 85 illustrations. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 38.

Specific Heat and Heat of Fusion of Ice. By H. C. Dickinson and N. S. Osborne. 32 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 248.

A Study of the Quality of Platinum Ware. By George K. Burgess and P. D. Sale. 20 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 254.

Measurements for the Household. 149 pages, 7 by 9 inches. 62 illustrations. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 55.

The purpose of this circular is to give information as to units, methods and instruments of measurement useful in household activities, and to describe the available means of assuring correct quantity of articles bought by weight and measure. The aim is to awaken appreciation of the importance of correct measurements in the daily life of the family.

The Modern Gasoline Automobile—Its Construction, Operation, Maintenance and Repair. By Victor W. Page. 873 pages, 5 by 7½ inches. 411 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $2.50.

This book is the 1916 edition of a work that has been noticed in these columns before. A 55-page supplement treating of the twelve-cylinder V-motor, eight-cylinder V motor, new valve operating systems, Stewart vacuum fuel feed, electric self-starting principles, cantilever and underslung springs, tilting steering wheels, hydraulic brakes, etc., has been added which brings an already excellent work up to date, making it one of the most practical treatises on the modern gasoline automobile published.

Effective Business Letters. By Edward Hall Gardner. 376 pages, 5¼ by 7¼ inches. Published by the Ronald Press Co., New York City. Price, $2.

An enormous amount of business is done by correspondence, and it is highly important that business letters be clear, concise and accurate in statements. The book was written for those in business or who intend to enter business, its object being to supply in systematic form the principles embodied in the best modern business letters. It treats of the general principles of business correspondence, the importance of appearance and correctness, the make-up of the letter, paper and envelopes, printing, mistakes in language, how letters asking for information should be written, etc. As might be inferred, the principles are demonstrated with many examples of letters, offered as suggestions of form.

Practical Mechanics and Allied Subjects. By Joseph W. L. Hale. 228 pages, 4½ by 6¾ inches. 201 illustrations. Published by the McGraw Hill Book Co., Inc., New York City. Price, $1, net.

This book is based on the author's appreciation of the needs of trade apprentice schools. Difficulty has been experienced in securing books suitable for these schools, and this work was compiled to meet these needs as the author saw them. It treats of forces, gravitation, center of gravity, density and specific gravity, screw threads, calculation of levers, pulleys (block and tackle), inclined planes and wedges, screws, gears, lathe gearing, belts and pulleys, efficiency of machines, motion, cutting speeds, speeds of lathes, volume and pressure of gases, work and power, calculation of belting, energy, logarithms, measurement of right triangles, measurement of oblique triangles, electricity and strength of materials. As indicated in the foregoing enumeration of contents, the book covers a wide range of subjects, and of course it deals with the elements only.

Valves and Valve Gears. By Franklin DeR. Furman. 200 pages, 6 by 9 inches. 213 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $2, net.

The second part of this work on valves and valve gears treats of gasoline, gas and oil engines, while the first volume treated of steam engines and steam turbines. It deals with the general characteristics of internal combustion engines, the commercial applications of various forms of valves and valve gears to gasoline engines, gas engines, aeroplane engines, Diesel oil engines, and compares prime movers. This volume, doubtless, will be more highly appreciated, if possible, than the first, dealing as it does with the characteristics of the internal combustion motor which has become of such great importance within the last decade because of the widespread development of the automobile, the motor boat and the aeroplane. Valve constructions once believed to be out of the question for gas engines, are now freely admissible and some of them promise to rival the old reliable poppet valve because of their smoother action and more easily controlled operation. This treatise on valves and valve gears is recommended to all wishing to obtain an up-to-date and reliable work.

Principles and Practice of Linear Perspective. By Herman T. C. Kraus. 53 pages, 9½ by 14½ inches. Fifteen plates. Published by Norman W. Henley Publishing Co., New York City. Price, $2.50.

This is a well worked up and typographically pleasing work on the theory and practice of linear perspective as used in architectural, engineering and mechanical drawing. The book is made large enough so that complete perspective drawings in a fair scale can be reproduced on a single page. The plates are all at the left-hand side, while the descriptive text explaining the plate is given on the opposite page, making reference to the illustrations very convenient. The work comprises a complete course in perspective drawing. One of the plates entitled "Self-explanatory Linear Perspective Chart" gives in brief outline the fundamentals of perspective drawing, together with a clear illustration of the methods used. On this chart all construction lines are shown by fine dotted lines, and the names and purposes of these lines are clearly indicated. This chart alone constitutes, practically speaking, a condensed course in perspective drawing. The book can well be recommended to those who wish to make a comprehensive study of perspective drawing.

Problems Pertaining to Steel Tubes. By O. G. Wellton. 172 pages, 5 by 7 inches. 34 illustrations. Published by C. W. K. Gleerup, Lund, Sweden. Sold in the United States by D. Van Nostrand Co., New York City.

The author of this book, who for several years was lecturer and assistant professor of mechanical engineering in the School of Mining, Queens University, Kingston, Canada, has recorded in this book the results of his investigations into the mechanical problems pertaining to steel tubes when used as conductors of liquids above ground. The treatise is profound in character, dealing in a highly scientific manner with the subject, and analyzing it by the aid of mechanics and mathematics. As practically nothing has been published on this subject in the past, the book no doubt will prove of interest to those of an investigating type of mind, to whom mathematical discussions and scientific methods of treatment are not objectionable. The book is divided into a number of chapters, of which the first introduces the subject in a general manner, defines the problem, deduces the bending moments, derives the normal and shearing stresses, and discusses the maximum error due to approximations. The deformation of the shell is then taken up. In a second chapter, the problem is taken up, including the weight of the shell. This naturally complicates the whole question somewhat and, in a third chapter, the conclusions obtained in the two previous chapters are combined, thus treating as one the two problems previously proposed. The book gives evidence of great thoroughness in its preparation and is an example of the enormous amount of work required to investigate scientifically a single mechanical problem.

NEW CATALOGUES AND CIRCULARS

Gould & Eberhardt, Newark, N. J. Circular of a continuous circular milling machine.

Crucible Steel Co. of America, Pittsburg, Pa. Booklet of "Rex" high-speed steel, containing suggestions for heat-treatment, etc.

J. G. Blount Co., Everett, Mass. Catalogue 17 descriptive of the line of grinding and polishing machinery and speed lathes made by this company.

Royersford Foundry & Machine Co., 54 N. 5th St., Philadelphia, Pa. Circular of the "Excelsior" twenty-inch double back-geared vertical drilling machine.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Bulletin 5003 illustrating nosing and banding presses for use in the manufacture of steel shells.

American Blower Co., Detroit, Mich. Bulletin entitled "Sirocco Service," illustrating Sirocco heating and ventilating outfits installed in a large variety of plants.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 130 on the lubrication of pneumatic tools, illustrating and describing automatic oilers and grease machines.

General Electric Co., Schenectady, N. Y. Pamphlets on constant current transformers for "Mazda"

street lighting systems, and "Novalux" street lighting units for "Mazda" series lamps.

Lumen Bearing Co., Buffalo, N. Y. Booklet on babbitt metals, listing the general line of babbitts made by this company, and giving the composition of each and the use for which they are adapted.

Speed Controller Co., Inc., 257-259 William St., New York City. Circular of the arc controller, a device for regulating the feed of the carbons in arc lamps so as to maintain perfect lighting efficiency continuously.

Columbus Lift Truck Co., Columbus, Ohio. Circular of the Columbia lift truck for handling materials. This truck is made in three styles and two capacities—the capacities being 1000 to 1500 pounds, and 2000 to 2500 pounds.

Lapointe Machine Tool Co., Hudson, Mass. Catalogue of Lapointe machines and tools for broaching. Some interesting examples of work done on this machine are shown, illustrating the economies that can be effected by broaching.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Bulletin 5002 illustrating and describing a hydraulic press designed for billet piercing and drawing operations on steel shells. These presses have pressure capacities ranging from 150 to 1000 tons.

National Machinery Co., Tiffin, Ohio. Tapper Talk 11 discusses the retooling of the National automatic (bent tap) nut tapper. It is claimed that the average operator, after a little experience, can change the machine when tapping square nuts for tapping hexagon nuts, or vice versa, in fifteen or twenty minutes.

Baldwin Locomotive Works, Philadelphia, Pa. Record No. 81 on the triple articulated compound locomotive built for the Erie Railroad Co., illustrating and describing in detail this ponderous locomotive which has twenty-four driving wheels; the total weight is 853,050 pounds and the tractive effort 160,000 pounds when working compound.

New Departure Mfg. Co., Bristol, Conn. Bulletin 43 FE of miscellaneous nut locking and bearing retention methods of value in machinery design; 44 FE, ball bearings in portable electrically-operated drilling machine; 45 FE ball bearings for water and air pump crankshafts; and 46 FE, ball bearing mounting for lineshaft friction clutch.

Thomas Elevator Co., 20-22 S. Hoyne Ave., Chicago, Ill. Circular of the "Baker" wrenchless chucks for lathes. The Baker wrenchless chuck is operated by a hand lever, the opening and closing of the jaws being actuated by a set of gears constantly in mesh, two of which are mounted on swinging arms to which the lever is attached.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has recently issued leaflets 3805, 3806, and 3807 on the application of automatic control apparatus to cranes and steel mills. They show the scheme of main connection, and describe the method of operation of the magnetic unit switches, as arranged for the severe service of steel mill practice.

Boston Gear Works, Norfolk Downs, Mass. Catalogue E8 of cut steel, cast iron and brass spur gears, brass racks, brass internal gears, steel, cast-iron and brass bevel gears, worms and worm-wheels, helical gears, ratchets, sprockets, transmission chain, universal joints, hobs, automobile gears, Hindley worm-gears, etc. Data and tables useful to mechanics are included.

Union Chain & Mfg. Co., Seville, Ohio. Folder describing the construction of the new Union steel rivetless chain. The links of this chain are stamped and formed in one piece, producing a rigid and self-contained construction that dispenses with riveting. When worn, the bushings and pins can be used upside down, thus bringing the unworn surfaces into service and giving the chain a double life.

Joseph Dixon Crucible Co., Jersey City, N. J., has published a twenty-page treatise by F. J. Jarosch, chief engineer of the Bearings Co. of America, entitled "The Use and Abuse of Ball and Roller Bearings." The text gives help in the selection, mounting and lubrication of ball and roller bearings in automobile construction, etc. Nineteen drawings were used to illustrate the article.

Standard Machinery Co., Auburn, R. I. General catalogue on presses, illustrating reducing presses—plain and back-geared—inclinable presses, arch frame presses, toggle or knuckle joint embossing presses, transfer presses, cut and carry presses, heavy double-acting and cam presses, armature notching presses, etc. The clutches used on the "Standard" power presses are described and illustrated in detail.

A. D. Granger Co., 90 West St., New York City. Bulletin 2 describes and illustrates the latest improved features of the "Oswego" internally fired water-tube boilers, and gives tables of dimensions, ratings and other data for both high-pressure and low-pressure boilers. The booklet shows illustrations of buildings in which these boilers have been installed, among which are office buildings, public schools, apartment houses, factories, etc.

International Oxygen Co., Newark, N. J. Catalogue of the I. O. C. system production of pure oxygen and hydrogen for the use of plants desiring to produce their own gases for oxy-acetylene welding and cutting. The method utilized in this system consists in separating water into its constituents—oxygen and hydrogen—by means of an electric current. The advantages claimed for the system are low cost of operation, safety, durability, simplicity of operation, regularity, and the fact that no attention is required beyond the addition of the necessary amount of distilled water daily. The book illustrates a large number of installations of I. O. C. plants in the United States and abroad.

Wells Brothers Co. Division Greenfield Tap & Die Corporation, Greenfield, Mass. Catalogue 34 of the "Little Giant" line of screw cutting tools and machinery, which includes taps, dies, screw-plates, die stocks, reamers, gages, automatic opening dies, threading machines, ratchet wrenches, etc. A folder in the front of the book lists the changes and additions that have been made since previous catalogue 30 was published. This catalogue is very comprehensive, containing 319 pages, 4½ by 7¼ inches. In addition to illustrating the general line, it includes many tables of useful information, among which are tables of tap drill sizes, giving the corresponding size of drills for every size and pitch of different thread standards.

American High-speed Chain Co., Commercial Drive Division, 608 S. Dearborn St., Chicago, Ill. Catalogue on American high-speed silent chain made in any pitch and width for all purposes. The catalogue shows this type of chain installed for various power transmission purposes, and gives suggestions on its erection, lubrication, etc. Some of the advantages claimed for this chain are that it is silent running, does not slip, is adaptable for use in cramped or other difficult positions, is unaffected by heat, cold, moisture or greases, maintains positive and correct gradation of speeds, and drives cutting tools smoothly. The book contains tables of horsepower of chains and dimensions of regular type, double side bar type and single-side bar type chains.

National-Acme Mfg. Co., Cleveland, Ohio. New blueprinted catalogue of National-Acme auxiliary screw making machines. The special machines illustrated and described are adapted to the so-called auxiliary operations on small work that must be completed after the parts leave the screw machines. The machines shown comprise semi-automatic screw slotting machines, single-spindle drilling machine, semi-automatic multiple-spindle drilling machine, automatic six-spindle drilling machine, stud threading machine, two-spindle bolt threaders, screw head shaving machine, coupling tapper, tool grinder and self-opening die-head. The illustrations in the book are blueprints and the reading matter is printed in blue ink, presenting a unique and attractive appearance.

Ford Motor Co., Detroit, Mich., has issued a pamphlet entitled "Helpful Hints and Advice to Ford Employes" that outlines the Ford profit-sharing plan. The book is intended to supplement the work of the Ford investigators, but should prove of interest to others engaged in welfare work. The object of the Ford plan is to improve the living conditions and morals of Ford employes, and to encourage habits of thrift and saving. The illustrations show types of good and bad homes, sanitary and unsanitary living conditions and good and bad neighborhoods. Of particular interest are the views showing workmen's homes before and after the inauguration of the profit-sharing plan. The "Safety First" section gives suggestions for the prevention of accidents both in the shop and in the home, and shows some horrifying examples of the result of neglecting the necessary precautions.

TRADE NOTES

Frost Gear & Machine Co., Jackson, Mich., manufacturer of gears and forgings, has changed its name to the Frost Gear & Forge Co.

Chicago Automatic Machine Co., Chicago, Ill., maker of automatic screw machines, has erected a large addition to its factory which doubles its capacity.

Vitrified Wheel Co., Westfield, Mass., manufacturer of grinding wheels, has begun the construction of a two-story addition, 40 by 100 feet, to its main factory.

Mechanical Handler Co., Hudson, N. Y., builder of elevating and conveying machinery, has erected a new factory, and equipped it with machine tools suited to jobbing and general manufacturing.

American Steel Foundries, McCormick Bldg., Chicago, Ill., has installed a six-ton electric furnace of the Heroult design at its Indiana Harbor, Ind., plant, for the manufacture of extra quality steel castings.

Monarch Machine Co., Sidney, Ohio, manufacturer of the "Monarch" engine lathe, has just completed another addition to its plant. The new building is 56 by 200 feet. The firm name has been changed to Monarch Machine Tool Co.

Tropenas Converter Co., 50 Church St., New York City, has opened a new laboratory at 2243 Nostrand Ave., Brooklyn, N. Y., where business of an executive nature will be transacted. The office at 50 Church St. will be maintained also.

Enkel Motor Co., Inc., Auburn, N. Y., has developed a four-cylinder Diesel type motor which operates successfully on kerosene oil. The expectation is that the new engine will be used for motor cars, kerosene being the fuel instead of gasoline.

L. H. Gilmer Co., 52 N. Seventh St., Philadelphia, Pa., manufacturer of endless belts, announces that Manning J. Smith, formerly treasurer, has been succeeded by J. S. Krauss, secretary, who was elected to the office of treasurer, thereby becoming secretary and treasurer.

Burke Electric Co., Erie, Pa., manufacturer of electric motors and generators, electric arc welding equipments, motor generator sets, transformers, etc., has appointed W. T. Osborn as its direct sales representative in charge of the Kansas City branch sales office located at 1505 Commerce Bldg.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, announces that the following officers have been elected: A. Q. Tucker, president; W. G. Beebe, vice-president; Frank B. McMillin, general manager and secretary; and M. W. Spear, treasurer. Dr. N. Tucker has been added to the directorate.

Aurora Steel Co., Aurora, Ill., has been incorporated by Alex. Nelson, D. R. Furnas, A. R. Carlson and P. R. Sparks. The incorporators were formerly with the All Steel Equipment Co. of Aurora. The new concern will manufacture machine shop equipment such as racks, bins, tote pans, etc., and a general line of factory equipment.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, made an exhibit of hydraulic presses and machinery at the Panama-Pacific International Exposition. The grand prize from the department of agriculture for press machines and the gold medal from the department of machinery, for forcing and bending presses and equipment, were awarded.

Waltham Emery Wheel Co., Waltham, Mass., manufacturer of grinding wheels has changed its corporate name to the Waltham Grinding Wheel Co. The change was made to eliminate the term "emery" which was a misnomer, giving the impression that the company's product consisted of emery wheels, when as a matter of fact its wheels are made principally of electric furnace abrasives.

Pedrick Tool & Machine Co., 3639 Lawrence St., Philadelphia, Pa., recently purchased the business, machinery, stock and equipment of the Sterling Machine Co., Norwich, Conn., manufacturer of the "Marathon" tool grinders and the "Sterling" grinder. It is the intention of the purchaser to continue the manufacture and sale of these grinders, following the reorganization of the business under its own management.

American Express Co., 65 Broadway, New York City, has opened an office in Buenos Aires in charge of A. B. Howard, manager of the company's South American department. Manufacturers are invited to investigate the service that will be rendered, which includes negotiating foreign exchange, forwarding freight and packages, examining opportunities for trade, displaying catalogues, making collections, looking after the mail of patrons, etc.

Westinghouse Electric Export Co., 165 Broadway, New York City, announces the election of the following officers at the meeting of the board of directors held July 28: E. M. Herr, president; L. A. Osborne and Calvert Townley, vice-presidents; Maurice Coster, managing director; J. C. Bennet, secretary; and H. D. Shute, treasurer. President E. M. Herr appointed E. D. Mills manager, E. R. Ellis, European manager and H. F. Griffith, assistant export manager.

Cowan Truck Co., Holyoke, Mass., maker of the Cowan transveyor, had the distinction of having its transveyor selected at the Panama-Pacific Exposition for transporting the Liberty bell to its place. The transveyor used is of a heavy hydraulic type, built to elevate and carry five thousand pound loads. The bell which weighs 2080 pounds has up to this time been a cumbersome object to handle, a large derrick having been the means heretofore of moving it from one place to another.

American Emery Wheel Works, Waterman, East River and Pitman Sts., Providence, R. I., is completing large additions, including a new third-floor office 50 by 100 feet. The remainder of the third floor, approximately 50 by 200 feet, together with the first floor space vacated as offices, has been released for additional factory purposes. A new kiln building and four additional fifteen-foot kilns are being erected. All necessary equipment including new elastic oven, gravity elevator system, etc., has been purchased.

Sociedad General de Representaciones, Madrid, Spain, contractors to Spanish war and navy offices, public works, railroad and tramway companies and dealers in American machine tools, elevators, cranes, derricks, electric machinery, locomotives, automobiles, motor trucks, ammunition, etc., have established a New York City office in Room 603, 30 Church St. The office will be under the personal direction of the company's general manager, Henry S. Moos and he will be assisted by Dwight W. Grover, manager of the New York office.

National Tube Co., Frick Bldg., Pittsburg, Pa., was awarded the grand prize, the highest possible regular award for the general excellence of its tubular products and fittings exhibited at the Panama-Pacific International Exposition. The greatest merit was recognized in the following special products: "National" oil well casing, tubing, drill pipe, drive pipe, drill pipe and tubing with upset ends, line pipe, lead joint pipe, "Spellerized" pipe and boiler tubes, and steel poles; "National" protective coating; "Kewanee" unions, valves and fittings; Shelby special alloy steel tubing, cylinders, flasks, steam pipe, drill pipe, mechanical tubing and trolley poles.

Fore River Shipbuilding Corporation, Quincy, Mass., is building a plate and angle shop, 188 feet wide and 769 feet long. The building has steel columns and trusses with a plank roof covered with tar and gravel. The sides are largely of glass in steel sash, with pilasters of brick. There is one high story for handling plates and angles for shipyard work. A partial second story above this includes the mold loft, 92 feet wide by 605 feet long and a sheet metal shop 92 feet wide by 164 feet long. The Aberthaw Construction Co. of Boston, in charge of the building, is erecting the steel columns of unusually large rolled sections, some of them being 30-inch I-beams weighin[g] 200 pounds per foot.

Turbo-Gear Co., Industrial Bldg., Baltimore, Md[.] maker of a helical reduction gear designed by G[.] Fast and described in the June, 1915, number, ha[s] made public reports of a test of a turbo-spe[ed] transformer conducted by the Consolidated Gas, Electric Light & Power Co. of Baltimore. The gear tested was designed for transmitting 25 H.P.

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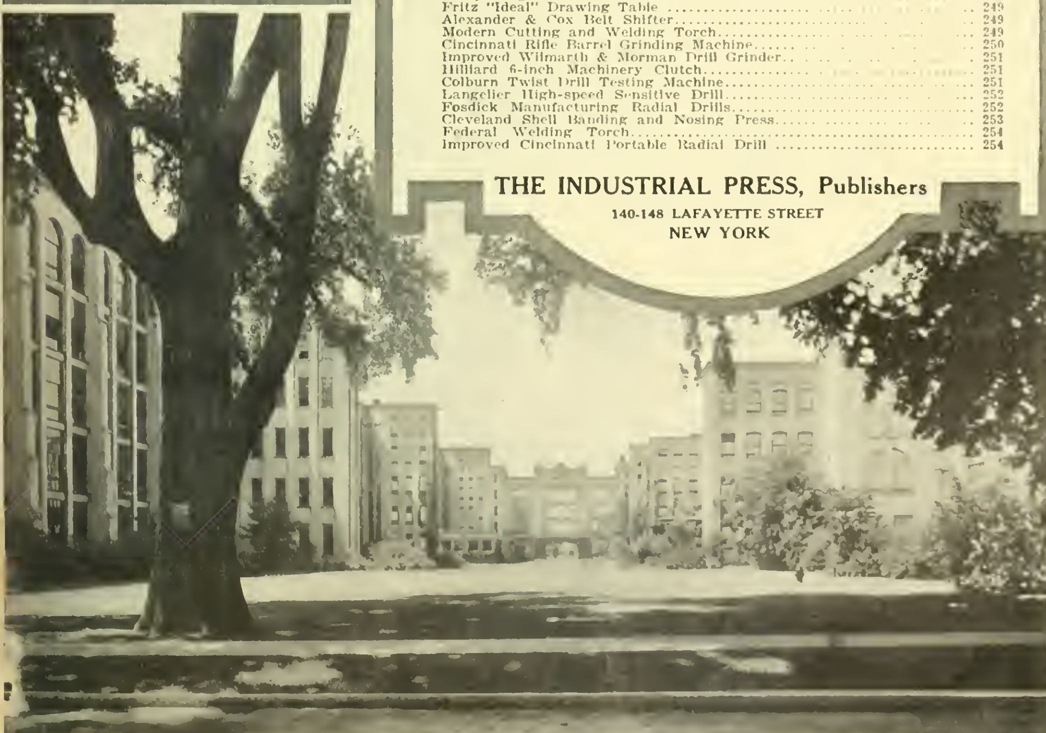

The Modern Spirit in Industry

Slowly and painfully, through the centuries, humanity acquires knowledge and wisdom, which are two different things. How many primitive men had been crushed and clawed into eternity before a really effective bludgeon was fashioned for defense and offence in a wild and savage world. How many centuries had rolled by and what vast changes had been effected by ceaseless nature before the bow and arrow was invented—an instrument for humanity surpassing in effective power and precision the strongest and swiftest paw or claw in a world which was largely an animal world. Humanity's pace is faster now, but new dangers are found in the new combinations of powers and forces invented by progressive peoples, and the book of human knowledge and wisdom constantly needs new paragraphs to teach the new defenses.

How far we have traveled, and into what new dangers, let the following illustrate:—

> "Take the case of a large machine shop, and see what are the probable causes of one hundred accidents. It will usually be found that out of every hundred accidents, about twenty are caused by workmen falling or slipping, or are strains incurred while engaged in lifting. About fifteen are caused by falling weights or by objects tipping or slipping, and about twenty-five are incurred while using hammers, wrenches, chisels and various other hand tools. These three causes account for the great majority of accidents occurring in shops using heavy, high-speed machinery, and they account for nearly all accidents in other forms of industry. Of the remaining forty accidents, about five are caused by men being caught in moving parts which it is impossible to guard, about six are caused by men being caught in moving machinery where it is possible to guard the machine, and about six are caused by the use of emery wheels or other grinding and polishing machinery. About sixteen out of every hundred accidents are due to flying particles, usually chips of metal or pieces of emery, sometimes projected from machine tools or grinding wheels, and sometimes from chisels or other hand tools. About three accidents are caused by projecting nails or splinters, while the remaining four have miscellaneous causes."

The quotation is from the very interesting and comprehensive survey of Safety and Welfare Work published in this number of MACHINERY. For generations factory dangers were regarded as inevitable and unavoidable—nobody's fault. But just as the tribesmen of old, when they had acquired wisdom as well as experience, cleared a place for the human family to live in peace and security, and established the necessary safeguards, so a later and much wiser humanity has learned how to make the workshop safe, and to protect the worker from his own thoughtlessness and carelessness, as well as from the whirling and racing objects which have so marvelously increased the productive power of his labor. There is still greater satisfaction in the things that are done and being done for the worker as a human creature. A place may be safe, though unlovely and uncongenial. The modern spirit is to make it not only safe but comfortable, bright and attractive. It is on such foundations that civilization builds securely.

INDUSTRIAL BETTERMENT

A Study of Safety and Welfare Work in Manufacturing and Selling Organizations*

by

Forrest E. Cardullo †

The subject of industrial betterment has grown so greatly in importance during the last decade that no large manufacturer or other employer can afford to neglect it. The present article is the outcome of a careful study of all phases of welfare work from the point of view of both the employer and the employe. Inasmuch as the author is not engaged directly in industrial work he brings an unprejudiced mind to the task. He has covered in this comprehensive article safety and sanitation, housing of employes, cooperative organizations, profit-sharing systems, pensions, workmen's compensation and the many other ramifications of the subject. Those who are interested in promoting welfare work should find valuable suggestions in the work that others have accomplished.

ONE of the prominent features of our present-day industrial life is the amount of thought and effort which is being spent by many employers to further the safety, comfort, health and well-being of working people. This matter has become so prominent and so many employers are engaged in different phases of the work, that it has attracted great attention from employers, from social workers, and even from law makers. The National Civic Federation, for instance, has for some years maintained a department for the promotion of welfare work and many great employers of labor have created committees or boards for the same purpose.

So various are the activities which are included under the head of industrial betterment or welfare work, and so diverse are the methods favored by different employers, that there seems to the casual observer to be an entire lack of unity of purpose in the movement. Out of this kind of work has come a great national movement for the promotion of industrial safety. This movement has spread to practically all industries, and seems to be about the only phase of the work in which everyone is really united. The rest of the work appears to be sporadic in its nature. We see here an effort to make workrooms and factories more pleasant for employes, and there an attempt to provide better facilities for the midday lunch. One employer will lay stress on lockers and lavatory facilities, sanitary toilets and such matters. Another employer is equally outspoken in advocating a mutual aid association, and in supporting it liberally, so that the sick and injured may not suffer. Still other employers concentrate their attention upon the housing problem. Some others are earnest advocates of profit-sharing. No two firms seem to entertain the same ideas in regard to the needs of their working force, and there seems to be no broad underlying principle in the work which is being done.

The fact that welfare work appears in so many diverse forms, and the fact that each employer appears to go in for those forms that suit his fancy and practically ignores other forms, gives to the movement the appearance of a fad. Many men predict that the whole thing is a transient outburst of humanitarianism, and that it will die out in the course of time just as roller-skating, bicycling or tooth-pick shoes have disappeared, leaving as its only prominent mark upon our industrial history the movement for greater industrial safety.

It is hard for anyone to realize the true extent and tendency of the social movements of his own time. He can see nothing of the future and he is so close to the events of the

* For other articles on safety and welfare work previously published in MACHINERY, see: "Proper Eye Protection," December, 1914 "Organization for Safety," December, 1914; "State Laws on Accident Prevention," August, 1914; "Safety as Applied to Grinding Wheels," July, 1914. "Power Press Guards," July, 1914; "Norton Safety First Association," June, 1914; "Duplex Safety Tripping Device," May, 1914; "The Safeguarding of Belts, Shafts and Pulleys," March, 1914; "Progress in the Safety Movement," January, 1914; "Grinding Wheel Protection Devices," January, 1914; "Guards for Polishing Wheels," November, 1913; "An Analysis of Lathe Accidents," April, 1912; "Finger Guards for Wheelbarrow Handles," December, 1911; "Safeguarding Machinery," December, 1907; and "Guards on Machine Tools," July, 1907. See also articles referred to in foot notes published in connection with these articles.

† Address: 48 Ashley Bldg., Lockport, N. Y.

present that things lose their perspective. Since everything is moving with him, he does not realize that there is any movement except the apparently senseless turmoil which he sees about him. Before we can appreciate the true meaning of this rapidly growing movement for industrial betterment, we will have to get a little farther away from it, and examine it in the light of recent historical development.

Brief History of Present-day Social Movements

During the Dark Ages it seems to have been the general opinion of mankind that society existed for the purpose of benefiting the nobility and clergy, and to protect them in the exercise of what they considered to be their rights. Government apparently was organized to confirm them in the privileges that they claimed and to so distribute and arrange their various privileges that they, as a class, might receive the maximum benefit therefrom. The peasants and serfs, who constituted the working population, might squirm and object a good deal, but their place in society was well known and thoroughly settled. Of rights and privileges they had none. In the eyes of the law and the "upper classes" they existed solely for the purpose of being exploited.

The invention of the printing press brought an end to the Dark Ages, and made modern democracy possible. With the advent of the printed word, the age of revolution began, a period which extends roughly from the beginning of the sixteenth century to the present. The age of revolution may be divided into four overlapping periods or phases. Following the introduction of printing came the religious and political revolutions of the sixteenth and seventeenth centuries. In this struggle the common people fought nominally for the right to freedom of worship, but the things which they really fought for were freedom of thought and freedom of speech. They were striving to liberate their minds and souls from the ancient thralldom of ignorance and dogma. While the struggle for freedom of thought and speech was still at its height during the seventeenth century, we find another struggle beginning in which the common people were fighting for the right to a more general participation in the affairs of government. This phase of the revolutionary movement is now approaching its conclusion. The period of political revolution was marked by a gradual extension of the suffrage and a gradual increase in the power of the representatives of the people, so that both the form and the spirit of government were radically changed.

While the political revolution was at its height, at the very beginning of the nineteenth century, we see the period of social revolution commencing. This period is marked by the simultaneous development of two great movements. The first was a movement to secure for the common people not only the benefits but also the control of the great social agencies which had hitherto existed only for the benefit of the privileged classes. The second was a movement to so change the spirit and letter of the law as to make personal rights superior to property rights. In their attempts to secure for themselves the control of the social agencies, the common people developed a system of free schools and universities, and made provision of public libraries, hospitals, parks and other social agencies. In their attempts to create laws which would make personal rights superior to property rights they succeeded in abolishing the debtor's prison, in procuring laws regulating conditions of housing and conditions of employment, in reducing hours of labor, in gradually abolishing child labor and in making tenements and workshops safe and hygienic.

During the latter part of the nineteenth century we find the fourth phase, the economic revolution, beginning. It is the purpose of the economic revolution to secure a greater degree of equality in the distribution of economic welfare. The economic, like the social revolution, has developed two separate movements. The first movement attempts by law to limit the accumulation of great fortunes, to limit the profits of capital, and to improve the economic condition of the poor. Thus we have graduated income and inheritance taxes, regulation of public service corporations, minimum wage laws, workmen's compensation laws, old age and mother's pensions and other provisions looking toward a more equitable distribution of human welfare. The second movement is quite different in its nature. It attempts by organization and concerted action to secure for labor higher wages, shorter hours, and more favorable conditions of employment. The labor organization struggles directly with the employer. This phase of the economic revolution is of such great industrial importance and has to do so intimately with the matter of welfare work that it will be taken up later at greater length.

Fig. 1. Exterior of the foundry of the National Cash Register Co. Attention to architecture and landscape gardening has made this foundry a beautiful building in an attractive setting. The cost is not prohibitive.

The age of revolution is a record of social advance. In it we see mankind progressing from tyranny to democracy, from ignorance to knowledge, from slavery to industrial freedom, from the bitterest poverty to comparative wealth. Nor can this improvement be attributed to any single social agency. Many agencies have combined in order to achieve the results we have observed. Sometimes these agencies have not been entirely harmonious, sometimes they have tended to counteract one another, sometimes the agencies intended to promote human welfare have been terribly destructive of that welfare. Always, however, the net result has been progress, progress in education, progress in methods of government, progress in industry and progress in human welfare.

Most of the social agencies to which this progress was due had a small beginning. They were not the ideas of any one man, but appeared here and there in different guises, making their way slowly against strenuous opposition. The ideas of different men underwent a period of consolidation and standardization before they became recognized as social agencies. We may consider, therefore, that the movement for industrial betterment is one of the agencies by which the social progress of the immediate future is to be carried on. It is not a transient movement nor is it a form of charity.

Nor when we come to study the situation do we find the movement so lacking in unity as we had thought. In the first place, the movement is new and it is difficult to tell just how it will eventually work out. In the second place, the local conditions of different industries vary so greatly that a line of action which may be successful and desirable

in one, may be useless and mischievous in another. A study of what employers are doing and how and why they are doing it brings the conviction that practically all the differences observed arise from differences in local conditions and are not due to serious lack of unity among those who take part in the movement.

When we cease to consider welfare work as a form of industrial charity, or a new method of increasing production, and consider it as one of the newest of the great social agencies for the promotion of human welfare, the subject takes on an entirely new aspect. Many of the so-called failures are explained. It becomes possible to see what lines of welfare work give promise for the future. It becomes possible to see the factors which will limit its extension in certain directions. It becomes possible to see the whys and wherefores of many recent industrial developments. But, most important of all, it gives us a new conception of the future industrial life. A century ago, industry was the instrument utilized by greed for the merciless exploitation of the working people. In the centuries to come, we see it infused with a spirit of humanity and democracy, and transformed into the greatest of all the social agencies for promotion of the general welfare.

Forms of Welfare Work

Welfare work may be roughly divided into two forms. The first deals with the physical condition of the factory and the conduct of the work itself. The second attempts to improve the community life. The first form of welfare work endeavors to make the factory a sanitary and pleasant place to work in, and, as far as possible safeguards the life, limb and health of the employe against accident and disease. An abundance of light, of pure air, and of good drinking water are provided. The working place is not only made safe and sanitary, but also as far as possible, pleasant and attractive. Every attempt is made to so order the environment and working conditions that the work will be healthful and pleasant, and the worker will reach the maximum of efficiency.

Fig. 2. Dispensary of the National Cash Register Co., Dayton, Ohio. The surgeons are treating one who has suffered from a slight accident. Prompt treatment prevents many cases of blood poisoning.

Having done all this, many employers feel that their duty is ended, but others realize that because of their relation to their employes and the community, because of the power which they can exercise through the possession of capital, and because of the executive ability which they command, they are in position to act as a social factor in the community, and to affect powerfully that part of the community life which has no immediate relation to its work. Many employers, for instance, realize that they are in a position to improve the standard of housing in the community, and to act in many other ways so as to promote community welfare. They realize that they have the power to make the town, as well as the factory, a more attractive and sanitary place in which to live, and to improve the lot of the women and children, as well as the workingmen. In consequence there is a growing tendency to extend welfare work into regions which have no direct connection with industry, and to make the factory an active agency in community development and community welfare.

Methods of Industrial Betterment—Improving the Workroom

It is in order at this point to turn from this general discussion of the origin, nature and purpose of welfare work, and classify and discuss the different lines of work that are at present in practical operation, leaving for separate consideration the matter of industrial safety.

Since more than half of a workman's working hours are spent in the place in which he works, it follows that a decent regard for his happiness and welfare requires, first, that the workroom shall be a place in which the workman may reach a maximum of physical well-being and efficiency, and second, that it shall be as pleasant and attractive a place in which to work as is compatible with a reasonable cost of construction and the best working efficiency. In order to meet these requirements, it is necessary that they be kept in mind when the mill or factory is being constructed. In the first place, the floor space and head room should be ample so that there is plenty of room for every workman to move about at his task with a minimum of strain and fatigue, and without that cramped feeling which is engendered by crowded quarters. A certain prominent textile mill has two shops, one of which was built about twenty years ago, while the other has been in use for only a year or so. The machinery in the two shops is equal in every respect, but the output in the modern shop is 20 per cent greater than in the older one. This is attributed to the greater head room and floor space allowed in the modern shop, although the customary amount of room is provided in the older shop. The employes much prefer to work in the modern shop, and the experiment of providing what many would consider to be an excessive amount of room, has turned out to be thoroughly successful.

A second point to be considered in the construction of a shop is the provision of ample light in all those parts where men work. This means more than an abundance of window space or skylight area. It requires a proper proportion of head room to width of building; it requires a proper structural arrangement, so that beams and trusses do not interfere with the distribution of light; and it requires that the walls, and particularly the ceilings, shall be painted some suitable color. If the room is free from smoke and dust, white is suitable. If, however, there is much smoke or dust, white paint is quickly discolored and a light gray, slate or some other such color will be found to be superior. If the dark corners, the places under the benches, all the overhead work, the roofs, trusses, beams and so on, are of a light color and frequently painted, the more even distribution of light and the better illumination resulting, will pay for the painting and cleaning many times over by increasing the efficiency of the workmen and reducing loss due to accidents.

There is nothing better than an abundance of light for promoting cleanliness and order in the shop, and health and efficiency among workmen. Dirt and disease are born in the dark, cleanliness and health thrive only in the light. Light makes work easier; it acts as a physical and moral stimulant. So powerful is this effect that no indoor athletic record has ever approached the outdoor record for the same performance. Abundant light means health and contentment for the employe as well as dollars for the employer.

Cleanliness and Order

The provision of a spacious building and ample light well distributed makes for clean, wholesome and sanitary work rooms. Without intelligent and continuous effort, however, the best constructed workrooms will soon become dirty and disorderly, and quickly cease to be a sanitary and pleasant working place. It is therefore necessary to do more than provide a well constructed workroom. It is necessary to maintain it in a clean and orderly condition. In the first place, the ar-


Figs. 3 and 4. The National Cash Register Co. endeavors to persuade its employes to beautify their homes in the same way that it beautifies its factories. Fig. 3 shows a yard before planting and Fig. 4 shows what was done with the same yard as the result of the campaign for beautifying homes.

rangement of machines, benches and working spaces must be such as to promote an efficient and orderly progress of the work. Systematic methods of transporting the work from place to place, and of caring for the tools, jigs, fixtures and other accessories, must be employed. A properly equipped and supervised force of men must be organized for the purpose of systematically cleaning everything about the building. In the case of a new building, properly constructed, this phase of the work presents no difficulties. In the case of many old buildings, poorly constructed and ill-arranged, it is extremely difficult to make satisfactory progress in this matter. Not infrequently, when the wave of reform strikes a shop, the man responsible for creating a condition of cleanliness and order finds himself confronted by a dingy and ill-lighted building, with beams and tie-rods extending down into the working space, the floor piled high with stock, some of which has not been moved for months or even years, heaps of scrap iron here and there through which the workman must paw for bolts, nuts, straps and so on, dark corners in which are found piles of rubbish and litter, and a general condition of dirt and disorder. The first thing which must be done in such a case is to put the shop in order and to create a definite system for the moving of stock in process of manufacture, and for the storage of the tools, jigs and fixtures needed for the performance of the work, to provide tote boxes, waste receptacles, and so on, and then to provide the necessary organization to see that the good work is kept up. Not only is it necessary to clean the workroom, but the halls, stairways, toilets, walls and grounds must be kept in a clean and orderly condition. Especial pains should be taken to see that they are kept free from vermin and from breeding places for flies and mosquitoes. The toilets, washrooms, lockers and drains should receive special attention, and there should be nothing about a toilet or washroom which cannot be cleaned with a scrubbing brush and a hose.

In this connection it may be well to say a word regarding the old-fashioned idea of disinfection. The best disinfectant on earth is soap and water, and if extraordinary measures are required, a pound of chloride-of-lime dissolved in a pail of water. The use of patent devices for the purpose of dropping minute quantities of disinfecting fluids into toilets and drains is not only useless but positively harmful. A drain or toilet should be kept so clean that no odor from it is perceptible under any circumstances, and soap and water with the occasional use of chloride-of-lime is all that is necessary to accomplish this result. The patent disinfecting fluids are used in such small quantities that they have no effect except to produce an odor which hides the results of uncleanliness. If the use of one of the patent devices seems necessary in order to avoid disagreeable odors, it is evident that the plumbing is out of order, or that the janitor is not doing his duty.

Making the Factory Attractive

So far we have considered only the hygienic aspect of the factory buildings and grounds. There is another aspect of the matter which is worthy of serious consideration. Not only should the factory be a healthful place, but it should also be an attractive place in which to work. At first sight the beautification of factory grounds and the construction of pleasant and attractive workrooms may seem to be a matter of pure philanthropy, but it may be shown that even this phase of welfare work has its economic aspect.

I do not mean that the factory grounds should be made into beautiful parks (although the National Cash Register Co. does this very thing), and the workrooms transformed into art galleries, but rather that, so far as possible, all offensive features should be removed, and that a reasonable amount of thought and care should be spent in the arrangement and design of the buildings, the care of lawns, roads and walks, and in the architectural treatment of the factory interior.

It does not need the wisdom of Solomon to see that a workman who is placed in a dingy, ill-lighted and unpleasant workroom is presented by his employer with a constant incentive to quit. Neither is it difficult to see that a workman in a pleasant, clean, cheerful and orderly workroom, where the architectural treatment of the interior is as pleasant and attractive as is compatible with its purpose and a reasonable cost of construction, has a constant incentive to stay. The first man is forever dissatisfied with his work, the second is not.

It is difficult to estimate the economic value of pleasant surroundings. That such surroundings have an economic value is well attested by the fact that those of us who can afford to do so always attempt to secure them. Whenever we are able, we purchase a beautiful house and furnish it in such a way as to transform it into a beautiful home. We hire a landscape architect to arrange our lawns, our trees and our flower beds, because we realize that the pleasure and satisfaction which they give to us have a greater value to us than the money they cost. And not only do we do this for ourselves and our families, by beautifying our home and its surroundings, but as a community, we take pride in the appearance of our city, and tax ourselves to maintain a system of beautiful streets and parks for the whole people. In a thousand ways we acknowledge the economic value of pleasant surroundings, and the moral duty of providing such surroundings for those who are unable to secure them for themselves.

Too many of us, however, believe that beauty ends and utility begins at the factory gate. In the past many industries have been conducted on the principle that the cost of factory construction and operation must be the absolute minimum. This is a short-sighted policy, even from the economic viewpoint, for light, cleanliness and order increase the efficiency of the workmen out of all proportion to their cost, and the feelings of satisfaction and contentment which come to the workmen from pleasant and attractive surroundings, have a wonderful effect on the dividends. But laying such considerations entirely aside, is it not rather foolish for us

to tax ourselves millions of dollars for a park system which the workman can enjoy for only three or four hours a week, and then to provide him with an ugly and unpleasant working place, because it would take a few thousand dollars to render this working place decently attractive?

We often find the most important industry of a town in the midst of the most unpleasant surroundings. Frequently the grounds are enclosed by a high board fence, painted a dingy red. Rusty iron stacks belch huge volumes of black smoke to deface the neighborhood. Cheap shacks and vile tenements line every avenue of approach. Within, the shops are dirty, dark and disorderly. In such a case the workman comes instinctively to associate unpleasantness, poverty and filth with the industry in which he is engaged, even though he receives good wages and lives miles away in a decent neighborhood. Such unconscious associations have a powerful influence on a man's attitude toward his work and toward his employer. They foster friction and antagonism among the men. Such conditions make a fertile field for the labor agitator. They repel intelligent young men, and keep them from entering the industry. They act as a sort of sieve, which rejects the desirable labor element, and retains the inefficient, the discontented, the lazy, and the neer-do-wells. No such plant can prosper in competition with a plant which offers pleasant and attractive conditions of employment at the same wages.

Factory Ventilation and Air Conditioning

The problem of factory ventilation is, in many cases, a very simple one. Where the outdoor air is free from objectionable dust, and the workmen are not too thickly distributed through the factory, ventilation will largely take care of itself. When the workrooms are thickly crowded, but the work is clean, an abundant supply of air is easily provided by mechanical means. When, however, the nature of the industry is such that large quantities of dust or poisonous or disagreeable vapors are produced, the question of adequate ventilation should be the first consideration in the design of the factory. In such cases it is necessary to entirely remove all traces of the dust or vapors by withdrawing at certain places in the workroom an enormous volume of air. This air must either be cleaned and returned to the workroom, or it must be replaced by outside air, and if the volume of air so removed is very great, this kind of ventilation may become an item of considerable expense, both because of the amount of power required to move the air, and because of the amount of heat necessary to bring the entering air to the temperature of the workroom when the weather is cold.

For many years it was thought that poisonous vapors were given off in the breath of human beings and animals. At first this poison was thought to be carbon dioxide, and when carbon dioxide was found to be harmless, it was thought that some unknown toxic substance must be given off in the breath. The most careful search has failed to discover such a poison, and we are forced to conclude that it does not exist. As a result of many years of scientific study of the principles of ventilation, we are now quite certain that foul air injures us for two reasons only: First, because it is hot and damp, and second, because it is loaded with germs and is therefore likely to give us disease. It has been definitely proved that if air is cooled and washed it may be breathed over and over again by a number of people without the least harm. The important things therefore are to have the air of the workroom of a proper temperature and humidity, and free from dust.

The human organism does its best work and is most comfortable and efficient when working in an atmosphere having a temperature of between 65 and 70 degrees F., and a humidity of about 50 per cent to 70 per cent. If the temperature or humidity rises above these figures, there is a decided loss in efficiency accompanied by a vague physical discomfort. At 80 degrees temperature and 80 per cent humidity, there is a loss of 50 per cent in efficiency in doing some kinds of work, and at higher temperatures this effect is still more marked. Not only does the efficiency of the workman fall off very rapidly with increasing temperatures, but the feeling of physical discomfort becomes almost unbearable unless a brisk breeze helps to carry away the heat of the body.

The body is cooled ordinarily by the evaporation of moisture from the surface of the skin and from the lungs. The cooler and dryer the air, the more rapid this evaporation, and the greater the quantity of heat so dissipated. The rate at which heat must be dissipated from the body depends upon the nature of the occupation, being least in the case of sedentary work, and greatest in the case of severe labor. If a number of people are in a closed room, the heat given off by their bodies soon raises the temperature, and the moisture evaporated increases the humidity, a condition of affairs which must be remedied by the introduction of a sufficient quantity of cool air.

Not only does proper ventilation maintain a proper temperature and humidity, but it also serves to remove foul odors which would make the workroom unpleasant, and the great quantities of germ laden dust which are given off from the bodies and clothing of the operatives whenever they are active. Every dust mote is the lodging place for a myriad of germs, some of which may be harmful. It has been shown in London that in those schools having no system of ventilation, the number of germs contained in each cubic foot of air was nearly ten times as great as where an adequate system of ventilation was provided. Clean air is much more important from a sanitary standpoint than clean floors, and a ventilation system is a method of obtaining clean air in the workroom.

Every industry sustains a considerable loss each winter because of the prevalence of colds and sore throats among its operatives. A part of this loss is sustained by the workmen themselves because of loss of time, but a still larger part is unquestionably sustained by the industry because of the loss

Figs. 5 and 6. If this is what you see on your way to work, your work will be pleasanter and your day will seem shorter. At least this is the opinion of the management of the National Cash Register C

in efficiency of men who are too ill to do their best work, and yet who are unwilling to lose time. Disease of this kind as well as many of the more serious diseases may be greatly reduced in amount by an adequate system of ventilation, and by maintaining the air of the workrooms in proper condition.

Nobody questions the necessity of warming the workroom during winter, and every shop makes ample provision for so doing. For some reason or other, however, we have greatly exaggerated the necessity of keeping a room warm during severe winter weather and entirely overlooked the fact that it is equally necessary to keep it cool at other times of the year. The systematic cooling of workrooms in hot weather, particularly in the South, ought to receive the same attention as the systematic heating in cold weather. The loss in efficiency and the effect on the health of the workman are just as serious when the room is maintained at 90 degrees as it is when it is maintained at 40 degrees. The time is not far distant when the intelligent and conscientious employer will realize this fact and in constructing his factory will make provision for keeping the workrooms cool and comfortable in summer, just as he now makes provision to keep them warm and comfortable in winter. It is possible, by means of suitable air-conditioning apparatus, to introduce into the workroom in hot weather air having a temperature of 10 degrees or even 15 degrees lower than that of the outdoor air.

By employing refrigerating machinery, it is possible to maintain any desired indoor temperature, no matter what the outdoor temperature may be. The employment of refrigerating machinery for such a purpose is probably too expensive a proposition to be practiced, but the use of air-conditioning apparatus capable of maintaining an indoor temperature of 80 degrees when the outdoor temperature is 95 degrees, supplemented by the free use of fans, has been demonstrated to be a paying proposition in several Southern shops. When the workroom is the most comfortable place in town, the worker will have no objection to spending his time there, and will not be so anxious for summer holidays. He will find his work less exhausting, he will be better able to enjoy his leisure hours, his health will be improved, and his efficiency will be greatly increased. The matter of air conditioning for the purpose of maintaining suitable shop temperature during the hot weather, is worthy of the serious attention of every employer interested in the welfare and efficiency of his employes.

In certain industrial processes large quantities of dust, or of disagreeable or poisonous fumes are liberated, which contaminate the air of the workrooms. Not infrequently such contamination produces serious occupational diseases, some of which are loathsome and deadly. In almost every case its effect on the general health of the workmen is easily observable, making them more readily subject to diseases of the nose, throat, lungs, and digestive organs. Examples of such industrial processes are dry grinding, buffing and polishing, stone cutting, the preparation of abrasives, electroplating, cement making, brass molding, and various chemical, textile and metallurgical processes. If such industries are not to be carried on at the expense of the health and even the lives of the workmen employed, provision must be made for removing the dust and fumes generated, before they have opportunity to do harm.

The only practical way to remove dust and fumes from the workroom is to withdraw from the room at the point where the dust or fumes originate, a large volume of air, moving at a fairly high velocity. This contaminated air may then be discharged from the building at some point where it will do no further harm. Such a system will be effective only when it is properly designed. The quantity and velocity of the air must be such as to completely remove the objectionable matter, and the system must be frequently inspected and intelligently operated. It is not enough to employ an apparatus capable of removing 90 per cent of the objectionable matter. The 10 per cent which escapes is still capable of deadly damage, and improvements in the design and power of the apparatus are usually all that is necessary in order to make it completely effective.

The grinding and polishing rooms of the Brown & Sharpe Mfg. Co.'s works are excellent examples of what may be done in the matter of dust removal. Each grinding or buffing wheel is partially surrounded by a suitably formed shield attached to a 4-inch flue, through which a large volume of air is drawn. The shield is so arranged that the dust generated by the grinding is discharged directly into the flue, and the design of the whole equipment is so excellent that not the slightest sign of dust may be seen in the air of the rooms.

Sometimes it is not possible because of the nature of the work to remove the dust or fumes which arise. A case in point is the process of "shaking out" after a heat has been taken off in a foundry. When it is absolutely necessary for men to work in an atmosphere laden with dust or fumes, respirators may be employed to protect the men against the ill effects which may result. In such a case, a great deal depends on the design of the respirator. If it is light and comfortable to wear and easily put on, the men will be glad to use it. If, on the other hand, it is hard to put on, or hot or heavy or uncomfortable in use, they will usually object to it.

Fig. 7. This beautiful building is devoted to the welfare, education and entertainment of the employes of the National Cash Register Co. It costs the company only a fraction of a cent per employe per day.

For some years we have had on the statute books of most of our states, laws granting compensation to workmen accidentally injured while they were working. For many years before that, it was a recognized principle of law that an employer was legally and morally bound to insure in every way possible the safety of his employes while engaged in their work. At present we do not have workmen's compensation for occupational diseases, nor has the law arrived at the point of requiring that every industrial process shall be conducted in the most healthful manner possible. In spite of the fact that the law is somewhat backward in this regard, every right-minded employer recognizes that it is his moral duty to see that every process in his factory is carried out under the most healthful conditions that can be devised. Whenever he can, by the provision of special ventilation or by changes in the methods of manufacture, render unhealthful conditions of employment more healthful, the employer is morally bound to do so.

Drinking Water

Just as important as the provision of a proper system of ventilation is the provision of an ample supply of good drinking water. A great deal of the water commonly used in this country is unfit to drink. A large part of it is polluted with sewage, surface drainage and decaying vegetable matter. It is a prolific source of typhoid fever, dysentery and minor digestive troubles, occasioning an enormous amount of sickness and great economic loss.

The drinking water used in a factory should if possible be procured from some uncontaminated source. If this is not possible, it should be purified before using it. Suspended impurities, such as mud, decaying vegetable matter and so on may be removed by mechanical filtration. Certain chemical impurities such as iron and sulphur, which make the water unpalatable, can be removed by chemical treatment. The greatest danger, however, is from disease producing bacteria which are found in many water supplies. These cannot be removed by mechanical filtration, and must be destroyed by some process of sterilization. One of the simplest and easiest methods of sterilization is to add a minute quantity of chlorine to the water, and then to permit it to stand in a tank until the action upon the bacteria shall have become effective. If the quantity used is just sufficient to effectively destroy the bacteria, it cannot be detected by the taste of the water, nor will any ill effects result from its use. Instead of using the chlorine itself, substances which give up nascent chlorine or oxygen when they are dissolved in water, are sometimes employed. Bleaching powder has been used in minute quantities for this purpose.

Fig. 8. Office buildings of the National Cash Register Co. The offices are as pleasant and attractive inside as the exterior of the buildings would lead one to expect.

Other methods of sterilizing polluted water are to treat it with ozone, which may be generated by a form of standard electrical apparatus readily obtained from dealers in electrical supplies; to subject it to the action of ultra-violet light in a rather expensive type of electrical apparatus; to heat the water to a boiling temperature for a short time and then to cool it; or to subject it to the so-called "slow filtration" which is a process of destroying the disease-producing bacteria by the action of other bacteria.

The question of whether or not the water supply is safe for drinking purposes can only be determined by periodic chemical and bacterial analyses. Such analyses are made, free of charge, by the board of health of every state. It is only necessary to request that such an analysis shall be made, in order to receive a container in which a sample of the water may be forwarded to the state laboratory of hygiene. A water supply which may be perfectly safe at some seasons of the year, may be dangerous at other seasons, and it is necessary to have both a series of analyses and a knowledge of the conditions at the source of the supply before it can be determined whether or not the water should be purified before it is safe to drink. If there is any question about the safety of the water supply, provision should be made for purifying it, as the cost of such purification is very slight compared with the great economic saving which results when it is effectively done.

Even though the water be drawn from a source of supply which is beyond suspicion, it may still serve to transmit disease. It may become contaminated by being contained in dirty pails or water coolers, and by being cooled with polluted ice. The common drinking cup also serves as a medium for the transmission of many communicable diseases, especially those of the mouth and throat. The most satisfactory way of avoiding these difficulties is by the so-called sanitary bubbling fountain which is rapidly coming into wide use.

Not only should the water supply be safe from the hygienic standpoint, but it should also be palatable and convenient of access to those who are to use it. The palatability of drinking water depends very largely upon the temperature. If the supply is not cold, the water should be cooled to a temperature of about 40 degrees by circulating it through pipes packed in ice. In order to avoid waste of water it is advisable to insulate the pipes by some covering such as is used for steam pipes, and to circulate the cold water through the entire system by a pump which returns the circulating water to the cooler. In this way cold water will run instantly from any drinking fountain, and it will be unnecessary for the workmen to allow a considerable quantity to waste in order to cool the supply. The fountains should be sufficient in number and so placed that every workman can find one convenient to his place or station.

While such provisions may seem to smack of luxury, it will be found that they are well worth while, both from the standpoint of the comfort and well-being of the employe and of the financial advantage of the employer. The purification of drinking water will eliminate a large amount of sickness, some of which is very serious and costly. The provision of an abundance of cold water, especially in summer, promotes not only the comfort but also the efficiency of the employe. The provision of sanitary drinking fountains will at certain seasons of the year reduce the number of cases of sore throat and other communicable diseases of like nature. Finally, the provision of an abundance of palatable drinking water serves to promote the general health and reduce the desire for alcoholic beverages, which is of great advantage to all parties concerned.

Lavatory and Sanitary Facilities

Thirty years ago the lavatory and sanitary facilities of the average industrial plant were crude beyond belief. Many plants were without sewage systems, and the toilet facilities were not only inadequate for the number of employes, but were also a menace to the health of both the employes and the community. In many shops the employe provided his own lavatory facilities, usually consisting of a tobacco pail, kept under a bench or in some dark corner. So numerous were these pails in one shop that they were used as fire pails on one or two occasions, with success. Since there were no coatrooms or lockers, the workmen wore their overalls to work, and hung their coats upon nails driven into some convenient post or wall. Mechanics usually returned from work with dirty hands and faces, and clad in old, often stained and ragged clothing. They did not do it from choice, but from compulsion. They felt that such conditions lowered the dignity

of their employment, and the community unconsciously assumed their employment was essentially inferior to those forms of work which permitted neat clothing and clean persons.

Some employers, perceiving that this state of affairs was unnecessary and objectionable, attempted to remedy it by the provision of proper sanitary facilities, by providing wash-basins with hot and cold water for the men's convenience, and by providing lockers or coat-rooms where their clothing could be taken care of during working hours. Their employes had an opportunity to return from work in good clothes, with clean hands and faces, and looking as respectable as any home-going bank clerk or lawyer. Since they were no longer ashamed of their appearance in public, they chose a better neighborhood in which to live, and the community speedily came to accept them as worthy followers of a dignified and necessary occupation. The workmen of such an employer ceased to be dirty laborers and became almost in a twinkling skilled mechanics and highly desirable members of the community life. The provision of lockers and wash-basins was a little thing, but it had an immense effect in improving the welfare of the men for whom it was made.

No sooner did the knowledge of such things begin to spread among workingmen in other shops than they began to demand that adequate and proper sanitary and lavatory facilities, lockers or coat-rooms and so on, should be provided in every shop. They insisted that they had a right to leave the grime of toil behind when they faced the public on their homeward way. They quickly saw that their improved appearance would secure for them a better understanding and a larger measure of public sympathy, in their other attempts to improve labor conditions. On the whole workmen have been very successful in their attempts along this line. There are few shops that do not make some provision of this kind, and in many states such provision is required by law.

Fig. 9. One of the factory buildings of the National Cash Register Co. Notice the excellent lighting, the convenience to the street and the pleasant appearance of the building. Its arrangement, particularly in matters of hygiene and sanitation and in other matters affecting the comfort and welfare of the employes, has received the same attention as lighting and exterior appearance.

The mere fact that such facilities are provided does not argue that they are satisfactory and effective. An individual wash-basin with hot and cold water should be provided for every two or three employes, and every employe should be provided with a suitable place in which to keep his clothing. The arrangement of the locker and lavatory should be such that there will be no crowding and confusion at the closing hour. Especial care must be taken so that the men move in one direction only, as otherwise there will be delay and congestion. Apparatus which furnishes the hot water must have ample capacity so that the supply will not fail. The location of the lavatory should be such that the men will not have to go out of their way in passing from the workroom through the lavatory to the street.

Many firms, in an attempt to reduce the cost of the necessary installation, adopt unsatisfactory expedients. Frequently the lavatory is placed in dark and crowded quarters and the men have to enter and leave through the same door. The arrangement of wash-bowls and lockers may be such that men are continually obliged to crowd past each other in narrow passageways. Lack of room and improper arrangement of the lavatory or its inconvenient location may easily make a difference of five or ten minutes in the average time required by an employe to wash up and make himself presentable for the street. This is equivalent to asking men to work a few minutes over time every day without pay. Other unsatisfactory schemes are often employed which are intended to reduce the cost of installation. One is to provide cold water only for washing. Another is to provide a long trough in which a number of men may wash and which is filled with warm water just before closing time. By the time fifty men have washed in such a place, the fifty-first is likely to decide that he will go home dirty.

Not only must a lavatory be properly arranged and provided with suitable equipment, but it must also receive proper care, and the details of its administration are well worth careful attention. It must, of course, be kept perfectly clean. Since the lavatory is damp, a great deal of attention is required in order to prevent bad odors, nor is attention to cleanliness all that is advisable. Men are usually expected to provide their own towels and soap, but it frequently happens that they find themselves without these necessities because of forgetfulness or neglect. A great many firms are beginning to provide towels and to launder them at frequent intervals, usually twice a week. Many firms provide soap, while others keep a supply for sale. The intelligent conduct of the lavatory and locker-rooms is a matter of so much importance that it deserves more attention than it usually receives. The details of the arrangement and cleaning of the lavatory and locker-rooms, and the furnishing of soap and laundering of towels may seem to be small matters, but it is on just such small matters as these that the effectiveness, not only of welfare work, but also of industrial administration, depends.

In mines, steel works, foundries and many other places where the work is hot and dirty, employes appreciate greatly an opportunity to take a bath and change their clothes before going home. Recognizing this fact, many employers provide shower baths for this class of employes. This permits the men to return home clean and refreshed, and adds greatly to their physical well-being and their enjoyment of their leisure time. Some employers go further than this and provide a sufficient number of shower baths so that each employe may make use of them two or three times a week. This is an expedient of questionable value, however, as many employes find it more convenient to bathe at home than at the place of employment if the conditions of employment are not unusually hot and dirty. The community welfare requires that the employe shall have a suitable place to bathe at home, since the other members of his family must bathe there. If he has not such a place either there is something wrong with the community standard of housing, or else the wages paid are insufficient to secure proper housing. It is usually found that when bathing facilities are provided for employes not engaged in hot or

exceptionally dirty work, only a small proportion of the men make use of them, unless they are permitted to use them on the company's time. When all sides of the question are considered, this is not a matter for surprise.

Not even the most conservative of employers can question the necessity of closets and urinals. Even though some provision of this kind is made in every shop it is not always that the provision is satisfactory and effective. The toilets ought to be convenient to the workroom so that time is not lost unnecessarily in using them. The accommodations must be adequate for the number of men who are to use them, or else time will be lost in waiting. The toilets must be situated in well lighted and ventilated rooms, or they will soon become offensive. They must be so constructed that they may be easily and thoroughly cleaned, and such cleaning must be done in a systematic manner. There are sanitary and unsanitary varieties of toilet equipment on the market, and a wise choice of such equipment is imperative if the welfare of the employes is to receive due consideration. The sanitary closet seat, for instance, is quite as important a matter as the sanitary drinking fountain. This seat is cut away at the front and rear, in such a way that it is impossible for it to be soiled in use. The two halves of the seat are united and supported by suitable metal bridges, and the apparatus is quite as strong and satisfactory mechanically as a solid seat.

Providing Comfortable Working Conditions

It is one of the traditions of industry more honored in the breach than in the observance, that no man or woman should appear to be comfortable while he or she works. One of the rules formerly enforced in many department stores was that the clerks should always *stand* behind their counters, although it would be much more comfortable for them to sit when they were not actually engaged in serving customers. Some time ago a prominent machine tool firm published an advertisement in one of the technical papers showing an operator seated at his work in the factory. The man appeared to be seated on a soap-box, and the advertisement called attention to the fact that all the controls of the machine were within easy reach. It brought many letters both to the paper and to the advertiser protesting against permitting a man to sit at his work. In answer to these protests it was claimed that the man would not only be more comfortable, but also more efficient, when seated than he would be when standing, and the contention was unquestionably correct.

There are many kinds of work which can be done better by an employe who has a comfortable seat than by one who is compelled to stand. The assembling of small parts is a case in point, and workmen engaged in such a task are now usually provided with a chair or stool. One firm having a large number of employes engaged in such tasks, maintains that the construction and proportions of the chair used is a matter of great importance. Not only must it be of a comfortable design and properly cushioned, but it must be adjusted to the individual to get the best results. They point out the fact that even though such chairs cost $5 a piece, it is money well spent if the efficiency of the operative can be increased by even so little as one per cent. Even this very small gain in efficiency will pay for the chair in less than a year. They claim that experience demonstrates that variations in efficiency as great as 20 per cent may be occasioned by the use of different kinds of chairs or stools. This gain in efficiency is obviously accompanied by reduced fatigue and increased physical welfare on the part of the employes concerned. They cease their task at the end of the day less fatigued and better able to enjoy their leisure hours. Even though there were no gain in efficiency to be expected, a decent regard for the welfare of the employe should prompt the employer to make his work as comfortable and pleasant as possible.

In almost all kinds of work, efficiency is promoted by frequent but short periods of rest. The fireroom is a case in point. The fireman is continually engaged in work which is hot and laborious, and yet every few minutes he has a period of rest which makes his task possible. If he is compelled to rest himself by holding up the side of the building, his task becomes very fatiguing. A soap-box or stool will reduce the fatigue and make him more efficient. A comfortable chair, however, will do very much more. A somewhat different case is that of a man employed in operating a machine tool, and who has nothing to do for a large part of the time except to see that things go right. Custom decrees that such a man shall stand around or lean gracefully against the frame of his machine. Common sense asserts that he might just as well sit down and be comfortable.

Some tasks are disagreeable or uncomfortable because of their nature. A man may be obliged to work in a cramped and uncomfortable position, as in cleaning a boiler, or in certain kinds of erecting work. His surroundings may be disagreeable because of filth, vile odors, or extreme heat. A great deal can be done to relieve such conditions by changing the processes employed, or by adopting special expedients to overcome the objectionable conditions. The matter of abolishing uncomfortable working conditions is well worth careful study.

The two things which employes most frequently contend for in times of industrial strife are better wages and shorter hours. Better wages obviously mean to them, or at least should mean to them, better homes. Shorter hours mean less fatigue and greater leisure in which to enjoy those homes. The fact that workingmen are willing to fight for these things is sufficient evidence that they value them highly, and anything which an employer can do to improve their home conditions or give them greater opportunities for leisure is a kind of welfare work worth undertaking.

The location of an industrial plant and the arrangement of the buildings and exits are matters of great importance in this connection. Every industrial plant ought to be so located that the employes may easily and quickly reach a suitable residence district, and it ought to be so arranged that every workroom is easily accessible from the street or car line. A plant located in the midst of a business or manufacturing district and at a distance from a car line lays a heavy burden on the leisure hours of its employes. This is particularly the case when transfers and delays are necessary before a suitable car line can be reached, and when the cars are crowded so that many must stand. The time required for transportation between the home and the shop is just as truly taken from the employes' leisure hours as though it were spent at work. Not only so, but the conditions of travel may be such as to make this period much more fatiguing and disagreeable than an equal time spent in labor. It is all very well to have an eight-hour day, but if the employe is obliged to spend two hours of his own time in going to and from his work, his eight-hour day is not a matter of great profit to him. He might as well work ten hours a day in a plant adjacent to a pleasant residence section, and avoid the expense and fatigue of the long ride.

Whenever possible small and medium sized plants should be so located that their employes may find suitable housing within easy distance. In the case of large plants, the number of employes becomes so great that this is not possible. In such a case the question of suitable transportation should be carefully considered in locating the plant. A great deal may be done to assist employes in securing adequate and satisfactory transportation. Large plants invariably have railroad connections, and are in a position to arrange for special trains by means of which employes may quickly reach suitable residence districts. Arrangements may be made with traction companies by which suitable terminals may be provided on the company's property, so that adequate transportation facilities may be secured and at the same time unnecessary congestion and waiting at street corners may be avoided. Special cars may be provided to transport employes by the most direct route to different parts of the city so as to avoid unnecessary transfers and delay. Motor busses may be provided to serve districts not reached by street car lines, or to reach car lines which do not approach the plant. A common sense study of the transportation problem and a conscientious effort to solve it by coöperation between the employer and the transportation companies will often be of immense benefit to employes.

One of the most difficult problems encountered in connection with transportation is that of traffic congestion. In some plants, notably that of the Ford Motor Co. in Detroit, this is solved by having the different departments start and stop or change shifts at different hours of the day. One department may have a shift from 6 A. M. to 2 P. M., another from 7 to 3, a third from 8 to 4, and so on. It is a tremendous task to bring eight or ten thousand employes to a given point between 6:30 and 7 o'clock, but it becomes an easy matter if the time in which this task may be done be properly extended.

Not only must it be made easy for employes to reach their homes, but it must be made easy for them to reach the different buildings once they have arrived at the plant. I have in mind one large plant where every year one or two men were killed while coming to work for the reason that it was practically necessary for them to cross a railroad yard adjacent to the company's property, and in which switching was frequently going on. The only way for them to avoid this was to walk a distance of about two-thirds of a mile. The provision of an overhead bridge across this yard would have made a tremendous difference to more than half of the employes of this concern. Often they would be delayed while switching was in progress. Almost always they were obliged to climb cars in order to get across the yards. The company had it in its power to do a fine piece of welfare work, but at that time matters of the safety and welfare of employes received only casual consideration, and an investment of several thousand dollars in such an enterprise would have been regarded as out of the question. Today the United States Steel Corporation is spending millions of dollars in safety work of this kind.

In most plants no dangers are encountered within the grounds or about the gates, and yet often the gates, the walks and the exits of the buildings are so unintelligently planned that employes are caused to go a great distance out of their way in order to reach their working places. Usually such entrances and exits are planned solely with reference to the movement of material, and the needs of the employes are practically ignored. As a matter of fact, the movement of employes to and from work and in going about their necessary business should receive the same consideration as the movement of material. In large plants a great deal may be done in this way to save time and to eliminate unnecessary fatigue.

The approach to a factory may be pleasant or unpleasant. Of late years a great deal of attention has been paid to the condition of the factory grounds. Most firms content themselves with grading and seeding these grounds and taking care of the lawns thus produced. A few flower beds here and there are sometimes added in order to give a touch of color and improve the appearance of the lawns. Some firms, however, have gone much farther than this. The grounds of the National Cash Register Co. in Dayton, Ohio, are beautiful parks, and although this is a highly organized and efficient factory, its presence is unquestionably a material addition to the beauty of the neighborhood. A wealth of flowering plants, shrubs and vines are employed in beautifying the grounds, and the advice of a competent landscape architect is followed in this work. Many beautiful vistas appear between the principal buildings, and there is scarcely a window in the factory from which one does not view an exquisite landscape. Labor leaders have often argued that the money expended by the National Cash Register Co. in beautifying its grounds, ought of right to go to the employes in the form of increased wages. An investigation of the cost of keeping up these grounds, however, will quickly show that the possible addition to wages would amount to less than a half cent a day per employe. It is obvious that such a minute addition to wages would not be an adequate compensation for the loss of these beautiful surroundings.

The company claims, however, that it receives many intangible returns from the money expended upon its grounds, and that if the grounds were not cared for as they are wages would be lower rather than higher. In the first place, the grounds are a good advertisement for the company's product. In the second place, they serve to automatically select a high class of employes, that is, employes who appreciate nature and beauty, and who are, therefore, likely to have superior aspirations and desires in life. It gives to these employes the idea that their work is of a superior character to that performed in other less attractive shops. It leads them to desire to have the attractiveness of their homes and community conform to that of their factory. It leads them to spend their time and money in improving and beautifying their homes rather than in other and less satisfactory ways. It tends to select as employes men who are sober, industrious, thrifty, contented and efficient, and it intensifies these characteristics more and more as their employment continues.

Not only does this company beautify its grounds, but it makes these grounds convenient of access. No fences surround the grounds, and the streets of Dayton run through them with a car line on each side. Since the work is light, the buildings are several stories high. The employes are not obliged to climb stairs, but huge elevators take them to their proper floors, and everything possible is done to make the working place convenient of access, and to conserve the time and strength of the employes.

Medical and Dispensary Service

A form of welfare work which is unquestionably of great value is a system of medical inspection, supplemented by a dispensary service. At first sight this may seem to savor of paternalism, but in many kinds of work, such as the manufacture of food products and clothing, it is the public duty of the employer to institute such a service. In many other lines of work the welfare of the whole body of employes demands the detection and segregation of the victims of communicable diseases. In all lines of work, the interests of the employer require that the employe shall be at all times in such a state of health as to work efficiently.

A complete physical examination and subsequent systematic medical inspection is of great value among a force of employes for several reasons. In the first place, it serves to detect those employes who are physically unfit for their task, so that their work may be changed or a systematic course of treatment instituted which will restore them to normal health. A man with a weak heart, for instance, may be easily injured by performing some kinds of work. If he is given a suitable task, however, and a systematic course of treatment instituted, he may recover from his trouble in part or in whole. A man having incipient tuberculosis, who would be a danger to the public if employed in the manufacture of clothing or food products and to his fellow-employes if placed in a crowded workroom, may be given outdoor work in which he will have an opportunity to recover his health and strength. In such cases men having physical defects may be given tasks which are fitted to their physical condition, and which they may perform without detriment to the interests of their employers, their fellow-workmen or themselves. Without such medical inspection, they might become a source of danger to others and steadily exhaust their strength and vitality in the work which they are performing until finally their health is utterly destroyed.

Another advantage of systematic medical inspection is the fact that it discovers communicable diseases at an early stage, and makes it possible to take measures which will prevent their spread. This is particularly important when large numbers of young people are employed in any industry, as they are subject to many so-called diseases of childhood which are apparently harmless, but which often leave their victims with serious chronic organic diseases.

A third advantage of systematic medical inspection is the fact that it early detects the development of occupational diseases and makes the cure of such diseases possible by suitable hygiene and a change of employment, when otherwise they might progress to an incurable stage. This is a matter of especial importance in those industries known to be subject to such diseases. In every such case, systematic medical inspection should be performed at frequent intervals, and any

Fig. 10. Grinding wheels provided with suction hoods to remove the dust from the polishing wheels. This room is as free from dust as any place in the factory.

employe who is suffering from occupational disease should receive proper treatment therefor.

Of no less importance than systematic medical inspection is the dispensary service which is a part of the welfare work of many industries. In military establishments such service has long been considered an important element in promoting the efficiency of armies. A regular time is set apart when soldiers showing questionable symptoms are required to report at the hospital. Such practice is as important in promoting the efficiency of an industrial establishment as it is in promoting the efficiency of an army. The benefit of such dispensary service is felt in two ways. In the first place, the prompt detection and treatment of incipient illness reduces the amount of lost time, which is of benefit both to the employer and to the employe. In the second place, many slight illnesses which would continue for some time for lack of treatment, and adversely affect the efficiency of the employe for a considerable period, may be promptly cured by proper treatment and the employe restored to normal efficiency. Common colds, rheumatism, sore throat, boils, acute bronchial disturbances, indigestion and similar indispositions are easily controlled and quickly cured by prompt treatment. A man who is unwilling to take an evening off in order to visit a doctor, and in addition to pay him a fee, will willingly take ten minutes of the company's time to visit the dispensary and to receive free treatment.

Of even more importance than the treatment of slight illness is the treatment of slight injuries, such as cuts, bruises, and eye injuries. When not properly treated, this kind of injuries may become serious because of infection and subsequent blood poisoning. Prompt attention to them in the dispensary will save a great deal of suffering and subsequent loss of time.

Dispensary service cannot be considered to be a form of charity. It is rather a form of welfare work in which the employer and the employe may cooperate to their mutual advantage. The employer is more than paid for the expense of maintaining such service by the reduction in lost time and the increased efficiency of his employes. The employe is benefited because of his increased physical well-being and his greater earnings. The fact that the dispensary service is maintained at the factory saves the employe much time that would otherwise be lost in visiting a physician and in waiting his turn at the office. The fact that the physician's time is utilized efficiently enables the interested parties to secure a maximum of service at a minimum of cost. In the dispensary service, we have one of the best examples of what may be accomplished for the benefit of an industrial organization when full advantage is taken of the possibilities of cooperation

In connection with the work of medical inspection and dispensary service, a system of collecting and tabulating sickness and accident statistics will be of great value. The collection and classification of information regarding illness and accident will lead inevitably to a systematic and effective study of the causes of illness and accident. Such information will point out the danger spots, detect unsanitary workrooms or residence districts, and disclose unsuspected sources of disease. It will show what safeguards are needed, and the lines of instruction that should be undertaken in hygiene and accident prevention. By studying the causes of accidents, we can eliminate dangerous conditions and improve our safety work. By studying the causes of illness, we may eliminate unhygienic conditions and improve the health of the workmen. Such a system of statistics will show very clearly the reduction in accidents and the improvement in health which result from systematic instruction and an earnest attempt to better conditions, which, in turn, will impress upon workmen the practical value of such work and thereby make it more effective. Since the collection and classification of such statistics promote the health, safety and welfare of the employes, it is

Fig. 11. This is not a church; it is the beautiful club house that the U. S. Steel Corporation has erected for the workers in its Joliet mills. It is a center of civic welfare.

just as important as similar work which is done by the cost department for an entirely different purpose.

The Lunch Problem

In the early days of American industry there was no lunch problem. The village blacksmith and his helper lived near the shop and went home to dinner. When the distance from the home to the shop stretched into a mile or two, they brought their lunch, which usually consisted of meat sandwiches, hard-boiled eggs, pies and coffee, in a two-story tin pail. The coffee was heated at the forge, or if there was no forge, over a bonfire. Fifteen or twenty years ago the two-story dinner pail lost out in its contest with the folding fiber box, and the coffee was replaced with cold water or beer according to the taste and habits of the owner of the box. The change was unfortunate. The new type of lunch was less satisfactory, nourishing and digestible than the old one. Nor is the modern factory a place as conducive to leisurely mastication and thorough digestion as the old blacksmith shop. Thoughtful employers began to consider ways and means of improving this situation, and particularly of providing an effective counter-attraction to the neighboring saloon that gave a hot frankfurter with a glass of ale.

Realizing that nothing is more effective than a hot drink in making a lunch palatable and combating fatigue, many firms provide a rack of steam pipes upon which the workman may warm coffee, tea and other liquids. A more satisfactory method is to furnish hot coffee or tea with milk and sugar to anyone who wishes it. In some places this is done without charge as at the works of the Larkin Co. of Buffalo, while in other works a small charge is made. A charge of ten cents a week is sufficient to cover the cost of this. Some firms go farther and provide a bowl of soup at a small cost, in addition to tea, coffee or milk to supplement the contents of the lunch-box. As a result, men and women find their lunches more appetizing, they take a longer time to eat, and the effect on digestion and efficiency is both marked and favorable.

A great many employes prefer not to carry a lunch. To meet the needs of this class of men, many firms have established lunch-rooms where a suitable meal may be obtained at a reasonable cost. This usually consists of meat, potatoes, bread and butter, tea, coffee or milk, and some form of dessert. The minimum price is usually fifteen cents. Sometimes soup and another vegetable are added, and occasionally the price rises to twenty-five cents. Often these lunch-rooms are conducted on the "take your choice and pay for what you get" plan, the employe serving himself. On such a plan the cost of a suitable meal is from ten to twenty cents for women, and from fifteen to twenty-five cents for men, who are usually more hearty eaters.

These lunch-rooms are sometimes operated by the firm without regard to profit. Sometimes they are operated by a co-operative association of employes, the firm donating the use of the necessary space and the kitchen equipment. Sometimes they are operated by private individuals for a profit. In most cases, when such a lunch-room is operated by the firm, the charges are insufficient to pay for the necessary material and the cost of cooking and serving the food. Very elaborate provision is sometimes made in this matter. For instance, the Pierce-Arrow Motor Car Co. of Buffalo has an enormous dining-room and about a thousand employes are served each day with a palatable and substantial luncheon at a cost of fifteen cents. Many firms who make no provision for male employes provide a dining-room for women employes.

In certain industries in which the operatives are liable to occupational diseases, the question of the lunch-room becomes an all-important one. A person working with poisonous materials, such as lead, may easily contract a case of poisoning by eating in the workroom. On the other hand, if such an employe has a separate place in which to eat, is served with proper food, and thoroughly washes his hands and face before eating, the danger of poisoning is greatly reduced.

Even when there is no danger of occupational diseases it is worth while both to the employer and the employe to see that the man has palatable and nourishing food and a suitable place in which to eat it. In a large plant, this requires a great number of chairs, tables and so on, and it is not usually attempted. There is no reason, however, why it should not be done, as the cost per man is very small and the results are proportional to the expenditure required.

It is often urged that workmen who are provided with suitable noon meals at a nominal price do not appreciate it. As a matter of fact, not all of them do. Some men feel that they cannot afford the price of a hot lunch. Others want the glass of ale that goes with the free soup and the hot frankfurters. It will be found, however, that a large proportion do appreciate it if the food served is to their liking. One difficulty has often been that the employer or the person responsible for serving the food has some fad which the workman did not appreciate. For instance, there are places where coffee is not served because the employer thinks it is not good for his men to drink it. One firm had considerable trouble because the man in charge of the dining-room was a vegetarian, and attempted to restrict the amount of meat consumed. Another firm found its efforts unappreciated because the menu consisted too largely of greens and similar vegetables. Workmen know what they like to eat, and they will not eat what they do not like. It will be found that a great deal of "lack of appreciation" is due to fads on the part of employers.

Fig. 12. Many of these little houses may be found scattered about the yards of the plant of the U. S. Steel Corporation.

Another frequent cause of "lack of appreciation" is a disinclination to eat at a second table. Men dislike to wait until thirty-five minutes past the hour for their dinner, when they quit work at twelve o'clock. When it is difficult to make provision for seating the entire body of employes in the dining-room at the same time, it may be arranged that some departments have their lunch hour from 11:30 to 12:30, while the others have their lunch hour from 12:30 to 1:30. In this way the men may be served promptly without waiting for half their number to finish.

A third reason for "lack of appreciation" is that the menu is often monotonous. The men get the same thing six days

a week and fifty-two weeks a year. Pot roast of beef and plain boiled potatoes pall on the appetite after they have appeared for the twentieth time. In an endeavor to secure a nourishing and easily digestible meal at a small cost, the manager of the dining-room often falls into the error of allowing the menu to become monotonous. If the men are to be satisfied and appreciative, an attempt must be made to give them some variety.

The lunch problem is probably the most baffling of all the problems connected with welfare work. In theory it is a fine thing to serve the men with a substantial and appetizing meal for a reasonable sum. This is an easy task for a hotel keeper, but not for a factory manager. It is a problem entirely foreign to his experience, and he bungles it. He is appalled by the magnitude of the task and the amount of equipment required, instinctively comparing his problem with the problem of administering his home kitchen. He fails to realize that its successful solution requires special knowledge and a high order of intelligence. He also fails to realize that the benefits derived are proportional to the magnitude of the task.

In considering the lunch problem, we must not lose sight of the fact that the greater the number of men to be fed the greater will be the beneficial results that will be accomplished. The mere fact that the task is large and that it requires a lot of gray matter to do it successfully should not deter us from attempting it. We have abundant evidence that when this work is well done it is worth while, and also that if we are not willing to devote the amount of work and thought necessary to make it successful, it is likely to be a most ignominious failure.

Profit-sharing

There are two problems which have always confronted the thoughtful employer of labor. They are "What constitutes a fair and just wage?" and "How shall I get my employes to take a real and personal interest in the welfare of my business?" Anything which offers a solution to these two problems will receive earnest consideration from such an employer. Apparently profit-sharing offers a solution to both questions. If the profits of an industry are divided with labor on a fair and equitable basis, the wage question settles itself. A knowledge that he is sharing in the profits of a business ought to lead a workman to take a very real and personal interest in the welfare of that business. Profit-sharing ought, apparently, to eliminate labor disputes, promote efficiency, and bring about a condition of prosperity and good-will.

The history of profit-sharing has, on the whole, been very disappointing. Companies engaged in profit-sharing have been no more free from labor troubles than companies not so engaged. Many firms have given up the idea after a lengthy experience with it. There are some cases in which profit-sharing has been a conspicuous success, but they are few in number. The methods which have been employed in apportioning the profits, and the reason this system has been unsuccessful are worthy of our careful study.

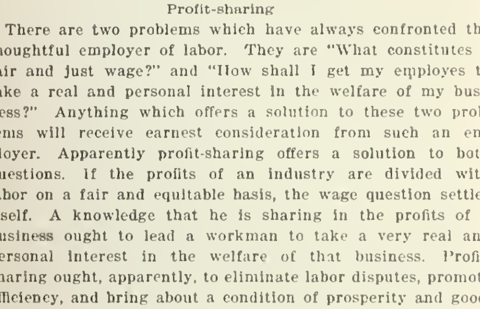

Fig. 13. The U. S. Steel Corporation believes that every man ought to have an opportunity to clean up before going home.

The simplest method of apportioning profits, and one which has often been used, is to pay each employe sharing in the profits the same per cent of his year's wages as is paid to the stockholder in the form of a dividend. Thus if a six per cent dividend is declared on the stock of the concern, every employe participating in the profits receives at the end of the year an amount equal to six per cent of his wages for that year. The division of profits is not necessarily deferred until the end of the year, but may be made quarterly or semi-annually.

A second method of profit-sharing divides the net profits of the business into two equal portions, one going to the stockholders, and the other to the employes. The half apportioned to the employes is usually divided in proportion to their earnings. Let us suppose that a firm having a capital stock of $500,000 has a wage roll of $1,000,000, and that the net profits for the year are $100,000. $50,000 of this is apportioned to capital, and the stockholders receive a dividend of 10 per cent. The other $50,000 is apportioned to labor, the employes receiving a dividend of 5 per cent of their wages.

A third method of profit-sharing is quite different from either of these. It assumes first, that labor is entitled to the current wage, and second, that capital is entitled to the current interest rate. After labor has received its wages and capital its interest, a surplus may remain. This surplus is then apportioned between the stockholders and the employes *in proportion to their earning power*. Thus if the current interest rate is 5 per cent, a man who receives wages amounting to $1000 per year has the same earning power as $20,000 worth of stock. (Strictly speaking, this is not true, if we recognize the fact that a man, like a machine, has a limited life and is therefore subject to depreciation. Allowance for depreciation reduces the value of a man's earning power by almost one-third. The introduction of this element of depreciation complicates the matter so greatly, however, that it gives the method an appearance of unfairness in the eyes of the average employe, and is best avoided.) The following case will illustrate the application of this method of profit-sharing. Assume that the wage roll for the year is $1,000,000, that the capital stock is $2,000,000, and that the total profits of the business are $320,000. Labor has already received the current wage. Assuming an interest rate of 5 per cent the $2,000,000 of capital stock is entitled to $100,000 in interest. The earning power of the employes, i. e., their annual wages capitalized at 5 per cent, is $20,000,000. Adding the earning power of the employes to the amount of the capital stock, we have $22,000,000, upon which a dividend of $220,000 will be declared. This amounts to 1 per cent and, accordingly, the stockholder will receive a dividend of 6 per cent upon the par value of the stock, and the workmen will receive a dividend of 1 per cent upon their earning power, which will be 20 per cent of their annual wages.

If we assume that capital is entitled to 6 per cent in the above case, and capitalize the employes' earnings at the same rate, the capital stock will receive $120,000 in interest, and $200,000 will be left as profits. The earning power of the employes will be $16,700,000, and the profits will be 1.07 per cent of $18,700,000. The stockholders will receive a dividend of 7.07 per cent and the employes will receive 1.07 per cent of their earning power or 17.8 per cent of their wages.

The above forms of profit-sharing usually strike the average man as being not only fair but generous. But when we come to examine the results, we find that they do not solve the two all-important problems. Profit-sharing usually does not settle the wage question because there are not enough profits. After allowing a reasonable return upon the capital actually invested, the profits remaining are a very small proportion of the annual wage roll. When an employe feels that he ought to receive a substantial increase in wages, a six per cent "dividend" (which is all that he may reasonably expect in the average case) appears to him to be utterly inadequate. He is apt to feel that profit-sharing is simply a scheme to forestall a demand on his part for a just and adequate wage.

Nor does profit-sharing secure from the employes a real and effective interest in the company's welfare. A little extra pay

every three months, if it supplements a generous wage, may cause the men to wish the company well in its undertakings. But such mild and passive good-will is not particularly effective. The feeling of mutual interest must be stimulated to the point where it produces a noticeable increase in activity and efficiency. Profit-sharing usually fails to do this for several reasons. In the first place, the amount of the profits apportioned to labor is not sufficient compensation for the sustained activity and efficiency expected. In the second place, the length of time intervening between the activity and the reward is too great. In the third place, the diligent and efficient employe feels that he is obliged to share the profits which he has earned with the lazy and careless one. A system of profit-sharing is emphatically inferior to a justly administered piece rate or premium system, in securing active cooperation and increased efficiency on the part of employes.

There are still other reasons why profit-sharing does not awaken in the employe an unusual interest in the welfare of the business. The profits are usually equalized from year to year by accumulating a surplus during years of plenty, from which dividends and profits are paid during lean years. In such a case the employe feels that his efficiency has nothing to do with the profits which he will receive. The dividends will be exactly the same year after year, and extra effort will bring no reward. On the other hand, if all the profits are divided at the end of the year, there will be some years when there will be no profits to divide. The employe will then feel that it is adding insult to injury not to give him a dividend when, because of short hours and slack work, his earnings have been small.

If the profits realized in different industries were apportioned between capital and labor by any of the three schemes which have been outlined, it would be found that, in some industries, the portion available for labor would be exceedingly small, probably only two or three per cent of the annual wage roll. In other industries, the profits would be very great, sometimes being sufficient to double the employes' incomes. The unfortunate part of the matter is that as a general rule the profits are the smallest in those industries where the wages are the lowest. It will be seen then that profit-sharing not only fails to solve the two problems so often confronting the employer, but it also fails to settle the great social problem of a just distribution of wages between the industries.

There are a few industries of special character or in newly established lines of manufacture where the margin of profits is large, and where it is possible to pay unusual profits to the employes. The Ford Motor Co. of Detroit is a case in point. It makes a highly standardized product in enormous quantities, and sells it at a relatively low price for a good profit. In consequence, the profits of this company have been so great that an enormous plant has been created out of the surplus profits of the business, and at the same time the most liberal profit-sharing system of which we have any record has been installed. Mr. Henry Ford, the moving spirit of this company, believes that high wages are the best, most democratic, and the most practical form of welfare work. Accordingly he has established in the Ford plant a minimum wage of thirty-four cents per hour or \$2.72 a day for the shop employes, and thirty cents per hour or \$15 per week for all office help. In spite of this liberal wage rate, Mr. Ford's profits were still piling up. Accordingly he has made arrangements to divide these profits with his employes in the following manner: All employes who satisfy reasonable requirements as to efficiency in their work, and good moral character, and who, in addition, are twenty-two years of age and support one or more dependent persons, are eligible to share in the profits of the business. About three-fourths of the working force participate in this profit-sharing. The division of profits is such that everyone participating receives at least \$5 per day of eight hours, while the maximum combined wages and profits for a shop employe is \$7 per day of eight hours. Separate arrangements are made for profit-sharing with factory executives and office help.

It will be seen that Mr. Ford's employes participate in profits practically equal to their wages so that their incomes are about double the incomes of other workmen engaged in similar tasks. With such incomes it is possible for them to provide themselves and their families with satisfactory living conditions. An adequate income makes it possible for them to solve every social problem if only they have the character and intelligence to spend this income wisely. Unquestionably most of them do spend it wisely, although a not inconsiderable minority require constant instruction and guidance in order to keep them in the right path. There is an old saying that "Too much money has ruined many a man" and one of the social problems of the Ford Co. is to prevent the extra incomes from being so used as to prove a detriment rather than a benefit to a small class of employes.

From one point of view Mr. Ford's profit-sharing system is a huge success. The money distributed to the employes has, for the most part, been wisely used by them and has procured for them a much larger measure of social welfare than they could otherwise enjoy. However, there is unquestionably another side to the story. There are many industries which are more efficiently operated even than Mr. Ford's magnificent plant, but which would find it impossible by the most careful management to divide among their employes profits amounting to 10 per cent of their wages. These industries are so thoroughly standardized and so keenly competitive that there is a sharp and definite limit to their profits.

Fig. 14. Much of the work is hot and dirty. The employes may take a bath to cleanse and refresh themselves before leaving for home.

Some General Considerations

Profit-sharing is simply a method for increasing the income of the workers. It is no better and no worse than an increase in wages. It accomplishes nothing that is not accomplished better by other means in most lines of industry. When a number of companies are engaged in similar work and some of them, because of superior natural advantages, or of better equipment and organization, are able to make larger profits than the others, the general welfare requires that these efficient concerns should grow at the expense of the inefficient ones. In the long run, the workers of the industry in question are better served by a growth of the efficient plants and the disappearance of the inefficient ones, than they would be by a system of profit-sharing which permitted the survival of the inefficient plants.

When in any industry the workmen already receive a wage as high as is paid in any other similar line of industry, society is better served by a division of profits in the form of reduced prices or by the investment of the profits in other productive enterprises requiring capital, than by a division of the profits with the workmen. Social justice requires that our whole industrial system shall be so organized and conducted that the total amount divided among workmen in the form of wages shall be a maximum, and that the apportionment of wages among different classes of workmen shall be just and equitable. Since, as has already been intimated, the largest profits are available for distribution in those industries already paying the highest wages, profit-sharing takes from those who have not in order to distribute to those who have. Social justice demands a readjustment of these inequalities before profit-sharing is attempted. On the whole, the interests of society are best served by adjusting wages so as to make the incomes of different classes of workmen proportional to their industrial value, and by reinvesting unusual profits derived in any particular line of business in those productive enterprises which appear to promise the largest returns.

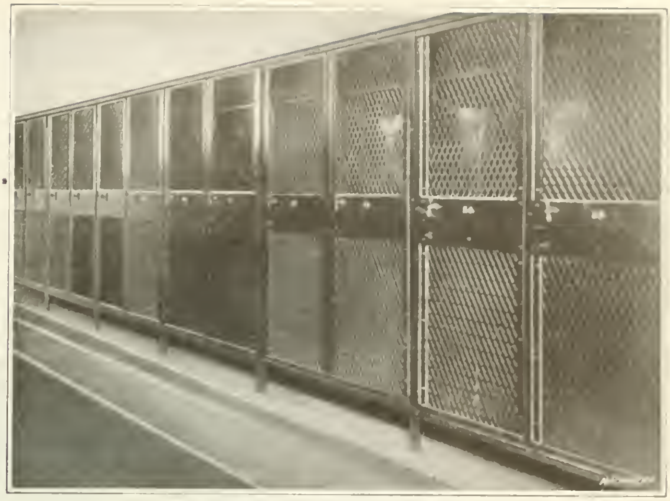

Fig. 15. In order that everyone may have clean dry clothes when they are through with their work, these lockers are furnished.

Safety Work

About twelve years ago America began to realize that preventable industrial accidents were a national evil of appalling magnitude. The agitation for workmen's compensation laws brought forth most astounding facts and figures in this connection. It was shown that both the number of accidents and the economic losses occasioned by them were increasing more rapidly than the output of our industries. It was shown that this loss was proportionately more serious in America than in Europe. As soon as the magnitude of the evil became fully apparent, a great safety campaign began. It has always appeared to the writer that self-interest has played quite as large a part in the spread of the "safety first" idea as altruism. For many years crafts unions had vainly demanded safeguards for machinery. For many years miners' unions demanded effective ventilation and drainage, and adequate timbering, and failed to get them. For many years we have had on our statute books various kinds of safety requirements which, although perfunctorily observed, were totally ineffective. As soon, however, as workmen's compensation laws transferred the burden of industrial accidents from the victim to the industry, the great "safety first" movement began. Under the stimulation of self-interest, national commissions, governmental bureaus, employers' organizations, and chambers of commerce began a serious study of the causes of accidents, the possible methods of preventing them, and the methods of minimizing the losses resulting from accidents.

The result of this work was another triumph for the scientific method when applied to the social and industrial questions. There is no question but what both conscience and self-interest have always recommended to workmen and to a vast majority of employers, a policy of accident prevention. There is no question but what a great deal of thought, time and effort had previously been expended in attempts to minimize or eliminate industrial accidents. But this work had previously been done in a haphazard and unscientific way, and was, in consequence, very ineffective. When self-interest entered as an ally of conscience and good-will, the methods of safety work underwent a great change. A thorough and systematic investigation was made of the causes of accidents. Then an equally thorough and systematic effort began for the elimination of these causes. By organizing the work, and by assigning responsibility for different phases of it, it was made more effective. A scientific study of industrial dangers was undertaken by government bureaus, and by private organizations. Finally there has resulted a full and free interchange of ideas through various engineering and industrial organizations and through the American Museum of Safety, which has made the work immensely more effective.

It is commonly assumed by those unfamiliar with the facts that the cause of the rapid increase in industrial accidents during the nineteenth century was the growing use of power-driven machinery, which was constantly increasing in size and weight and operated at speeds which appeared to be daily growing more dangerous. It was assumed that if this machinery could be guarded or changed in character or operated at lower speeds, or that if other and safer tools could be substituted for the dangerous ones, industrial accidents would be greatly reduced in number. This view of the matter has been shown to be very far from the truth. Less than one-third of all industrial accidents are caused by the use of machinery. Undoubtedly most of the failures among the earlier attempts at safety work were due to the fact that efforts were largely confined to safeguarding machinery, on the theory that machinery was the source of all the difficulty; whereas the real source was a prevailing spirit of carelessness among workmen and a lack of appreciation on the part of employers of the importance of the work and of the radical and thorough methods it was essential to employ.

It must not be inferred that workmen often consciously and voluntarily exposed themselves to danger. If they were given a task to do, they usually adopted for its performance the first method that suggested itself, and attempted to do the task in the most expeditious manner without considering possible dangers. The prevailing attitude of mind was "It is easier to take chances than to take time and trouble." Obvious and certain dangers were always avoided. The little things, however, like the frayed rope, the loose plank, or the insecure fastening received little attention. Of course all these things were attended to in the course of time, but they were often permitted to go uncorrected until an accident resulted. Chances were taken daily that ought not to have been taken, and danger spots were allowed to exist for a much longer period than was necessary.

The employer was equally careless in regard to such matters. His attitude of mind was expressed by the slogan, "Get out the work." The man who received his approbation was the man who "did things," meaning the man who accomplished results in a short time. The fact that such a man took unusual chances was regrettable, but it was the way of the world, and accidents were the price of success. Of course neither the employer nor the employe voluntarily permitted obviously dangerous conditions to continue indefinitely, but the danger usually had to be very obvious before the condition

was abolished. Both the employer and the workmen were unusually obtuse in the matter. Certain dangerous conditions which had existed from time immemorial were apparently sacred because of their antiquity.

This attitude of mind was reflected in the state of the law upon such subjects, which at that time held that while an employer was bound to carry on his work in a *reasonably* safe manner, reasonable safety did not require him to take precautions not usually undertaken in similar circumstances. In other words, he was not bound to abolish the danger spots if they were common in the industry. Unguarded gearing is a case in point. Such unguarded gearing was very common in certain types of machine tools, and was a frequent cause of painful accidents. Obviously guards were called for. However, since unguarded gearing was usual, the common law held that the employer was under no obligation to provide guards, unless they were required by some special statute or by some inspector or commissioner specifically authorized by statute law to make such requirements.

The real cause of the great growth of industrial accidents was the general acceptance on the part of both employers and workmen that these accidents were nearly all inevitable to the conduct of the business and that it was impossible to guard against or prevent them in any way. So long as this spirit endured, accidents were bound to become more and more numerous. Nor was the matter helped any by the well intended but unintelligent efforts often made by workmen to reduce accidents. The usual remedy proposed was to go slow, to take plenty of time, and to do everything in a safe, inefficient and ineffective way. There was no true appreciation of the causes of accidents and therefore no logical plan put forward to remedy the causes. The acceptance of the doctrine that accidents were inevitable was fatal to the cause of accident prevention work, and the continual failure of ill-considered schemes for accident prevention served only to fix the doctrine more firmly in the minds of all.

Fig. 16. Why some companies find dispensary service advisable

The first step in accident prevention was to explode this doctrine and to show that accidents were unnecessary. This could only be done by serious study of the causes of accidents and a willingness to invest time, money and brains in methods of accident prevention. Sentiment may make men anxious to abolish accidents, but only self-interest makes them willing to collect and classify accident statistics, to hire competent engineers to devise methods for accident prevention, and to spend a great deal of money in making these methods operative. That is why the beginning of effective safety work coincided with the introduction of workmen's compensation laws.

A Study of Accident Statistics

Accident prevention, like any other form of human endeavor, if it is to be successful, must be based upon a knowledge of facts. If we are going to prevent accidents, we must first know how and why accidents occur. If we have such information, we will be in a position to foresee how and why other accidents may occur, and we will also be in a position to devise effective safeguards. As an illustration of how accident statistics may be classified and studied, we will take the case of a large machine shop, and see what are the probable causes of one hundred accidents. It will usually be found that out of every hundred accidents, about twenty are caused by the workmen falling or slipping, or are strains incurred while engaged in lifting. About fifteen are caused by falling weights or by objects tipping or slipping, and about twenty-five are incurred while using hammers, wrenches, chisels and various other hand tools. These three causes account for the great majority of accidents occurring in shops using heavy high-speed machinery, and they account for nearly all accidents in other forms of industry. Of the remaining forty accidents, about five are caused by men being caught in moving parts which it is impossible to guard, about six are caused by men being caught in moving machinery where it is possible to guard the machine, and about six are caused by the use of emery wheels or other grinding and polishing machinery. About sixteen out of every hundred accidents are due to flying particles, usually chips of metal or pieces of emery, sometimes projected from machine tools or grinding wheels, and sometimes from chisels or other hand tools. About three accidents are caused by projecting nails or splinters, while the remaining four have miscellaneous causes.

An inspection of the above figures shows that one-quarter of the accidents are incurred while using hand tools. This suggests immediately an investigation and classification of the reasons for these accidents. What tools were the men using when they occurred? In what way were they using the tools? What were the contributing causes of the accidents? Let us suppose that we find that three of the accidents were caused by wrenches slipping. That raises such questions as these: What kind of wrenches were they? Were they defective? Were they being used properly? Were the nuts defective? Were the nuts too soft? Were the threads defective so that too much force was required to screw the nuts up? A careful study of this kind may suggest that the accidents occurred because the nuts were of poor quality, being too soft and improperly tapped so that the workmen had to exert a great deal of force. The remedy is to use better nuts. Or it may be found that the workmen were using wrenches which did not fit the nuts, possibly because the nuts were under-sized or slightly over-sized, or possibly the jaws of the wrenches had been forced open or the proper sized wrenches were not available. This suggests an improved pattern of wrench. We may, for instance, consider the advisability of using box wrenches of the ratchet pattern, to avoid this cause of injury.


Fig. 17. The U. S. Steel Corporation goes outside of its works in order to benefit the employes. A visiting nurse looks after the sick ones and does much to instruct the families in matters of right living.

Let us take another case, and investigate the cause of falls. Suppose we find that some of these falls were caused by slipping on greasy man-hole covers, turntables, or industrial tracks. Such knowledge points out the necessity of using non-slip treads, or of covering metal floor plates with wood, and of keeping tracks clean and free from grease and oil. Suppose that some of the falls were caused by the defective soles of workmen's shoes. A campaign of education is necessary in order to persuade the men that shoes with loose soles are dangerous and should be discarded. Suppose we find that some of the falls occur on a certain stairway. Inspection of that stairway may show that the rise of one step is a quarter of an inch greater than that of the rest, which is a matter requiring the immediate attention of the carpenter.

Let us consider for a minute a third class of accidents—those due to projecting nails and splinters. These may be eliminated by substituting steel barrels and tote boxes for the wooden barrels and soap boxes often employed to hold parts, and by requiring all cleats, boards and sticks to be immediately removed from the floor, properly sorted and stored in designated places.

Enough examples have been given to show the possibilities arising out of a collection and classification of accident statistics. The more thoroughly statistics are collected and the more completely and logically they are classified, the greater will be the value of this kind of work. Nor should these statistics be confined to accidents requiring medical attention. "Near accidents" ought also to be reported even though no harm results. A man may slip on a stairway, pick himself up and go about his work without any injury whatever. Yet the circumstances which caused him to slip may cause a serious injury to someone else, and "near accidents" of this kind often deserve the same attention and study as accidents which cause severe injuries. Nor should attention be devoted exclusively to one's own shop. A study and classification of accidents reported in other shops is of great value in indicating possible danger points which might otherwise escape attention. The study of safety devices in use in other shops may in the same way suggest valuable safety devices for similar lines of work and obviate a number of accidents.

Some of the causes of industrial accidents are quite obvious and are readily determined by even a cursory study of accident statistics. Others, however, are difficult to determine because of their nature. Fatigue may be taken as an example of this type of causes. Fatigue is a frequent cause of accidents which occur late in the day and of those occurring in laborious work and in work conducted under hot or otherwise disagreeable conditions. Darkness is another cause of accidents which is sometimes difficult to fix upon. A machine may be in a fairly well lighted place, and yet at the approach of nightfall at certain seasons of the year may become a source of danger because of the lack of illumination. Here again the time of the accident may serve to show its cause. In studying accident statistics it is well to have before us a complete schedule of the causes of accidents and to consider which of these have anything to do with the matter.

In this connection it may be pointed out that not infrequently an accident will be due to a combination of causes, none of which acting singly would be sufficient to produce it. The abolition of one of these causes may prevent the recurrence of the accident, but, wherever possible, all of them should be abolished, since the remaining causes may in time produce other accidents. The causes and best methods of prevention of industrial accidents are worthy of the most thorough and scientific study.


Figs. 18 and 19. It is necessary to do more than pay men good wages or share with them large profits if they are to be really benefited. These pictures illustrate the results of instruction in hygiene and domestic science by the Ford Motor Co. of Detroit, Mich.

Fig. 20. View in the storeroom of the Ford Motor Co. Note the abundant light, the wide passageways and the careful manner in which the material is stacked. All this promotes safety.

chosen from among the foremen and workmen in such a way that every department is represented. The safety committee is often elected by the workmen. It meets at specified intervals in order to study the causes of accidents, to make regulations for safety, and to create an interest in safety work. In order to bring the largest possible number of men into this committee and to give the whole body of employes a knowledge of the way in which safety work is carried on, and to inspire them with an enthusiasm for the safety movement, the members are changed at frequent intervals. By this means every workman, in course of time, is caused to study the condition of the plant with a view to making it more safe. The mere fact that for a month or two he has the problem of safety more or less on his mind and talks with other workmen about some of the things which he is considering spreads a knowledge of safety work and brings all the men to consider the problem in a serious manner. Even after such a man has left the safety committee, his interest continues and he has a new conception of his duty both to himself and to his fellow-workmen.

A great deal is being done in the general education of the workmen by means of placards, pamphlets and lectures, and by bringing to their minds the necessity of considering questions of safety. It is pointed out to them that "it is better to be safe than to be sorry," and that a moment's carelessness or the neglect of some prescribed plan may cause them much suffering and loss of time and wages. It is also pointed out

Fig. 21. When men receiving thirty-four cents an hour sleep in such quarters as these, it is evident that they need something besides high wages. This is a basement room and the bedsteads are set up on tomato cans because the floor is frequently ankle deep with water.

that carelessness will make them a menace not only to themselves but also to their fellow-workmen, and that they owe it to every other man in the shop to so conduct their work as not to harm their fellow-workmen. It is pointed out to them that if they see any dangerous condition or practice which is likely to injure them or others, it is their duty immediately and forthwith to report it. They are impressed with the idea that the company and every fellow-workman owes them absolute safety, and that it is their right to demand it. With such a system of education an entirely new attitude of mind toward industrial dangers is created, and the cooperation of the workmen becomes a powerful factor in promoting safety work and eliminating danger spots.

Safety Education

A fact of great importance which has come to light through our scientific study of industrial accidents is that the safety of any plant is largely determined by the mental and physical habits of its workmen. Certain prevailing habits of mind will be found in every industrial plant. In one plant, for instance, the foremen and workmen will approach every job with the idea that it must be done in the easiest way. In another plant every job will be approached with the idea that it must be done in the most expeditious way. In a third plant the prevailing attitude of mind will be that the largest possible quantity of work must be gotten out. In such cases the question of safety is rarely considered when work is being planned or performed. It is only when danger becomes obvious that safety receives consideration. Effective safety work requires a thoroughgoing campaign of education.

One of the first steps in safety education is to establish in the minds of foremen and workmen the habit of making safety the first consideration when work is being planned or performed. After that come considerations of quality and quantity of output. At every step in the process of performing a new task the workman must be taught to ask himself, "Is that safe? Is there a danger spot anywhere?" Whenever there is a departure from the usual procedure or conditions of work, the same questions must be asked. Not only is it difficult oftentimes to get men to consider these questions, but not infrequently they feel that it savors of cowardice. It is therefore not only necessary to establish new habits of thought, but also to uproot the idea that courage and manliness require that they shall ignore considerations of safety. The more dangerous the occupation the more necessary it is to do this, for men so engaged are often foolhardy and delight in taking unnecessary risks in order to show their courage and skill in escaping the dangers of their occupation.

A second step in safety education is to break the workmen of dangerous habits while at work. Men will often be found performing their tasks in unsafe ways. They should have those dangerous methods pointed out to them and safer methods should be devised and followed. The result of such a practice is that dangerous habits which are the causes of accidents gradually disappear.

A third step in safety education is to instruct the men in the causes of accidents. This is a place where accident statistics are of great value. It is all very well to point out to a man that he is doing a dangerous thing, but when you can back up your statement with the further information that three men were injured last year while doing the same thing, and give names and particulars of the accidents, the lesson is much more powerfully impressed.

In order to create a more widespread interest in safety work as well as to get the largest possible volume of information on the subject, "safety committees" have been found useful. A safety committee consists of a number of men

Improving Dangerous Machinery

There are a great many machines and kinds of work which are subject to special types of accidents. The punch press is a case in point. The punch press has in the past been the cause of the loss of a great many fingers. For years this loss was regarded as sad but inevitable. Any attempt to provide the punch press with safety devices was considered to be impracticable because it would reduce the speed and in-

crease the cost of the work. As soon as safety became the first consideration, however, the question of the punch press was taken up, and several solutions were offered for the problem of abolishing the danger.

The first solution of the problem was the suggestion of the workmen. It was that the work be put on a day-rate basis and that a small task be expected in order that the men should not feel hurried in their work. The workmen thought that if they took their time about it, they would perform their task in a perfectly safe manner. This suggestion was a failure for two reasons. The first one was that the production was so reduced as to make the cost of the work appear to be prohibitive. The second was that the work was not made noticeably safer. Because the work was done slower, the men's movements did not have that automatic quality which is one of the requirements of safety, and in consequence injuries were still frequent.

A second solution was to so arrange the press that *both* hands were employed in order to start it. This of course made the operation of the press slow, although it was perfectly safe since it was impossible to have any part of the hands under the punch while the press was moving. The loss in speed, however, was not as great as was anticipated, because as soon as the fear of injury was removed, the operators became more skillful and certain in their movements, and the mental fatigue occasioned by the sense of danger was no longer felt during the late morning and afternoon hours, as had previously been the case.

A third method of attacking the difficulty was to place a guard before the punch which had to be clear down before the punch could start. With the guard down, the hands were necessarily out of the way. This arrangement permits of faster work than does the method of using both hands to start the punch, although perhaps theoretically it is not quite so safe since a derangement of the guard may occur. A fourth method was to make the punch self-feeding, so that it is unnecessary to place the hand near the punch when it is in operation.

So far we have considered making the punch safe. There is, of course, the alternative of making the method of work safe. Instead of so arranging the punch that the workmen's hands are removed from danger before the punch starts, tweezers, sticks and so on may be employed to handle the work so that the workman does not put his hands in danger. Workmen soon become so skillful in using properly constructed tools of this kind that their efficiency is not materially less than when the fingers are used.

Woodworking machinery is a type of dangerous machinery in which the best results are obtained not so much by guarding the machinery as by teaching the workmen safe methods of work, and insisting that they be followed. Of course guards are important in woodworking machinery, but they are effective in eliminating only a fraction of the accidents. The jointer is a machine which causes more finger accidents probably than any other machine in the pattern shop. Practically all jointer accidents are caused by an improper use of the machine. I know of a number of such. One was caused by a loose sleeve which caught in the jointer knife, drawing the man's hand in. A second was caused because the man attempted to plane the flat side of a piece that was only four inches square. A third was caused by the operator stumbling in the pile of sticks and shavings in front of the machine. A careful study of the jointer and the cause of the various accidents which occur will show that when properly used, a jointer is a safe tool. The fence must be close to the working side so as to leave as little of the knives uncovered as possible. The knives must be sharp and in good order so that the force required to feed the piece will be slight. A guard which covers the knives and forces the work against the fence will eliminate many chances of accidents. Wood which contains many knots or nails is dangerous, especially when it is in short lengths or small sections. Many men get themselves in trouble by attempting to work up small pieces in the jointer. When it is necessary to handle such pieces special methods should be devised for handling them safely. Flat wood may be handled more safely if a tool which looks something like a plane handle, is employed in order to push it through. Thin square sticks may be fitted into a recess in a larger piece, so as to be handled safely. Jointer accidents are entirely unnecessary, and by using proper precautions in performing the work, always doing it in the safest way and never taking any of the risky methods, they may be eliminated.

Not only should we strive to eliminate accidents, but a good deal may be done to make accidents less serious if they do occur. The old-fashioned square jointer head which permitted the whole of a man's hand to be caught between the knife and the table would produce a much more serious accident than the modern round head which gives very little room for the fingers to be caught. A week's careful study of the methods of work which may be safely employed on a jointer, of the proper form of guards, and type of cutting head, and the provision of special appliances for making the dangerous work safe, and of a convenient cabinet or rack in which these appliances may be kept for use, will eliminate a great many painful and serious accidents. Similarly, any tool or machine which is likely to cause an accident, will repay careful study, and this study, if it is to be really effective, must take up not only the question of guards and safety devices, but also the matter of methods of use.

Equally as important as the elimination of industrial accidents is the proper treatment of those accidents which occur. Many injuries which are originally very slight, may, because of lack of prompt attention, become serious or even fatal. Not infrequently a small cut or scratch may develop a case of blood poison. Injuries of the eye may give a great deal of trouble if they do not receive proper treatment. Strains and sprains recover much more quickly if they have prompt treatment. Consequently a "first-aid" room of some kind where men can receive intelligent treatment for slight injuries ought to be a part of every industrial plant. The first-aid room may be under the supervision of any intelligent person who has been thoroughly trained in the emergency treatment of minor injuries, but if the size of the plant warrants, it should be under the supervision of a physician, and equipped for emergency operations. Many large industrial plants have a thoroughly equipped operating room with the necessary surgical tools and apparatus, and hospital supplies. It should be insisted that any eye injury,

Fig. 22. An assembly department in the Ford Motor Co.'s works. Notice the abundant light and the great amount of space which gives the men plenty of room to work in.

any wound sufficient to cause a flow of blood, and any strain or sprain should be immediately reported to the one in charge of the first-aid work for treatment. Prompt measures in this regard will often save a great deal of time and suffering, as well as expense.

Community Betterment

So far the welfare activities which we have considered are carried on within the plant. They have to do with the workman while engaged in his work. Their object is to increase his welfare and efficiency as an employe and to properly remunerate him for what he does. Here the moral and social responsibility of the employer, as an employer, ceases. There are other forms of welfare activities in which he can engage for the benefit of his employes, but he does it not as an employer but as a philanthropist.

In undertaking work in community betterment the employer finds himself in a field already occupied by other social agencies, some of which are commercial while others are purely philanthropic. For instance, in promoting a benefit association which would give his workmen sick insurance, he is competing with many insurance companies organized for this very purpose. In attempting to promote the community welfare and to raise the community standard of intelligence and physical well-being, he engages in the same work as that of the Y. M. C. A., the social settlement, or even the public schools. In furnishing housing for his employes, he assumes the place of the landlord. In spite of this there may be ample justification for such activities. The employer is certainly entitled to do anything which will benefit the community, and to become a leader in the work of community betterment whenever his ideals and ability warrant his assuming such leadership. At the same time we must clearly recognize that this phase of welfare work is on a different basis from that which is done within the industry itself. In engaging in it the employer must cease to be the boss and learn to be the leader. He must learn not to rule but to cooperate. His activities must recommend themselves to the good sense of the community because of their benefits and not because of any particular relation which exists between the employer and the other members of the community.

Some kinds of work are difficult to classify and it is not easy to say whether the employer conducts them as a matter of community betterment or simply to increase the welfare and efficiency of his working force. They may be begun with the latter object in view and yet they are always tending to spread out until they affect the welfare of the whole community.

Education

Education is an example of this kind of work. It is not essential to the conduct of the industry that the employer should *educate* his workmen. He may allow them to pick up their own education in the course of their employment, as is frequently done even where the men are supposed to serve an apprenticeship. There are many shops in this country in which absolutely no attempt is made to instruct apprentices. A boy enters a shop and is given simple and easy jobs to do until his own observation and native ability make him capable of attempting something harder. In the course of time if he is naturally bright and ambitious, he may manage to acquire a smattering of the trade at which he is supposed to be apprenticed.

A majority of the men engaged in many trades have never been apprenticed. The machine industry is a case in point. Because of the objection on the part of labor unions to the training of an adequate number of apprentices, and because of the fact that many young men do not care to apprentice themselves, it has for many years been necessary to operate machine tools with the help of unskilled laborers who gradually familiarize themselves with the operation of some particular class of work or kind of machine tool. Such men, if intelligent, are soon able to obtain employment at the particular line of work which they have picked up, so that we no longer have machinists, but have instead lathe hands, planer hands, shaper hands and so on. This matter has gone so far that we often hear a workman referred to as a Smith & Jones lathe hand, or a Byron & Robinson milling machine hand, according to the make of tool which he has been trained to operate.

This system is unsatisfactory both from the standpoint of the man and from that of the employer. In the first place it limits the man's opportunity for employment since the character of the work which he can do is limited. In the next place the employer has much greater difficulty in filling a vacancy for the reason that a large proportion of intelligent and competent applicants will not be skilled on the particular machine which he desires them to use. The result is to greatly increase the number of idle operators, to make it more difficult for men to secure positions, to make it more difficult for the employer to secure help, and to reduce wages. The obvious remedy for this state of affairs is for the employer to provide or cooperate with a system of industrial education which will produce men competent to engage in a much larger field of work. Under present-day conditions it is possible to improve greatly upon even the best of the old-fashioned apprentice systems.

In the first place, because of our improved school system, young men having a better preliminary education may be secured for apprentices. They have a knowledge of mathematics and science which will be of great value to them. Many of them have done manual training work, and thereby gained a certain grasp of elementary mechanical problems and an ability to read and to make drawings, which is of great value. Not only can the modern shop secure better material for its apprentices, but it is able to give them better instruction. We have learned a great deal about education in the past few years. We have learned how to teach to the best advantage, and how to give the maximum of instruction and development in the time that we have at our disposal.

One of the best apprenticeship courses in this country is that conducted by the Brown & Sharpe Mfg. Co. of Providence. A toolmaker serves an apprenticeship term of four years, during which time he is given a thorough course of instruction in every branch of machine work. He does not go in a haphazard manner from one class of work to another, but the amount of time spent on the different classes of work is carefully proportioned to the importance of the work and to its difficulty. A portion of this time is spent each week in the company's schoolroom where he studies mathematics, drawing and other theoretical subjects. When he has finished his course, he will have received excellent and thorough instruction in a variety of subjects of which the old-fashioned apprentice never even so much as dreamed.

In giving such a course of training as this, the Brown & Sharpe Mfg. Co. is, of course, promoting its own interests. It secures in this way a corps of

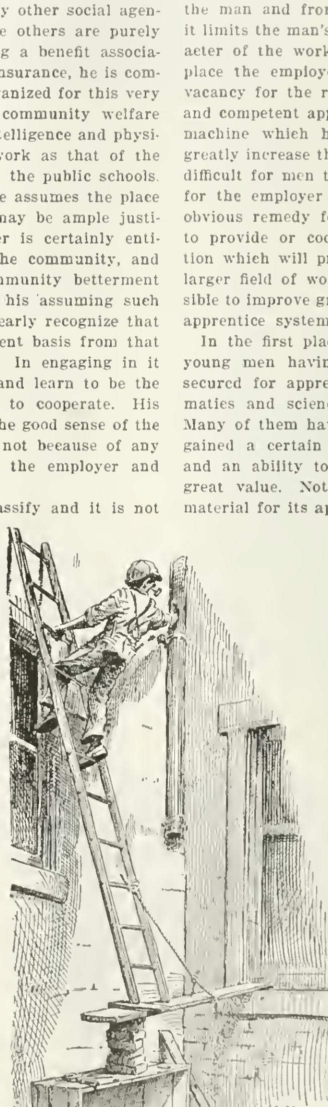

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Fig. 23. Carelessness is a frequent cause of accidents. Should this man fall it would be hard to convince him that it was not due to his bum luck.

workmen of the highest class, which insures that its products shall be efficiently and carefully made. On the other hand, it must always be remembered that the training is of more benefit to the young men than to the company. It enables them to make high wages, and to secure employment at practically all times. It has put them in a class by themselves because of the knowledge and ability which they have gained. In training them in this way the company has been doing the very finest kind of welfare work. It has done more for these men than any system of profit-sharing or any other form of welfare activity could do.

If such a system of training is to be worth while, it must be well done. There is no branch of endeavor in which it is more difficult to distinguish between the good and bad than in education. Any system of training must be in the hands of a competent teacher who understands the true objects and proper methods of educational work, and who knows how to train and develop young men, or it will be largely a waste of time. To place the burden on the shoulders of the already overworked foreman is folly. To pay low wages while the boys themselves, through their own efforts and observation, pick up a smattering of the trade, and then to call such a scheme an apprenticeship course, is dishonest. Because such boys are not trained or instructed, they never grow to be worth very much unless they have unusual ability to start with. Their work will be small in quantity and poor in quality, and they will find it difficult to earn even the small wages which they receive. A poor apprenticeship system may be properly designated by the term "illfare work," and is really no better than no system at all.

The educational work which an employer does, need not necessarily be confined to the training of apprentices nor to instruction in shop processes and methods. It is often worth while to conduct educational classes for the benefit of employes who are already advanced beyond the apprenticeship stage, thus greatly increasing their efficiency and value. A draftsman, for instance, may with advantage learn a great deal about foundry and machine work. A blacksmith may with advantage learn something about the metallurgy of steel and the theory of heat-treatment and hardening. Machine tool operatives will find it a great advantage to learn drafting, shop arithmetic and geometry. By giving these men opportunity to learn other lines, their intelligence is quickened, they become better employes, and a larger sphere of usefulness is opened to them.

Many employers are beginning to extend their educational work beyond the limits of industrial training. In those industries in which a large number of recent immigrants are employed, education in English is of benefit to the men and to the company, and is undertaken in many plants. This work is usually done during the evening hours. The company furnishes the necessary rooms for the work and often pays the teachers.

On account of the fact that the efficiency of the employe depends a great deal upon his health, many companies believe that it is to their interest to give instruction of some kind in matters of sanitation and hygiene. This is attempted usually by means of lectures and pamphlets, and by personal advice from the company's physician to employes suffering from indisposition. In this connection it must be realized that a very considerable portion of our working population are of foreign birth who have had no opportunity to attend American schools and that many of those of native birth have had their education curtailed for various reasons. In giving such advice and instruction, the company is merely supplementing our public education system, and giving to their employes something which they should have had but which circumstances forced them to miss.

In this connection it may be noted that when some men suddenly find themselves with a considerable increase in salary, they do not know how to spend it. A few of them continue on the same scale of living and save their increase. Many of them spend their increase foolishly, and sometimes in ways that are harmful to them. It has been the experience of most employers that when the wages of their unskilled laborers are raised gradually through a period of years, the men learn to spend the increase wisely, but that when wages are raised suddenly the increase is often expended foolishly unless special pains are taken to teach them what to do with it. To expend wisely money earned often requires more good judgment than is needed to earn it.

Many employers, therefore, are cooperating with social workers, educational clubs and so on for the purpose of educating the community in matters of personal and community welfare. Many workmen need to learn what we mean by the American standard of living. They need to learn the advantage of keeping their children in school as long as possible. They need to learn American standards of morality. Their wives and daughters need to learn cooking and dressmaking. In doing this sort of work, the employer needs to use great tact. He must treat his workmen not as persons dependent upon him for their livelihood, but rather as fellow-citizens. As far as possible, the work should be carried on through agencies which are not part of the corporation. The churches, the social settlements, the fraternal organizations of the community, and the employes' cooperative association (if there is one) may all do a part in this work, stimulated thereto, and financially assisted by the wise and thoughtful employer.

Cooperation in Little Things

There are many ways in which an employer may cooperate with his employes in order to save them loss of time and waste of effort. Such cooperation does not involve much expense to the employer, but the aggregate saving of time, effort and money may be of great importance to the employes. I have in mind a firm whose employes are organized in a cooperative and benefit association. The firm allows the association the privilege of having a store for the sale of tobacco, candy, magazines, and a variety of other articles, on the company's premises. There are two advantages in this: In the first place, it saves the employes' time by making it unnecessary for them to go out of their way to purchase such articles at other stores, and the cooperative association reaps the profits resulting from the sales. This cooperative association also maintains a push-cart service throughout the works. From these push-carts employes may at any time purchase tobacco, candy, gum, sandwiches and milk. This firm believes that such service is beneficial to the men and of advantage to the company. Of course this is a matter open to question. Many will question the benefit of such purchases during working hours, and many others will suggest that such service will have an adverse effect upon the efficiency of the men and on the quality of the work done. These questions can be settled only by observation and experience.

There are numerous errands which every man finds himself compelled to do one time or another, and which in the aggregate take a considerable amount of time and carfare. A great saving in these items may be effected by intelligent effort on the part of an employer. For those employes who are interested in books, some firms maintain a branch of the public library. The library collects and delivers books at the plant, receiving requests for specified books or classes of books, and filling them as far as possible at the next delivery. In this way, many trips to the library are saved.

Another way in which an employe may be served in such matters is by making arrangements to help him pay his bills. An employe having a bill which he wishes to pay may make out an order on a printed form to which is attached a copy of the bill. The order directs the firm to pay this bill and charge the same to his wage account. The firm then notifies the merchants that it is prepared to pay certain bills owing them by their employes, and the merchants' collectors, upon receipting the several bills, receive a check for the total amount. The amounts of the individual bills are then deducted from the wage accounts of the several employes, the employes receiving the receipted bills in their pay envelopes on the next pay day. This scheme is satisfactory both to the merchant and to the employe. The merchant makes his collections with a minimum of trouble, and the employe is not obliged to visit the merchant in order to settle his account.

Fig. 24. View in the men's dining-room of the Pierce-Arrow Motor Car Co.'s plant. This room seats 800 and each day an appetizing and nourishing meal is served for fifteen cents. This dining-room is very popular because the men get good food of the kind that they like.

In one case in which this scheme is used, practically all the employes avail themselves of the opportunity in paying their gas, electric light and telephone bills.

Some firms make the services of their purchasing department available for their employes when they desire it, and the employes are thereby enabled to make a considerable saving in certain classes of purchases. This is especially the case with hardware, stoves, coal, building material and furniture. Employes of this concern have saved hundreds of dollars when building homes through the services of the purchasing department. A further extension of this idea is the establishment of a cooperative purchasing association among the employes. The employes buy their supplies in quantities at wholesale prices, and utilize the transportation facilities of the company in order to distribute them. A considerable saving has been made in this way, the company donating storage facilities, the use of a motor truck delivery, and the services of the purchasing department.

Mutual Benefit Associations

Mutual benefit associations (or cooperative associations, as they are sometimes called) were originally established to care for sick and injured workmen. Usually they were instituted at the initiative of the employer. Not infrequently the cause of his interest was a desire to relieve his own pocket of the demands which charity was continually making upon it as a consequence of industrial accidents. At the time when mutual benefit associations first came into being, the burden of industrial accidents lay entirely upon the shoulders of the workmen, and because of the inferiority of the public health service of that day, serious illness was much more frequent than it is now. In consequence, the mutual benefit association was an organization which met a clearly defined need on the part of the employes, and its usefulness was great. With the growth of the workmen's compensation laws, however, the necessity for accident insurance has disappeared. Modern science is steadily reducing the amount of serious illness among our working population, and as a result the health insurance feature is less important than it was. It may also be pointed out that there are now many insurance companies who sell health and accident insurance at reasonable rates, and that a great many workmen are members of fraternal organizations having sick benefit features. However, the cost of the sick insurance provided by such mutual benefit associations is usually less than the cost of such insurance in commercial insurance companies or fraternal orders, and a great many men become members of mutual benefit associations who would not take advantage of the other forms of sick insurance. When wisely conducted, and especially when conducted in cooperation with a medical inspection and dispensary service, a mutual benefit association is still of great value.

The funds of mutual benefit associations are usually derived from the workmen. The employer sometimes contributes part of them, and in a good many cases fines levied for infractions of the rules are turned over to the mutual benefit association. Sometimes a share of the profits of the business is assigned to such an association. Sometimes the association has the use of a part of the company's property and often collects its funds through the pay master's office. Nevertheless, the fact remains that in most cases practically all the funds of the association are derived from the employes themselves, and to them belongs the credit of the work which it accomplishes.

The mutual benefit association need not, by any means, confine itself to sick insurance and death benefits. It may engage in any form of social activity which will benefit its members. It may become a very effective agent through which the employer can carry on much of his welfare work without arousing that antagonism and friction which sometimes appears when the employer attempts to become a leader in community welfare. The mutual benefit association has one very great advantage over any other agency which the employer can use for this purpose, because it is entirely democratic, and its efforts are not open to criticism from the employes. When such an organization is directed by a wise body of officers who have a realization of the needs of its

members and of the community, and have a vision of the kind of services which such an organization may give, an enormous amount of good may be done.

The nature of the work undertaken by such an organization and the benefits to be expected from it will vary according to the circumstances. A mutual benefit association of the employes of a small or medium sized plant located in a small town will have radically different opportunities and possibilities from one organized in a very large plant, especially if this plant is situated in the midst of a great city. However, there are many things which such an organization can do. It can, for instance, undertake the cooperative purchasing of family supplies, clothing and furniture, thereby saving its members many dollars. It can conduct a properly safeguarded savings and loan department, in which its members may deposit their savings, and from which they may receive loans in time of real need. It may conduct a building and loan association, accepting the savings of its members, and loaning money, upon proper security, for the construction of homes. It may conduct literary, social, and athletic clubs, musical organizations and so on. Under competent leaders it may organize the boys and girls of its members into companies of boy scouts and campfire girls. If its officers are wise and tactful, they can do much in influencing the younger members and in keeping them in the right paths. It may be so organized as to form an effective and satisfactory substitute for the labor union, serving as a connecting link between the employer and the employes, and presenting to the employer the wishes and needs of all classes of workmen. Finally it may enable the employer and his executives to come into personal contact with the workmen so that each may come to know the character, the ideals, and the wishes of the other, and incidentally, as one employer has put it, "Learn that the other fellow does not wear horns."

The employer may further the work of such an organization in many ways. In a large number of cases employers have contributed a large part or even the whole of the cost of construction of a club house for such an organization. Not infrequently a share of the profits of the business or an annual appropriation of stated amount is set aside for the work. Some employers have secured the services of social workers of experience and ability to supervise the work of the organization, and paid their salaries. In order that such an organization may be successful it is necessary that the workmen shall have leaders of ability among their number. There have been cases where employers have successfully provided for this need by hiring men whose nominal employment was connected with the work of the plant, but whose actual business it was to become leaders and directors in the work of the mutual benefit association. These men were chosen not because of their qualifications for the work which they nominally performed, but because of their ability as organizers and social workers.

The Housing Problem

Every large industry creates in any community in which it settles a housing problem of considerable magnitude. Many such an industry has bolstered up a dying community, has given value to its tumbledown dwellings, has greatly increased the rent of its stores, and has from the standpoint of the real estate dealers, very greatly increased the community's prosperity. The thoughtful employer, however, does not consider this real estate boom an unmixed blessing. He knows that it is his unskilled laborers who give value to the tumbledown tenements, and his skilled workmen seeking to build homes, who boost the price of vacant lots. He knows that all of this prosperity comes out of the pockets of his workingmen, and it is not at all surprising if he attacks the problem of providing houses for his employes at a reasonable rent.

One of the most successful attempts in this line is that of the Ludlow Mfg. Associates, of Ludlow, Mass. They are manufacturers of jute goods, one of the coarsest and simplest forms of textile work, and many of their employes are immi-

Fig. 25. View in the machine department of the Pierce-Arrow Motor Car Co. Note the excellent light, the abundance of room about the machines and the neat and orderly appearance of the shop and the system of ventilation.

grants, who make the jute mills a stepping stone to better things in the textile world. This firm located at Ludlow because of the water power there available. There being no place where their employes could be properly housed, they were obliged to begin the construction of dwellings as soon as they began the construction of the factory buildings. These dwellings consist for the most part of single or double tenements, of from five to eight rooms each. They are well built houses, kept in neat repair, nicely finished and decorated, and the company charges a rental of about six per cent of the cost of construction of the house. After allowing for taxes, insurance, depreciation and repairs, and the value of the land, the net rate realized on the investment is less than one per cent.

The dwellings provided by the company for their help, whose individual earnings range from six to eighteen dollars per week, and whose family earnings will probably average between eighty and one hundred dollars per month, are very greatly superior to the dwellings usually provided for this class of operatives. The rents range from $1.85 per week for a six-room house equipped with electric lights and plumbing, to $2.35 per week for an eight-room house with electric lights, furnace, bath and plumbing equipment. In most communities it would be practically impossible for labor of this class to afford to live in neat and sanitary dwellings, with ample grounds. In adjoining communities, such labor is obliged to find housing in huge tenements, often in bad repair, always with insufficient light and air, and usually at much higher rental than this.

This textile mill, by its liberal and enlightening policy in regard to housing, has secured for its help such favorable home conditions, that the work has resulted in a distinct profit to the mills. The fact that the houses are within a few minutes walk of the mills increases very materially the employes' leisure time, without the necessity of decreasing their working time.

The fact that the mill buildings are situated in pleasant surroundings and are convenient of access, promotes, in no small degree, the happiness and contentment of the employes. The fact that the houses have proper sanitary facilities, are kept in good repair, and have ample yard space, promotes good health and efficiency. Anyone comparing these houses with the crowded, dirty, sunless, ill-aired, and noisy tenements, which are the usual habitation of many American textile operatives, will understand why the death rate from tuberculosis among the Ludlow operatives is below normal, while among other textile operatives it is twice the normal rate.

The company began this system of housing as a matter of necessity. While they unquestionably feel that from a financial standpoint, they would be glad to withdraw from the work and invest their capital in more productive ways, it is also true that they are indirectly receiving a very considerable return from their investment, and their employes are profiting to a still greater degree. The company is apparently a generous landlord, and opportunities to rent their houses are eagerly sought by the few employes who are obliged to rent elsewhere because of the lack of a sufficient number of company houses. Of course it would be possible for the company to charge much higher rent for these dwellings, and to secure a reasonable return from its investment. If it did so, however, many of the employes would be obliged to seek cheaper (and less satisfactory) quarters elsewhere, and it would create in the minds of the men the idea that the company was trying to exploit them by charging exorbitant rentals. So long as the rentals are obviously low, and repairs are made promptly and willingly, the company receives the benefit of a large measure of good-will, which would disappear the instant it attempted to make a paying investment out of this portion of its capital.

Another New England firm, with an entirely different class of employes, who is also attempting to do something in the housing problem, is the Draper Co. of Hopedale, Mass. On account of the rapid growth of this company, which manufactures all kinds of textile machinery and which employs two or three thousand machinists, molders and other skilled workers, it became necessary to provide housing for its employes. The Draper Co. has built several hundred desirable tenement houses with first-class equipment in every respect, with handsome exteriors, well kept lawns and very nicely finished and decorated inside. While the rent charged for these is low, it is still high enough to bring a rate of three or four per cent upon the investment, after making deductions for necessary repairs, depreciation, insurance and so on. The housekeepers are quite enthusiastic in the praise of the company as a good landlord, remarking on the excellent repair in which the houses are kept and the very satisfactory conditions that the company maintains. There are not sufficient houses for all the Draper Co.'s employes, but I understand that there is never any lack of applicants for any of the houses that may become vacant.

Fig. 26. A corner in the storehouse of the Pierce-Arrow Motor Car Co. While the unusual floor space and the excellent equipment is costly, they save money by keeping the stock active and facilitate the work of the storekeeper.

One cannot avoid the impression that of these two companies the Ludlow people are doing a much more necessary work. The employes of the Draper Co. are mostly skilled workmen who command good wages, and who would be able to secure for themselves proper and sanitary housing. It is true that it would be difficult for them to find quite as pleasant conditions as they enjoy in Hopedale, where the brains and resources of a great manufacturing organization have been employed in building up a beautiful industrial village, but they unquestionably would secure very satisfactory conditions on their own initiative.

The employes of the Ludlow Co., however, would find themselves in a very different position without the assistance of the company. They have not the initiative or the ability to secure for themselves conditions anywhere approaching those which their employer secures for them. The Ludlow Mfg. Associates are doing a real welfare work which has a remarkable influence upon the health and general well-being of hundreds of families. Unquestionably this is a form of paternalism, but we must remember that first, the company was compelled to engage in this form of welfare work, and second, that the good which results is ample justification for this particular example of paternalism.

There is an old and very true proverb to the effect that "all is not gold that glitters." Many companies have been and still are providing housing for their employes who are

not engaged in welfare work. In many cases the housing is not what it ought to be. In many cases, the company creates a privately owned village, in which employes are deprived of the right of self government, and the company maintains complete control, not only of the houses, but of the streets and public places. Not infrequently the rents charged are high, when the nature of the accommodations is considered, and it is often truly alleged that the wages paid in such communities are so low, that cheap housing is a totally inadequate compensation. Before any form of industrial work can be truthfully classed as welfare work, it must be apparent that it is intended to and actually does benefit the workmen.

Workmen's Pensions

The problem of caring for those who are dependent because of superannuation or illness is a social and not an industrial problem. In those countries which have made the greatest advance in providing for the welfare of their citizens, old-age pensions, as well as sick insurance and unemployment insurance, are provided by the state. Our several states, however, have not considered the question of caring for those who are too old to work efficiently, and accordingly, old-age pensions are a feature of the welfare work of some corporations. One of the companies which has adopted this plan has done so because of the fact that failing activity, and especially failing eyesight, make employment with them impossible long before their employes would become superannuated in other industries. This corporation recognizes the fact that these men have given the best years of their life to the service of the company, and that while they are not too old to earn a living in other lines of work, they are too old to learn a trade or to begin a new kind of industrial life. Therefore, they consider that their employes are entitled to some compensation for the disadvantage which their employment has now forced upon them. Another reason why many firms have instituted pension systems is the fact that such systems induce the better class of employes to remain in the service of the company, particularly if they have already served them for a long time.

An efficient employe of good character, who is thoroughly familiar with his work, is a very valuable part of the intangible assets of any firm. For such an employe to leave his employment is a serious loss. Anything which will induce him to remain will be of advantage to the company employing him. The prospect of a pension secured at a given age by a required number of years of service is a very strong inducement for such a man to remain with the firm. It is not an inducement to a thoughtless employe who is not well trained, and who feels that he may lose his place because of his lack of ability. Such a system, therefore, acts as a sieve, retaining the best men, and permitting the others to depart. A pension system is in effect a form of profit-sharing in which the payment of the profits is deferred, the payment being made in the manner which will bring the greatest benefit to the employer, and the money going to the employes who have the greatest need of it.

There is considerable objection to a pension system in some quarters on the ground that it is "un-American," and "pauperizes" the workmen. It is argued that our American social and industrial system requires that good wages shall be paid to all employes, and that the "American plan" requires the workmen to save for themselves a competence for old age. In theory this is an excellent system. Every man saves part of his wages, and puts his savings in the savings bank. These savings form part of the community capital, making possible new industries, adding to the productive power of the community, increasing prosperity, and raising wages. When old age overtakes the workman, the savings are gradually withdrawn to support him in his declining years.

Like many other systems, however, the "American plan" is good only when it works. If the employe, because of lack of thrift (which in many cases is a doubtful fault) or misfortune or illness, or because he spends his surplus earnings in educating his children, or in providing for his family the opportunity for a more abundant and happier life, finds himself in his declining years without any savings, the scheme is unsuccessful, no matter how excellent it may be on paper.

A second practical objection to the "American plan" lies in the fact that it does not meet the basic requirement of any satisfactory pension system, which is that the cost shall be graduated in accordance with the pensioner's ability to pay and the pension shall be proportional to his needs. The employe who saves a satisfactory competence may be accidentally killed at the age of fifty-five, leaving no dependents. Another employe who is obliged to support a large family may spend all his savings in time of illness which renders him unfit for further active service. The "American plan" is unquestionably unsatisfactory.

We must therefore expect that the idea of pensions, as a reward for long service, will grow in the industrial world until our states are sufficiently advanced in applied sociology to provide such pensions out of the public funds.

A Remarkable Experiment in Industrial Democracy

The purposes which lie behind welfare work have been variously described by different employers. Some employers say that they are engaged in this work for the purpose of giving the employe a square deal. Some say that they are under moral obligation to do everything possible to promote the welfare of their employes. Others state that their object is to bring about a spirit of mutual understanding and cooperation between the workmen and themselves. Many employers in discussing their work lay stress on the idea that it must not be considered as a form of charity. They are at great pains to avoid the supposed evils of paternalism, and attempt to make the work as spontaneous and democratic as possible. It will be well worth while for anyone interested in these problems, to consider the very remarkable work carried on by the Filene Cooperative Association (usually known to its members as the F. C. A.) in the department store of the William Filene's Sons Co. in Boston. While this work is carried on among a class of employes and in a kind of business totally different from the mechanical industries, its success has been so great, its methods have been so unique, and the powers and duties of the F. C. A. are so unusual as to merit most careful attention.

There are three features which distinguish this corporation from any other mercantile or industrial corporation with which I am acquainted. In the first place, the employes have a voice in the conduct of the business. In the second place, the employes have complete control of all of the conditions of employment, including wages, hours of labor, rules and discipline. In the third place, the employes, through their own organization, carry on a very elaborate and successful system of welfare work. The policy of this corporation is so revolutionary in these respects that it at once challenges our attention.

The William Filene's Sons Co. is organized for the purpose of conducting the department store established by William Filene about the year 1888. It is capitalized at $400,000 and occupies an immense building in the shopping center of Boston. This corporation is governed by a board of eleven directors, *four of which are elected by the employes*. The great majority of these two thousand young men and women own no stock in the corporation, but are nevertheless, represented in the board of directors in this unusual manner.

Every employe of this corporation, by virtue of his employment, is a member of the F. C. A. The organization requires no dues. For the purpose of administration the store is divided into twelve sections in a manner analogous to the political subdivisions of a state. Each year the F. C. A. elects a president, vice-president, secretary and treasurer, who serve without compensation. These officers, together with nineteen others who are elected by sections, form a council or executive board of twenty-three members. The council elects an executive secretary and staff who have charge of the entire system of welfare work carried on among the employes. The salaries of this secretary and his staff are paid by the corporation and not by the F. C. A.

Fig. 27. Assembling floor of the Pierce-Arrow Motor Car Co. This is one of the most pleasant and attractive shops that the writer has ever seen.

Besides the F. C. A. council the members of the F. C. A. elect a number of committees whose duties are to supervise and control the various activities of the organization. The most important of these is the one known as the arbitration board. It consists of twelve members elected from different sections of the store and a chairman who is appointed by the president of the organization. It exercises powers which are in other organizations reserved entirely for the management. According to the constitution of the F. C. A. the arbitration board is established for the purpose of insuring justice in the administration of the work of the store. It has jurisdiction in all cases of difference arising between an employe and the management, or between two or more employes in matters of store interest, or in any case where the enforcement of the store rules appears to work a hardship or injustice. The questions most frequently brought before the arbitration board relate to discharges, changes in position, wages, transfers, loss of stock, differences between employes and so on. The decisions of the board are final for all cases arising within its jurisdiction. By a two-thirds vote it may reinstate an employe who has been discharged, or it may increase the pay of any employe or class of employes. In all other cases only a majority vote of the board is required to render a judgment. This arbitration board is in effect a court of last appeal in matters affecting wages or discipline. The justice of an employe's case is finally referred to the judgment of his fellow-employes.

It will be seen that through this arbitration board the employes of this store have complete control of all conditions of employment. While the firm itself is responsible for the management of the store and for its merchandising policy, the employes determine the wages, the conditions of employment, the hours of opening and closing, and the rules governing their conduct. It would appear to the average man, and especially to the average employer of labor, that this is a very dangerous power to place in the hands of the employes. Most of us, I fancy, would expect that the employes would take advantage of the fact in order that they might increase their wages and reduce their hours of labor beyond reason. Such has not been the experience of the William Filene's Sons Co. The employes have used their unusual powers with justice and fairness.

The following example will serve to make clear the attitude of the employes of this store when there appears to be a conflict of interests. The employes had at one time voted that the store should remain closed on July fifth when that day fell on Saturday, thus giving themselves a three days' holiday in certain years. In 1911 Bunker Hill Day, which was the 17th of June fell on Friday. Many employes felt that the store should be closed on Saturday, June 18, as it would when July 5th fell on Saturday. When the matter was put to a vote, however, the employes voted by an overwhelming majority to keep the store open. The reason for their action was as follows: During July the Saturday business following the holiday would be very light, and the store would lose but little business by being closed. During the month of June, the Saturday business is usually very brisk, and this is especially the case on the Saturday preceding Commencement week. The employes, therefore, voted to forego their holiday rather than to deprive the firm of the large volume of business which might be reasonably expected on that day.

There is no question but that the employes of the Filene store have secured for themselves admirable working conditions. The hours of work are very favorable to the employes. The store does not remain open on the evenings preceding Christmas. There is a minimum wage for girls of eight dollars per week. Apparently the employes treat themselves with as much generosity in such matters as is compatible with full justice to the firm for which they work.

The William Filene's Sons Co. believes that welfare work is most satisfactory and effective when it is carried on by the employes themselves. Accordingly the F. C. A., through its executive secretary and his staff and through a number of committees elected by the employes or appointed by the council, carries on a system of welfare work which is unsurpassed in variety and effectiveness by that of any similar

Fig. 28. View in the washroom of the Pierce-Arrow Motor Car Co. The lockers may be seen in the distance.

concern with which I am acquainted. There is a sick insurance and death benefit fund which is designed to take care of employes during periods of illness. A part of the store building is set aside for an employes' club house. A lunch room is maintained there for the benefit of the employes. The employes also have a cooperative purchasing association which enables them to reduce greatly the cost of many of their purchases by purchasing in quantities and under favorable conditions. A banking and loan association pays 5 per cent upon deposits and lends funds to those employes who might otherwise have to patronize the loan sharks. There is a medical department having nursing and dispensary service which cares for the health of the employes and the hygienic aspects of their employment. There are also educational classes, organizations such as campfire girls, men's, women's and girls' clubs, a dramatic club, an orchestra and various athletic organizations, and other minor activities.

It will be seen that the F. C. A. is an exceedingly active organization engaged in a great variety of social work. This is attested to by the fact that each year the organization receives and disburses somewhat more than $100,000. The William Filene's Sons Co. contributes to the support of the organization, but the greater part of the funds are furnished either by the employes themselves, or through their activities. Unquestionably the suggestions of the owners of the store are effective in initiating and controlling many of these activities, but the final control and direction of these activities is vested in a voluntary organization of the employes. That the scheme is successful and satisfactory in all its aspects is shown by the fact that the work continues to grow in volume and scope and that the company professes to be well satisfied with their very unusual experiment. The management is at present contemplating the installation of a system of profit-sharing in which, after paying reasonable dividends upon the capital stock, the surplus profits are to be divided equally between the management and the employes.

It is impossible to escape the conclusion that this industrial experiment of the Filene company is profoundly significant, and furnishes a possible solution for many of the industrial problems of the present day. It is impossible, for instance, to conceive of friction arising between the employes and the management when the conditions of employment are under the control of the former. There is no need for collective bargaining, nor for any kind of labor agitation. The fact that the employes are represented on the board of directors of the company gives them an insight into the workings of the corporation, and an understanding of its needs and problems. The system of profit-sharing makes clear the possible limits to wages, and impresses upon each employe the truth that wages must be paid out of earnings and not out of capital.

At the same time it must be recognized that before working people in general may be entrusted with the powers and privileges enjoyed by the employes of the William Filene's Sons Co., a preliminary period of education is necessary, and that if such a system is to be successfully introduced, it must be introduced gradually and not suddenly. To bring the economic errors and the present-day attitude of mind prevalent among working people, to the solving of such problems as confront the F. C. A., would result in the speedy ruin of the business.

Why Do Employers Engage in Welfare Work?

Employers are led to engage in welfare work either because they think it advances their interests or because they feel a moral obligation to do so. Not infrequently self-interest and conscience coincide, and many men who engage in such work because their conscience bids them do so, lay stress upon the advantages which they reap from it.

Self-interest is the ruling motive which has prompted many employers to engage in safety work. The operation of workmen's compensation laws has led them to look carefully into the danger spots around their plants, to guard their machines, and to educate their workmen to use better and safer methods of working. Self-interest leads many employers to take an interest in the physical welfare of their employes, for they realize that by keeping their operatives in good health, they are increasing their efficiency and so benefiting themselves. Many employers are fully persuaded that congenial conditions of employment, plenty of light, good ventilation, pure drink-

ing water, and perfect hygienic conditions result in increased dividends. These men engage in such work because they believe that it pays.

Self-interest leads other employers to engage in certain kinds of welfare work in order to attract to their service a higher class of employes than they could otherwise get. They believe that the efficient and dependable man is the man of superior skill, intelligence, and character, and that he appreciates the opportunities which come to him through certain kinds of welfare work. The "hobo machinist" who usually spends from two to six weeks upon a job before *wanderlust* compels him to seek employment elsewhere, is attracted by high wages rather than consideration for his welfare. Such a man is apt to give a "welfare plant" a wide berth, and the plant thereby escapes the expense of hiring and training him. By being careful of the welfare of his employes, and by making their employment pleasant and satisfactory, an employer can very greatly decrease the floating element on his pay roll and thereby increase the efficiency of his plant.

Still other employers engage in welfare work in order to gain the good-will of their employes. They believe that such work creates a feeling of mutual respect and confidence which minimizes that friction which is so destructive to efficiency. By their just considerations of the needs and wishes of their employes, they hope to avoid labor difficulties and the loss and trouble which spring from them.

Some men engage in welfare work because it is the style. Not that these men are actually striving to "keep up with the styles" in the manner that the women of fashion are popularly supposed to do, but they desire to do the right and proper thing, and without any true appreciation of the fundamental purposes of welfare work, they engage in it because other firms of note have already done so. Still other men go into welfare work for the sake of the advertising which they can get from it. It brings their product to the favorable attention of their customers and creates in the public mind a feeling of good-will toward them. Perhaps advertising is not the only motive which causes them to undertake such work, but it is often one of the motives, and such motives are frequently responsible for the accomplishment of a great deal of good.

Another class of employers engage in welfare work because their conscience lays upon them the duty of doing all that they can for the benefit of the men who help them to earn their profits. These men are glad that welfare work pays, and they are not at all averse to making it pay, or to securing any of the selfish advantages which may be realized from it. Self-interest, however, is not their first consideration, and they would engage in any line of welfare work which would benefit their men even though it could be shown that this work was conducted at a loss to them. Such men have always engaged in some form of welfare work, and their ideas and teachings regarding the duties and obligations of employers have been an important factor in building up better industrial conditions.

Unquestionably the principal reason for the present rapid growth of the welfare movement has been the development of what we may call the "social conscience" among employers. I wish to make a distinction between those employers already described who feel that they have a personal responsibility to each and every individual employe, and those employers who are beginning to feel that every industry exists primarily for social service, and only incidentally for the earning of dividends.

For many years our entire theory of economics was based upon the idea that every man was working continuously, consciously, intelligently, and determinedly for his own self-interest. According to the nineteenth century economist, the motto of humanity was "Every man for himself and the devil take the hindmost." We are, however, beginning to get a broader view of the purpose of industry. The best thought of the present day holds the view that industry exists for the welfare of society, and that the profit accruing to the owners is only an incident to its primary purpose. Let us take the case of a particular industry in order to illustrate this point. Formerly a railroad was regarded as an enterprise by which certain men could make a great deal of money. Nowadays it is regarded as an enterprise whose primary purpose is to serve the public, and whose incidental purpose is to make reasonable profits for its stockholders. We recognize that the making of profits is an essential part of the railroad's business, and that without them it cannot continue to serve the public, but we no longer believe that these profits are the one consideration which must settle every element of policy in the conduct of its business, and in its relations to its employes and its patrons.

It has been slow and uphill work to secure the establishment of this principle, but it is gradually gaining wide acceptance even among those who receive the profits. It is but a step from the public service corporation to the industrial corporation. Both are engaged in work essential to the public welfare. While there are many points of difference, these

Fig. 29. Store in the plant of the Pierce-Arrow Motor Car Co. conducted by the Mutual Benefit Association. This store has proved a great convenience to the employes.

differences are not so great as to produce separate codes of ethics. Hence we find a growing recognition of the truth that every industry exists primarily for the benefit of society, and that, in consequence, its owners are under obligation to do everything possible to promote the interests of their workers.

Cost of Welfare Work

Like every form of human activity the success of welfare work must be measured by the relation between the cost and the results obtained. From this standpoint welfare work is amply justified, for it is not usually very expensive. The National Cash Register Co. of Dayton is one of the leaders in this form of social activity. For years this concern has been noted for the lavish way in which the welfare work is carried on and for the great amount of good which it accomplishes. Notwithstanding this, the cost of the welfare work is a trifle less than six cents per employe per day. This includes the fixed charges on the plant devoted to welfare work, the cost of maintaining the beautiful park-like grounds, the cost of the medical and dispensary service, the value of the time given to the employes in which to avail themselves of some of the welfare privileges which the company offers, the cost of the company's educational work, and the cost of the work in community betterment.

The Attitude of Labor

Labor holds three different attitudes toward welfare work. The first of these is the attitude of working men in general toward such work. The second is the official attitude of labor unions toward such work as expressed in their official organs and the public utterances of their leaders. The third is the attitude of labor organizers and other salaried employes of the unions.

In general, workmen are highly appreciative of anything which obviously benefits them. Anything which makes for their bodily comfort or which makes their work safer or cleaner, or less laborious or disagreeable will have their unqualified approval. However, many forms of welfare work are not appreciated, either because the men do not see the necessity for such activities, or because they believe them to be an unnecessary outlay of money which might better be given to them in the form of increased wages. A good many workmen, for instance, do not appreciate proper shop sanitation, because they have no conception of the method of transmission of diseases, and they regard such efforts as a ridiculous waste of money. Other men hold similar views with regard to beautifying the grounds of an industrial plant. They imagine that an enormous sum of money is spent in this way, and that it could be made to give them a substantial increase in wages.

In considering the attitude of workmen toward welfare work there are four things which we must keep in mind. The first is the fact that workmen, like other men, resent anything which savors of paternalism, or which infringes in any way on their personal liberty. Any form of welfare work which appears to do this will receive unsparing condemnation. In like manner they resent any assumption of superiority, either in wisdom or in goodness, on the part of anyone else. This is especially true of workmen of American birth. For example, they have no objection to their employer's furnishing them with a hot dinner at a nominal cost. They do not consider such a thing to be charity but rather a part of their compensation. However, if the employer should attempt to feed them something which he thinks is good for them, but which they are not in the habit of eating, there will be trouble, because they think they know just as much about what is good for them as he does, and resent his assumption of superior wisdom.

The third matter which we must bear in mind is the hostile attitude of labor toward anything tending to promote their efficiency. Almost all working men believe that increased efficiency means lack of employment and lower wages. This is the principal although not the only reason for their attempts to secure an eight-hour day, to limit the number of apprentices, to abolish piece work, to prevent the introduction of scientific management, and to limit production. This economic error colors the working man's whole view of industrial life, and we must remember it when we are considering his attitude toward certain kinds of welfare work. Working men know that economists heap ridicule upon this idea and they have therefore learned to keep it under cover as much as possible. When this is their real objection to any proposal, they bring against it other and more plausible reasons. In such a case it is necessary to appreciate the important and hidden objection and to tactfully remove it by pointing out to them the substantial benefits which the proposed innovation will confer upon them.

Finally working men very often feel that they are not receiving a just share of the wealth which they help to produce. They are often justified in this belief, but they fail to recognize that the fault usually lies in our economic organization and is not due to greed on the part of their employer. When such men see great sums of money expended for welfare work, they often feel resentful, believing that the money should come directly to them in the form of increased wages. The fact of the case is that the possible increase in wages would be insignificant, and the probable reduction in efficiency would soon compel a reduction in wages.

Most of the employers who are engaged in welfare work are very sympathetic with the just aspirations of labor in general. The very fact that they are engaged in systematic efforts to improve the conditions of their employes argues that they are more likely to be just in their dealings with them than are those employers who do not take such an interest. It will usually be found that in those plants where welfare work is attempted, the attitude of the workmen toward their employers is very friendly, not so much because of the welfare work done but because they feel that they are receiving just and generous treatment. Their attitude toward the welfare work introduced by such employers is apt to be sympathetic and friendly, whereas the attitude might under other circumstances be one of suspicion and distrust.

The Union Attitude

The avowed purpose of the labor union is to increase wages, to secure shorter hours of labor, and to secure more favorable conditions of employment. This latter phrase denotes many of the things which are being introduced by employers in their welfare work. The official union attitude with respect to such matters as safety work, lavatory and locker facilities, and many similar things, is that the worker is justly entitled to them, that the union was organized for the purpose of securing them, that it has persistently fought for them, and that, in general, employers are merely performing their manifest duty in making such provision.

The attitude of the rank and file of the union, however, is the same as that of other workmen. They are very glad to have certain things done for them and they do not feel "pauperized" when it is done. A union workman is no different from any other workman and he is just as keenly appreciative of the advantages gained by a thorough and sympathetic study of his needs as is anyone else.

When employers attempt to do anything in the line of welfare work beyond the officially expressed wishes of the union, the official attitude of the union will be one of gratitude or objection, according to the nature and effect of the work attempted. There are several points which must be borne in mind in connection with the official union attitude. The first of these is that a labor union is the most dogmatic organization on the face of the earth. As a combined result of logic and experience (the logic often not bad) labor unions have arrived at certain conclusions in regard to what is beneficial and what is harmful to their membership. In the main their conclusions are correct. They may have found that the results of certain activities were usually bad, and accordingly unsparingly condemn all similar lines of work, irrespective of the motives of the employer or of the effects of such work on the well being of their membership. Their excessive dogmatism causes them to condemn some forms of welfare work which are not only entirely justifiable but highly praiseworthy.

A case in point is the union attitude toward the housing problem. Unquestionably certain companies have exploited their help in providing dwellings for them. The union attitude is therefore opposed to any provision of housing even by the most enlightened and sympathetic of employers, and makes no distinction between housing provided for the purpose of exploitation or to secure control of the activities of the workmen, and housing provided for the purpose of securing the workmen's best welfare. Similarly, the unions are opposed to the provision of dormitories or boarding houses or of any similar plans on the part of employers, although this is often one of the finest types of welfare work.

In like manner the union is opposed to cooperative purchasing unless it is carried on by an exclusively mutual organization. The reason for this is that in the past the unions have found "company stores" to be a prolific source of exploitation. The union is heartily in favor of first-aid facilities and of dispensary work, but is utterly opposed to systematic medical inspection. The reason for their opposition is that such medical inspection may be used to exclude the defective from employment, and as one leader put it, "increase the human scrap pile." When medical inspection is employed for the purpose of excluding the defective, it cannot be classed as welfare work, although such a proceeding may be justifiable in the interests of the employer and his customers.

There is one matter of which the union is very jealous, and that is what may be termed their fighting power. The union holds that the advantages which they secure must be won by "force," that is, by economic pressure. (This does not mean riot or disorder.) Accordingly, the union is very much opposed to any form of welfare activity which tends to limit their power in any way during times of industrial strife. Hence we find the union opposed to company housing on the ground that employes may be dispossessed during labor difficulties, and so find themselves without homes at a time when they are unable to pay their rent in advance. For the same reason unions are opposed to profit-sharing and benefit schemes unless the profits are paid in cash. The unions regard deferred profits or the ownership of equities in securities as a sort of bond retained by the employer to secure the good conduct of the employe.

The attitude of the unions on the question of profit-sharing is an interesting one. They appreciate the money but they do not like the way in which it comes. They would very much prefer to have the profits come to them in the form of an increase in wages for two reasons. In the first place, the moral pressure of such a wage increase would assist them in securing an increase elsewhere. In the second place, an increase in wages is usually a permanent thing, while a share in the profits may vanish whenever there are no profits to divide. They are opposed on principle to any system of profit-sharing in which the profits are confined to certain individuals, they object strongly to any investigation into the private affairs of their membership, and they feel that it is wrong to submit to any form of regulation or supervision by an employer or his agents, outside the walls of the factory.

It may be inferred, therefore, that the official union attitude is not entirely favorable toward the work of the Ford Co. While there is no complaint regarding the actual results of this company's welfare work, they maintain that the powers and privileges which the company are assuming may in other hands become highly dangerous to the welfare and even to the liberty of the workingmen, and it must be admitted that there is some measure of truth in this contention. They further allege that the unusual profits of the Ford Co. are obtained by a system of "driving." (That is, by the employment of highly efficient methods of production and by a high standard of diligence and industry in the work of the men.) They try hard to convince themselves that the output expected of the workmen is too great, and that such strenuous tasks will result in premature superannuation. Their real objection to "driving" however, is the fear that the general adoption of more efficient methods of work will throw large numbers of men out of employment, and reduce the wages of the remainder. This is an attitude of mind, however, which they are obliged to keep to themselves, for the reason that it is based on economic fallacy.

It may be pointed out that there is much to be said both for and against the Ford Co.'s methods. Their welfare work is in the hands of men who are deeply conscientious, and who are doing more in an endeavor to promote the welfare of their employes than any other firm has ever done. They are attacking some very grave social problems in a courageous and common-sense manner, and they have succeeded in obtaining at least a partial solution applying to the special case which they have in hand. On the other hand, we must recognize that both the leaders and the rank and file of union labor are thoroughly honest and conscientious in their convictions, that they have arrived at many of these convictions as a result of bitter experience, and that when these convictions are wrong it is because of a lack of knowledge of economics rather than a lack of willingness to see the right. The writer has sometimes thought that if every employer would give one hour a week to each employe for systematic instruction in the elements of economics and would himself devote the same time and study to the subject a great many of our labor differences would quickly die a natural death.

While we are discussing this subject, we must recognize that a part of the Ford Co.'s activities have nothing whatever to do with their industrial enterprise. In attempting to share the profits only with those employes who show a disposition to use them wisely, and in attempting to educate its workmen in the proper use of money, and in supervising their expenditures and methods of living, this company has made itself one of the philanthropic agencies of the community, and stands in the same relation to its employes as do the other organized philanthropic and social agencies. Were the profits of the Ford Co. divided as an increase in wages, it would be absolutely necessary for the welfare of the workmen to have some social agency undertake the kind of work which the Ford Co. does, and unquestionably it can perform that work much more effectively than any police court, social settlement, or any church or fraternal organization could possibly do. Without such instruction and supervision the high wages which the men would receive would sometimes be expended wickedly, often foolishly, and nearly always without receiving full value. There still remains, however, the possibility that this work might better be undertaken by a mutual organization such as the Filene Cooperative Association which has already been described, and which avoids in a very admirable way all the objections which may be raised against such activities on the part of an industrial corporation.

The attitude of the professional labor organizer toward welfare work sometimes becomes a matter of serious importance. It is the business of this class of men to secure certain things for the unions. Their bread and butter depend upon the service which they can render in this way. Like other men they are unwilling to see the source of their incomes destroyed, and while, in general, they labor for what they conceive to be the best interests of the worker, they are but human and therefore inclined to find fault with anything which weakens their power or appears to render their efforts unnecessary. These men are apt to look upon welfare work with divided feelings. They are in the position of an attorney who sees his client approached in an effort to settle his case out of court. While they are anxious to have everything possible done to promote the well-being of their clients (*i. e.*, the membership of the unions) they dislike to see anything which weakens their power or raises a question as to the value of their services. It is perfectly natural, therefore, that they should look upon many phases of welfare work with suspicion, and should believe that the employer by this means is attempting to undermine the influence of the union by developing in its membership a false sense of security and good-will.

Future of Welfare Work

It is beyond question that welfare work will become a permanent feature of our industrial life. This does not mean that all the features which we now include will remain in-

definitely, because many of them will vanish when changing conditions make them no longer necessary. The fundamental principles of welfare work, however, will remain so long as industry continues to exist on its present basis. Welfare work has its basis in the idea that it is the duty of the employer to utilize all the powers which he possesses—capital, initiative, judgment, and executive ability—to promote the welfare of the workmen whom he employs.

The social philosophy of the nineteenth century was highly individualistic. According to that philosophy it was the duty of every man to look out for number one. It was thought that if every man would exercise a reasonable amount of diligence and common sense in attending to this duty, the organization of society would be satisfactory, and that everybody would be as happy as could be expected. Welfare work found no proper place in this philosophy.

The social philosophy of the twentieth century, however, finds its basis in the advantages of cooperation. The new idea is team work. The coordinated and directed efforts of the minds and wills and wealth of many men are seen to be much more powerful in securing the welfare of the whole than are their individual efforts in securing the welfare of each. Hence modern social philosophy recommends organization and cooperation for the purpose of securing the general good. Welfare work is a manifestation of this spirit. Not only do we find employers using their powers for this purpose, but we find them organizing into associations with the idea of bringing their combined knowledge and experience to the service of their workmen.

As has already been stated, welfare work is only one of the many social agencies working for the betterment of the community. The work affects directly only those who are engaged in industrial work. It affects them for only a part of the time. In spite of its great importance, welfare work is one of society's minor agencies for good. It does its part in promoting the welfare of certain people and it does its part also in making the other agencies more effective. The knowledge and experience gained by the men engaged in welfare work become available for the other social agencies, and stimulate them to better and more effective efforts.

Welfare work is indicative of some new and promising tendencies in our industrial life. One of these is the tendency to be more thoroughgoing and painstaking in all matters pertaining to our social welfare, and particularly in the task of increasing our industrial efficiency. Another is the growing tendency to regard the primary purpose of industry as social service. The third is the ever-growing tendency to make society, in all its manifestations, more democratic. All of these tendencies are great with hope for the future. Through increased efficiency will come a larger measure of material satisfaction and comfort for the community. As industry becomes more and more an instrument of social service, society will be better served by it, and the present economic injustices which mar its administration will grow less. As industry becomes more democratic, the welfare and the wishes of workingmen will receive more and more consideration, and as a consequence they will gain a better knowledge of the laws of economics and the purposes of industry. This, in turn, will give to workmen a larger voice in the direction and control of industrial affairs, lead them to give efficient service more cheerfully and willingly, and enable them to share more equitably in the wealth which they create.

Figs. 30 to 32. Two-family Houses of the Better Grade provided for Employes by the Draper Co Hopedale, Mass. These houses rent for about \$3 to \$4 per week per tenant.

Probably the most important, and at the same time the least appreciated effects of welfare work, are those which are indirect. The fact that an employer devotes systematic attention to the welfare of his employes is bound to awaken in his mind a new conception of the possibilities of community welfare. It is bound to give him a new vision of his social obligations. It is bound to call to his attention the enormous power for good which industrial leaders may exercise, especially when they are united in an association for this purpose. It is bound to give him a new and powerful light on those age-old social problems of whose solution we have made such a sorry mess. And out of it all are bound to come new social agencies of greater power and higher efficiency than those we now have.

Nor are the indirect effects on the working classes to be neglected. Welfare work means to them more than health and longer life and better conditions of employment. It means another generation of workmen, stronger, better trained, more intelligent, more efficient, more self-respecting. It means less bitterness and class consciousness, and more good-will and cooperation in our industrial relations. Following the example of their employer, they gain a new and clearer view of their social obligations. They gain new conceptions of family welfare and neighborly duty.

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NOVEMBER, 1915

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THIS number of MACHINERY is largely devoted to a review of safety and welfare work in manufacturing plants and selling organizations. We all know that the movement for better industrial conditions has spread over the country in a remarkable way during the past ten years, and evidences of "safety first" are to be seen on railroads, in steel works, in mines and other places where formerly there seemed to be an almost total disregard of the life, health and well-being of employes. The change is caused by an awakening to the fact that industry could not afford to go on year after year paying the enormous toll that carelessness and lack of forethought impose. It is not good business to kill efficient workers in the prime of life and leave their families destitute, to become burdens on the community. Nor is it good management to maim and cripple them, or to allow them to fall ill because of unsanitary conditions.

This great change has involved a vast amount of educational work among all classes, including men of every capacity, from the presidents of great corporations down to the humblest laborers. One of the chief principles to be inculcated was that an accident is not merely unfortunate—it is little short of criminal if avoidable or the result of carelessness. MACHINERY has consistently promoted the movement for years by publishing many articles written by men of practical experience in welfare work.

The movement for safer conditions in industry has spread with many ramifications, embracing almost every activity of life. One large employer of labor noted for his liberality to employes found that doubling wages was not sufficient to insure decent and healthful living conditions for his men. It was necessary to send out welfare workers to show them how to take care of themselves and their families. To what extent such paternalism is warranted is open to argument, but its immediate good effects can hardly be questioned. The impressive feature of an awakening industrial conscience is the realization that no longer are men and women regarded as subjects of exploitation only—they are to be regarded as co-workers whose unimpaired bodily vigor and health are assets of the community and must be conserved by every legitimate means to promote general welfare. As the author of the leading article points out, the change in the condition of workers as regards safety and housing is another evidence of the phase of social evolution through which we are passing. The employer of thousands stands in a somewhat different relation from the small employer, and that which may smack of paternalism, if carried on in a narrow way, has another and broader aspect when done on a large scale.

* * *

WHEN a manufacturer wants to purchase a machine tool his decision regarding the proper one to use is generally dependent upon several factors such as the productivity, cost of the machine, its adaptability to other manufacturing conditions besides that for which he is purchasing it, the power, strength and rigidity of the tool itself and its convenience of operation. If he already has a machine which is just about what he wants, his inclination is to order another of the same kind, although the one in use may represent an obsolete design.

Progressive manufacturers will refer to the mechanical journal on which they rely, and write to a number of advertisers therein for catalogues. Then comes the manufacturer's opportunity to make a showing in his catalogue that will impress the buyer. In some catalogues the inquirer finds complete details and tabulated information of the various sizes of machines, giving the range, feeds, speeds, horsepower, traverse and other necessary details. But in many catalogues the information is either very meager, or mingled with reading matter eulogizing the machines to such an extent that the inquirer may often read the entire catalogue before obtaining any real information.

The "talking points" of a machine should undoubtedly be set forth in a catalogue; but they are of secondary importance. Vital points in construction and operation and detailed information should come first, and in such forms that comparisons of various sized machines can be easily made. When arranged in this way the information forms a valuable reference which is appreciated by a prospective customer—and it pays the manufacturer.

* * *

WHEN a machine tool builder sells a new type of machine, or one differing radically from existing models of the same type, he usually sends a competent mechanic to superintend the installation and to see that the men who are to operate it fully understand its functions. The maker gives the service in order to insure having his machine properly installed and started under fair conditions.

In some cases, this service is being demanded of machine tool builders for standard machines; the buyers ask that the expense of installing new machines, even though they are of a well-known type already in use in the plant, shall be incurred by the maker. This is unwarranted and unjust. The manufacturers' prices on such machines seldom include the cost of installation, which, in addition to the traveling expenses of a competent mechanic and his pay while on the job, is often a considerable amount. A serious feature of this abuse of service, aside from the actual cost, is that in times when the demand for machines is very great, the best men must be sent out on installation work, as it will not do to send an ordinary mechanic. Only experts—men of good judgment, tact and considerable experience—are fitted for it. Mechanics of this type are scarce, and the demands of purchasers of machine tools for installation service puts a burden on the makers that they should not be expected to carry.

The practice is uneconomic and wasteful, and the National Machine Tool Builders' Association should discourage it. The price of standard machine tools should be fixed F. O. B. and demands for free installation on standard machines should be refused. Of course when a new type of machine is being developed and introduced, the rule may be modified, but at the option of the maker. The service should be regarded as a concession and not as a right.

* * *

Oil used for drawing the temper of hardened articles should be a mineral oil with a flash point of not less than 600 degrees F., this temperature usually being sufficiently high for the drawing of the temper of all ordinary tools. If higher temperatures are required, a mixture of two parts potassium nitrate and three parts sodium nitrate may be used for drawing temperatures up to 1000 degrees F.

Safety Organization of a Machine Shop

by Luther D. Burlingame*

ACCURATE records of accidents that occur in typical machine shops have now been kept for a sufficient length of time to show where the greatest dangers exist, also what are the hazards causing the greatest number of accidents and which of these are most serious. Thanks to the vigorous campaign for accident prevention now going on in America, as well as to the adoption of compensation laws in most of the manufacturing states, there has been a marked change for the better in accident prevention work and the way has been pointed out to a still further reduction of the number of accidents. The records which have been kept show the importance of safeguarding machinery, and on account of the steps taken in this direction the percentage of accidents resulting from such causes as unguarded gears or belts, and projections on revolving parts, has been materially reduced. Fig. 2 shows the proportion of accidents from various causes occurring in the Brown & Sharpe works last year, from which the comparatively small percentage of mechanical accidents will be noted; it will be seen that the majority of accidents are non-mechanical, and that most of these are caused by falling, being struck by falling objects, or having the eyes injured by flying chips.

This plainly shows where the greatest efforts should be made toward further accident reduction; and these efforts should take the form of an endeavor to inject the "safety spirit" into the working force, so that men will be more thoughtful of their own and others safety. In this way the non-mechanical accidents, many of which have been classed as "unavoidable," will be avoided or at least greatly reduced in number. Such a reduction has invariably been found to follow in the shops in which it has been possible to instill the safety spirit and to continually keep the subject before the workmen. It is believed that even though only a small proportion of shop accidents are directly attributable to unguarded machinery, thorough work in guarding these hazards is not only of help in avoiding such accidents as being caught in machinery, but is also of great help in keeping the matter of safety before the men and indicates a willingness on the part of the management to do its full share toward preventing accidents.

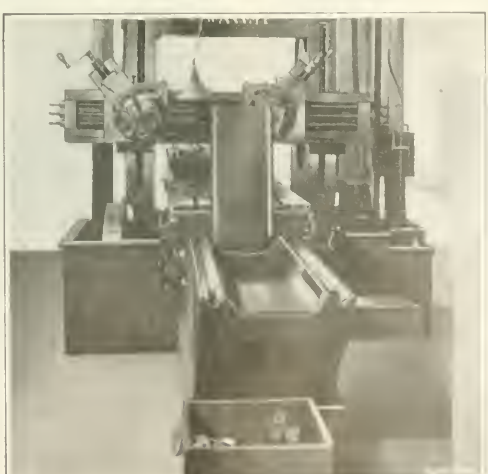


Fig. 1. Guards for covering Openings between Ways of Planer

Mechanical Safeguards

It is not the purpose of this article to give a comprehensive survey of mechanical safeguards as used in the machine shop, but rather to dwell upon methods of reducing the number of non-mechanical accidents which are of so much more frequent occurrence and of so much more serious character than the so-called "mechanical accidents." A few examples of mechanical guarding and mechanical means of preventing accidents are given, however, largely to indicate what can be done for orderliness, cleanliness, etc.—factors upon which greater stress should be laid when considering the question of accident prevention. Fig. 1 shows a set of guards for covering the openings between the ways of a planer. While the hazard of being caught by the platen of a planer when the hand is in one of these pockets is rather remote, such accidents have occurred and the guards not only prevent their recurrence but also tend toward neatness and cleanliness in keeping the spaces clear of rubbish. Another illustration of a device to serve the same purpose of orderliness is shown in Fig. 3, which illustrates a rack of the kind provided in each department for the storage of ladders when not in use. This view also shows methods of piling and storing unfinished work, a fire extinguisher on the wall and a safety door for the elevator designed in such a way that if the door is left open or even ajar the elevator cannot move from the landing unless the door is closed.

Exhaust Systems

Exhaust systems to carry off dust from grinding and polishing machines as well as metal chips, sawdust, etc., are coming more and more into use. While the prime motives for such installations are the protection of the workman's lungs and eyes, and the protection of the machine from

* Industrial superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

Fig. 2. Proportion of Accidents from Various Causes which occurred in the Works of the Brown & Sharpe Mfg. Co. during 1914

wear, there is also an important advantage in bringing about a condition of cleanliness which expedites the work and reduces the accident hazard. Where it is not found possible to install a complete exhaust system, individual exhausts can be applied to the machines, as shown in Fig. 4 for a surface grinding machine and in Fig. 5 for a cylinder grinding machine. Fig. 6 shows an automatic gear-cutting machine cutting cast-iron gears, on which an exhaust system is employed so that the dust and chips are carried away. This is not only of advantage to the bearings of the machine and the lungs of the workmen, but the cooling effect produced by the air current keeps the cutter clear of heated chips and makes it possible to nearly double the production without affecting the accuracy of the work. In striving for cleanliness and orderliness it is of assistance to have white lines painted on the floor to mark

Fig. 3. Rack for holding Ladders when not in Use: it serves the Double Purpose of providing for Safety and Neatness

the aisles which are to be kept clear of obstruction. This is of direct help in keeping a clear path for trucking, as well as in constituting a safety feature. If an obstruction, such as a long piece of work held in a machine, protrudes over a passageway, a piece of white paper or cloth should be hung on the projecting part to attract the attention of passersby, thus serving as a warning. Fig. 7 shows such a piece of work with a newspaper hung over it.

Punch Press Safety Methods

One of the first problems that were taken up for study a few years ago, when the Brown & Sharpe Mfg. Co. made a comprehensive survey of the accident problem, was the prevention of accidents in punch press work. Although strict instructions had previously been given to have the work done in a safe way, accidents continued to occur. After studying the situation it was decided to provide means so that the work could be done without the necessity of putting the hands between the punch and die in handling the work. This plan was carried out and various means have been devised so that practically all of the work can be handled as economically as by the old method of using the hands, and with no danger of injury to the workmen. One of the means devised calls for the use of tweezers for inserting the work and a brush, stick or other device, if needed, for removing it from the die; a chute has usually been found to be the best means for inserting the work, using a stick for removing it; another means consists of the use of a sliding die-bed so that the hand can place the work in position when the die is out from under the punch, and then the die-bed can be slid back into position for performing the operation. This sliding die-bed is shown in Fig. 8. One of the punch presses has also been fitted with a guard which automatically drops when the press operates, and which prevents the descent of the ram if any obstruction like a man's hand is in the way. This was provided for work which it was thought could not be done to advantage by either of the methods already described.

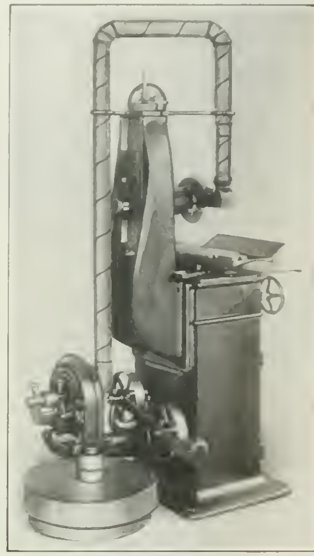


Fig. 4. Individual Exhaust System applied to Surface Grinder

Clearing Chips from Revolving Cutter

One of the most frequent of mechanical accidents has been in the operation of milling machines, due to catching the fingers between the revolving cutter and the work when wiping away the chips. Even when brushes are provided for this purpose it requires constant vigilance and the exercise of discipline to secure their use and prevent these accidents. One way which has been devised to keep the chips

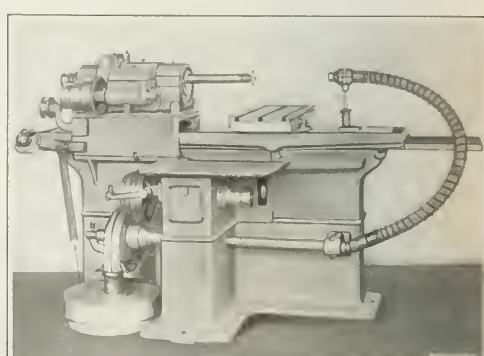


Fig. 5. Cylinder Grinder equipped with Individual Exhaust System

cleared away is to provide an auxiliary flexible pipe connected with the system supplying the cooling fluid, so that by pressing a push-button a stream under sufficient pressure to wash away the chips can be directed upon the work. Fig. 9 illustrates the application of this idea.

Means for Reducing Non-mechanical Accidents

Among the means for reducing accidents in general, with special reference to non-mechanical accidents, the following are of importance:

1. Securing statistics and figures to show just what kinds of accidents are occurring, their degree of seriousness and in what departments accidents are most frequent.

2. Impressing upon the department heads and foremen that they have a responsibility in the prevention of accidents, and seeing that they try to stimulate interest in the prevention of accidents among their sub-foremen and workmen.

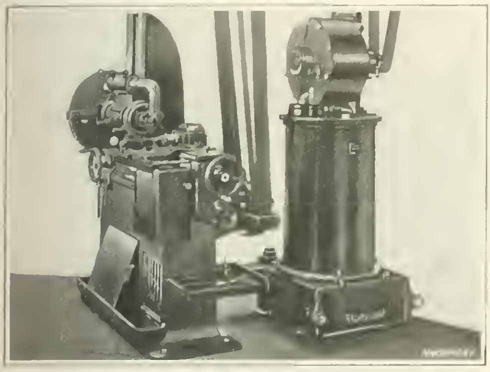


Fig. 6. Automatic Gear-cutting Machine with Exhaust System to carry away Chips and Dust

3. Reaching the workmen themselves through literature, safety meetings and posted notices, so as to impress them with the importance and need of safe methods of working.

4. Providing for regular safety inspection in order to see that means for safety are provided and used and that danger points are done away with.

5. Providing "first aid" and taking care of all cases of accident promptly so as to prevent their developing into serious cases through infection or otherwise.

In order to secure statistics in regard to accidents, full records of every accident should be kept on printed forms; and these should be reviewed each week so that steps can be taken promptly, in case a remedy is needed, to avoid a repetition of the same kind of accident and to place the responsibility if there is cause for blame. Sometimes these records disclose interesting entries as, for example, one where, in the case of a severe bruise, there was entered on the report under "Remarks:" "There were some but they were not proper to be set down." The statistics gathered from the accident reports can be classified and put in the form of monthly reports, arranged according to departments and to the kinds of accidents, showing in what departments the conditions have been growing worse, and from the nature of the accidents where attention is needed in taking further steps for accident prevention. By tabulating these every few months and obtaining percentages, the actual situation can be laid before the safety committee and the foremen at frequent intervals, without waiting for the annual report.

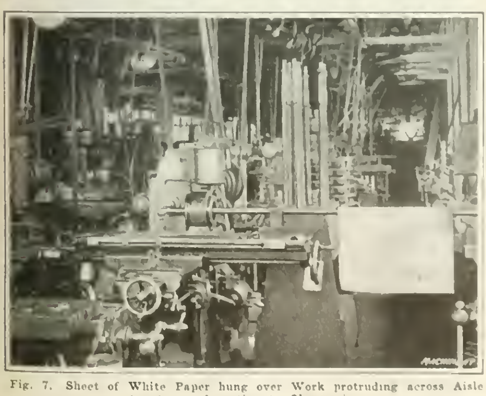


Fig. 7. Sheet of White Paper hung over Work protruding across Aisle to attract Attention to Obstruction

Fig. 8. Application of Sliding Die-bed to provide against Accidents

The annual report gives statistics regarding accidents for a sufficiently long period to give a fair average of conditions, both as to the standing of the departments and as to the kinds of accidents most frequently occurring. It was found, however, that such figures did not give a fair indication as to just how much effort was being made to provide for the safety of employes and what interest was being taken in reducing the number of accidents in the various departments, because the hazard was so much greater in some departments and for some kinds of work than for others, and because the departments varied so greatly in size. For this reason, the posted notices would keep a dangerous department always on the very bad list, even though a more intelligent and more determined effort was being made in such a department to reduce the number

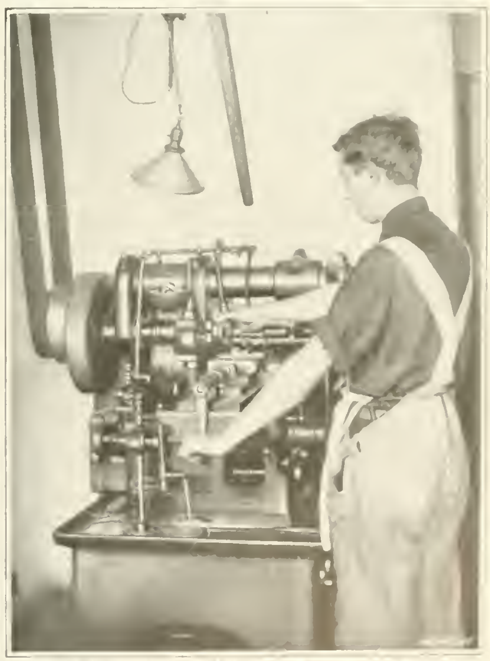
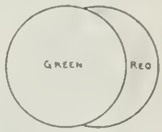


Fig. 9. Milling Machine provided with Auxiliary Lubricant Tube for supplying Flow of Cutting Compound to wash away Chips

JUNE 1915

THE EXTENT TO WHICH SAFETY HAS ECLIPSED DANGER IN THIS DEPT
GREEN = SAFETY RED = DANGER

SMALL TOOL DEPT.



STANDING OF DEPARTMENTS ON SAFETY

BASED ON A HANDICAP ALLOWANCE DEPENDING ON THE DEGREE OF RISK AND THE SIZE OF THE DEPARTMENTS

CLASS 1 EXCELLENT UNDER 25
" 2 GOOD 25 TO 2 0 INCLUSIVE
" 3 BAD ABOVE 2 0 TO 4 0 "
" 4 VERY BAD " 4 0

DEPARTMENTS	POSITION	NO OF ACCIDENTS	HOURS LOST	DR BILL & WAGES	RATING	CLASS
OFFICES	1	0	0	0	00	EXCELLENT
ENGINEERING & DRAFT	2	0	0	0	OC	-
FONGE SHOP	3	0	0	0	OC	-
PIPING	4	0	0	0	00	-
SUPPLY & ROUTING	5	0	0	0	00	-
CUTTER DEPT.	6	0	0	0	00	-
CARPENTERS	7	0	0	0	00	-
POLISHING	8	0	0	0	.00	-
PATTEAN SHOP	9	0	0	0	00	-
MILLWRIGHTS	10	0	0	0	.OC	-
CHUCKING	11	0	0	0	00	-
MESSENGER SERVICE	12	0	0	0	00	
ELECTRICIANS	13	0	0	0	00	
POWER PLANT	14	0	0	0	00	
MASONS	15	0	0	0	OC	
TOOL MAKERS	16	1	0	0	34	GOOD
PLANING DEPT	17*	0	0	YES	.38	-
PAINTERS	18	1	10	0	40	-
MFG MILL. MCHS.	19 +	5	16	YES	55	
HARDENING DEPT	20	2	0	0	60	-
MFG GR & GEAR CUT. MCH	21 +	9	42	YES	74	
SMALL TOOL DEPT	22	4	7	YES	87	-
LABORERS	23 +	6	27	YES	102	
INSPECTORS	24	2	0	YES	1.22	
MFG ATTACHMENTS	25 +	6	24	YES	1.33	
SEWING MCHS.	26 +	2	5	YES	1.48	-
REPAIRS	27*	0	0	YES	1.56	-
GEAR DEPT.	28*	3	0	YES	1.75	-
BOXING	29*	0	0	YES	1.86	-
GRINDING	30	4	90	YES	1.90	-
FOUNDRY	31 +	6	857	YES	3.20	BAD
MFG. SCREW MCHS	32 +	11	644	YES	5.07	VERY BAD
SCREW MCH DEPT.	33*	0	0	YES	8.20	"

* WOULD HAVE BEEN 'EXCELLENT' BUT FOR COMPENSATION FOR ACCIDENTS OF PREVIOUS MONTHS.
+ WOULD HAVE BEEN BETTER BUT FOR CASES HOLDING OVER FROM PREVIOUS MONTHS.

Fig. 10. Reproduction of a Copy of one of the Safety Reports. Such Copies are posted in Each Department of the Factory

of accidents than in one where the hazard was much less or which was smaller, but which was reported good.

In order to equalize these differences a handicap plan was devised so as to take into account both the degree of hazard and the number of employes in each department. The handicap allowance determined on was as 8 to 1 between the extreme departments, the foundry and woodworking departments being rated at 8 while the drafting and engineering departments were rated at 1. As the foundry employs practically three times as many men as the combined drafting and engineering departments, this gave a ratio of 3 by 8 or 24 to 1 between these departments, so that 24 accidents occurring in the foundry would be equivalent to one occurring in the drafting and engineering departments. The other departments were rated between these extremes, all general machine departments being rated at 5. By the use of formulas, the relative rating for the departments could be obtained by the month, the year, or for any other period. The matter of lost time and compensation or doctor's bills is also taken into account in obtaining a rating of the departments, the proportion being that one accident is considered equivalent to twelve hours lost time, or to \$2.50 compensation or doctor's bills. The yearly rating is obtained by the following method: A constant factor is found for each department by the formula:

$$\frac{10}{\text{Number of employes} \times \text{handicap factor}} = \text{constant factor.}$$

[Number of accidents + (hours lost ÷ 12) + 0.4 expense in dollars] × constant factor = yearly rating.

Example:

Number of employes in department....	364
Handicap factor	8
Number of accidents in one year......	40
Number of hours lost.................	2557
Doctor's bills and compensation........	\$247

$$\frac{10}{364 \times 8} = 0.0034 = \text{constant factor.}$$

$$\left(40 + \frac{2557}{12} + 0.4 \times 247\right) \times 0.0034 = 1.20 = \text{yearly rating.}$$

The classification is as follows: Ratings under 0.25, excellent; 0.25 to 2 inclusive, good; 2 to 4 inclusive, bad; over 4, very bad. In the above example the standing would thus be good. The formulas for the monthly reports are such as to give the ratings on the same basis. The monthly reports naturally fluctuate more on account of the short period covered, and in a small department, especially if the handicap is low, a single accident may put it well down on the list. The monthly reports are posted in all departments of the factory, showing each department, its standing for safety and how it compares with other departments. Such a report reproduced is shown in Fig. 10. Green and red disks are placed at the top of each of these reports, the green disk covering the red to the extent to which safety has eclipsed danger during the past month in that particular department. The name of the department is entered above, and, at a glance, it can be seen what its standing is.

In the case of accidents where there is absence from work for several months and compensation to be paid for such a period, it sometimes brings about the condition that a department is classed as "bad" or "very bad" for a month, when no accidents have occurred during that time, because of payments for accidents that occurred in previous months. Such cases are indicated on the report and explained by a foot-note. The posting of these reports introduces an element of competition which has a stimulating influence on foremen and workmen in making them try to have their department stand well, and the fact that a handicap is allowed for the more dangerous and larger departments does away with the claim of unfairness which resulted from the posting of earlier reports before such a plan was put into effect. The yearly reports are also put into a form which

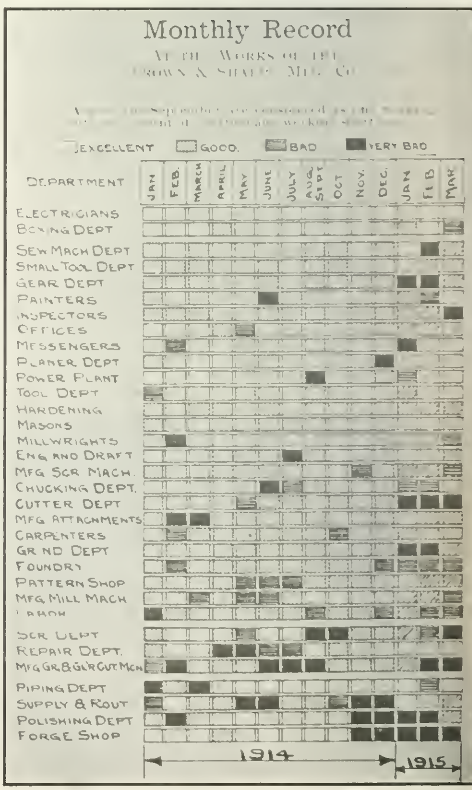


Fig. 11. Monthly Record of all Departments arranged in Diagrammatical Form

presents the standing of departments, month by month, in diagrammatic form, as shown in Fig. 11. This is of value in showing whether a department has just averaged good through a long period or whether it has been excellent most of the year and then been brought down by just one bad month. In the case of a small department with a low handicap, one bad accident will spoil its record for a long time. This was the fact in the case of the forge shop given last on the list in Fig. 11, where one eye accident resulting in the loss of an eye put this department at the bottom of the list, although through a large part of the year it had been rated as "excellent."

The annual report is also posted in diagrammatic form, presenting the relative standing of departments during the year, as shown in Fig. 12. On this poster there also appear notices of especially good records made by some of the departments. Copies of large size are conspicuously displayed in those particular departments, showing where they have made a great gain or for other reasons should be commended for good work in safety. In the case of the foundry, a notice like that shown at the bottom of the group of notices in Fig. 12, was posted to impress the workmen of that department with the gain that had been made in reducing burning accidents following the insistence upon the wearing of "congress" shoes and leggings while pouring off. Such a showing helps to disarm criticism from men who think the old way is good enough for them, by showing the real gain resulting from accident prevention work.

Fig. 13 shows a workman equipped with congress shoes and leggings, pushing a wheelbarrow equipped with handle guards through a pair of swinging doors. These handle guards, shown just outside of the workman's hands, allow the wheelbarrow to be pushed through the doors without danger to his arms or hands when the doors swing back. Besides the posting of special safety notices, the workmen are given instructions in regard to working in safe ways by means of a booklet entitled "Health and Safety" which

Fig. 13. Foundry Employe wearing Congress Shoes and Leggings, and pushing a Truck provided with Handle Guards

is distributed to all Brown & Sharpe employes, and this is supplemented by instructions from the foremen and members of the safety committee as to safe methods of working. In the case of the apprentices, special instructions for safety are also given in the school-room during class hours. One way to give definite instructions as to safe ways of handling machines when moving them about is to photograph them when properly hung in a rope "sling," and indicate in each photograph the points to be looked out for. Fig. 14 shows such a photograph, and also a diagram and description showing the varying strain on a "sling," this data being taken from "Health and Safety."

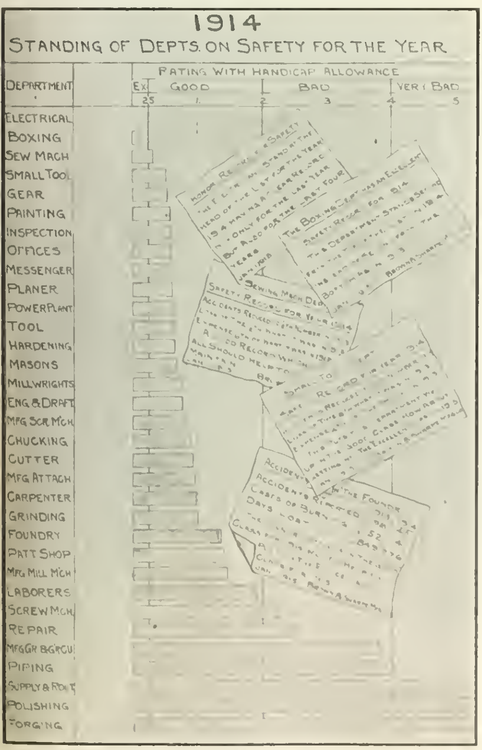


Fig. 12. Annual Safety Standing of all Departments arranged in Diagrammatical Form

Safety Committees

The responsibility for accident prevention work at the factory of the Brown & Sharpe Mfg. Co. is placed in the hands of a committee of three, representing the industrial, engineering and machine departments, with a secretary to carry on the work and look after the necessary details. Under the direction of this safety committee, there is a committee composed of foremen and workmen, one member from each of the main floors and departments, making a total of about thirty men who act in groups as sub-committees for each building, there being five or six men in each of these groups. These safety inspectors, as they might be called, are responsible for safety work in their respective departments, and countersign all accident reports which are sent in. They make suggestions on printed slips of the form shown in Fig. 15, which are in book form with provision for keeping carbon copies. The importance of this part of the work is emphasized in a report made by William H. Doolittle, safety inspector of the National Metal Trades Association, who, following a recent inspection of the Brown & Sharpe works, writes: "Most important of all in our opinion is the working of the safety system—the system that provides a safety man for each floor of the building, carrying with it perpetual inspection of the plant and bringing practical suggestions directly to the central head of the general system. The stimulation of the department spirit by posting comparative tables showing the standings of the different departments is a helpful feature of this system." Following are some extracts from the instruc-

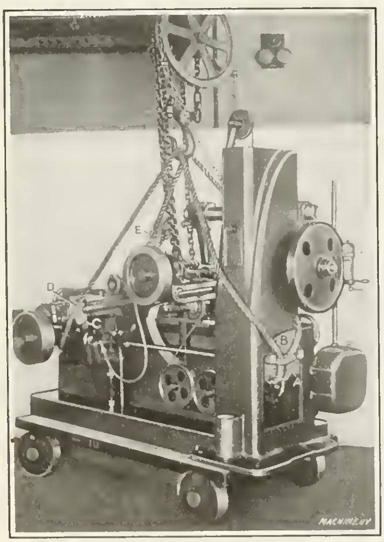
tions given to members of the Brown & Sharpe safety committees and points to be observed and reported by them.

Instructions for Members of Safety Committees

The subcommittees will each represent a building or group of departments, and in the main buildings there will be one member of the committee from each floor. These members will be appointed by the general committee on the first of January of each year to serve for one year, subject to removal by the general committee, which shall also have power to fill vacancies. As a member of one of these subcommittees it will be your duty to look after matters of safety on your floor or in your department, and it will be your duty to make suggestions for safeguarding, using the forms in the book provided for that purpose. Any suggestions which you have to make, or which are made to you by fellow-workmen, and which in your opinion are worthy of attention, should be forwarded at once to the secretary of the general committee, so that anything which demands immediate attention can be taken care of promptly. All accidents occurring in your department should be brought to your attention so that you can see whether steps can be taken to avoid their recurrence. Aside from the regular inspection you should be alive at all times to conditions of danger. After your period of service on the committee has expired, it will still be your duty to make further suggestions at any time as to safety. The committee representing each building will meet together and make an inspection of that complete building once in three months, comparing notes and getting the benefit of each others experience and suggestions.

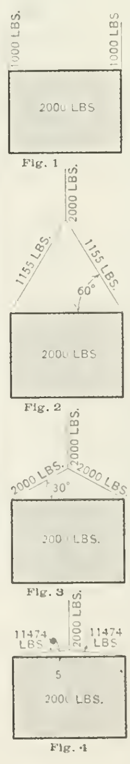
Some General Points to be Observed and Reported by Members of the Safety Committee

1. Report all exposed gears where workmen may be caught.
2. See that guards provided for grinding wheels are used, and that wheels have soft collars to clamp on.
3. Report when high-speed belts near the floor are not guarded.
4. Report when any mechanism is such as to allow the workman to be caught or pinched.
5. See that there are no projecting set-screws or other projections on exposed revolving parts.
6. See that work is so piled as to prevent falling, and that passageways are kept clear.
7. See that there are no projecting nails, splinters, etc.
8. Report broken glass in doors, etc.
9. Report cases where apprentices, also operatives of machines under twenty-one years, do not wear short-sleeved jumpers.
10. See that loose or ragged sleeves, hanging neckties, etc., are avoided. Loose rags should not be used on the fingers by workmen operating machines.
11. Report any parts overhead which may become loose and fall on workmen.
12. Report any workmen working in an unsafe manner and taking unnecessary risks.
13. See that unsafe methods of holding work in chain hoists or rope slings are avoided.
14. See that the fingers are never used for wiping chips from work in milling machines, etc.
15. See that eye protectors are used in departments where there is danger to the eyes.
16. See that guards and other means of safety are used. This refers to guards on woodworking machines, etc.
17. See that padded aprons are used in woodworking departments when using slitting saws.
18. See that circular and band saws, also buzz planer knives, are kept sharp.
19. See that congress shoes and leggings are worn in the foundry when pouring off.
20. See that workmen do not work under a heavy suspended weight without using "horses."
21. See that all electrical work, switches, etc., are properly guarded.
22. See that fingers are never put between the punch and die on presses, or in any other similarly dangerous place.
23. See that pipes on screw machines are up close to the machine so as not to leave exposed revolving stock.
24. See that wrenches are in good condition.
25. Hang white paper on any exposed part which projects into a passageway.



Method of handling a Machine by Means of a Rope "Sling"

A, block of wood so applied as to avoid chafing or cutting of rope; B, leather so applied as to avoid chafing or cutting of rope; C, wooden block back of shaft to avoid springing it; D, cloth to protect shaft and rope; E, extra knotting of rope as a precaution against slipping.



SLINGS FOR HOISTING

In handling loads by the use of slings, care should be taken to see that the slings are not subjected to undue strains. While the strains coming on slings and ropes vary greatly with the conditions, they are affected in particular by the inclination or obliquity of the sling, and the strain is in the proportion shown by the diagrams.

Too often men engaged in hoisting take it for granted that a rope or chain that will support a load when the ends are vertical will be strong enough to support it under other conditions. The diagrams show plainly that this is not so, and that No. 4 needs a much stronger sling than No. 1.

Sharp corners should be protected where slings pass over them and it should be remembered that there is an inward pressure on the corners such as might spring or break any delicate part of a machine against which such pressure is brought. An example of protection against such damage is shown at *C* in the half-tone.

Fig. 14. Instructions to be followed when moving Heavy Machinery in Factory

Importance of Proper Medical Attendance

In spite of care taken to have first aid given in all cases of even minor importance, some of the heaviest expenses in the past have been in cases of neglected scratches and cuts which were thought to be too slight to be worthy of attention but which have afterward become infected and developed into serious cases. This, like all other branches of safety work, requires education on the part of the workmen so as to get them into the habit of having such injuries attended to no matter how slight, rather than take chances. First-aid departments are provided throughout the Brown & Sharpe works so that help can be obtained with the minimum of trouble. A dispensary is also provided at a central point, where a male nurse is in constant attendance; and a physician attends during certain hours of the day to care for cases of accidents or illness which occur within the works. In the majority of cases employes can be kept at work by obtaining such aid, which, as will be readily recognized, will be to their own as well as the company's advantage.

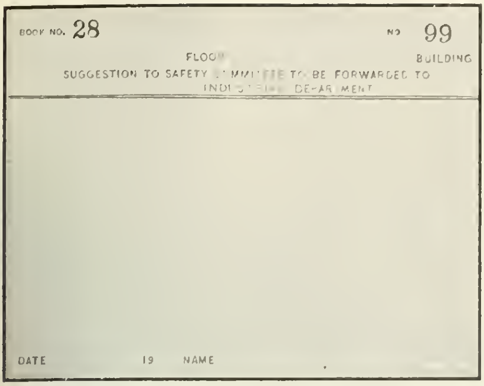


Fig. 15. Form used by Safety Inspectors in making Suggestions concerning Improvement of Conditions in Factory

Many interesting questions arise as to how far to go in giving help to workmen along the lines of medical treatment, and as to where to draw the line in cases of compensation. Some such questions are as to whether accidentally breaking the workman's false teeth or his eye glasses in the shop can be classed under personal injury; also, as to whether a man suffering from boils on his arm should be cared for and paid compensation on the theory that the boils might have occurred from oil used in connection with his work. Cases of rupture often raise a question of doubt as to whether the man's condition was caused by, or had any connection with, his employment in the shop. The feeling among manufacturers seems to be that in a general way compensation laws are a help in creating a better feeling between workmen and employers, and result in the money paid out for accidents going to cases where the help is really needed and where in justice it should go, as compared with past experiences where so much went for litigation.

Periods of industrial activity, when there is much overtime work and when a great many new men are employed, increase the accident hazard materially and greater efforts must be made if the accidents are to be kept down. In our own case, recent accidents have been in the proportion of more than 4 to 1 among new men, as compared with those men who have been for more than six months in our employ. This condition exists in spite of efforts which have been made to instruct new men in matters of safety. The percentage of accidents among men working overtime has also been many times greater than among those working regular hours. Curiously enough, however, very few of these accidents have occurred during the overtime period. This whole safety question is one which must be constantly followed up—one which will not take care of itself after it has once been "tuned up" to a point where good results are being obtained. It is not believed that the goal has by any means been reached, but that the safety spirit and safety methods can be developed and extended in the future so as to still further reduce the number of shop accidents. Technical societies and the technical press are rendering direct and invaluable assistance by keeping this matter of accident prevention constantly before the attention of manufacturers and the employes in their factories.

* * *

OFFICE MANAGEMENT

BY J P BROPHY*

Did you ever enter an office and gaze in amazement at the number of employes engaged therein, all apparently busy? Then perhaps you think of your own place of business and make mental comparisons. Possibly your own office might contain twice as many employes, or perhaps not half the number. Whichever it might be, it would set you to thinking seriously, especially if the number in your office were large compared with that in the office you were visiting.

There is no question but that work in offices has not kept pace with the manufacturing end of many lines, and the waste because of inefficient management is in some instances enormous. Proper classification of employes according to their qualifications is just as essential in office work as in the producing end of the business.

The proper assigning of work according to each individual's ability is a matter to be seriously considered, and this is uppermost in the minds of those who are using the efficiency system or otherwise producing your product at a minimum. This being a fact, why neglect the clerical end? In some cases a man is overcrowded, whereas another individual is not doing half a day's work. Planning office work requires good management, and laxity means disorder and many times irreparable mistakes because blunders in office work are often conveyed to the other fellow by Uncle Sam.

There is no question but that hundreds of offices are over crowded with help just because the man in charge is not capable. Mismanagement in this respect is apparent in many cases, and one of the primary reasons for this is in the distributing of the work and failing to arrange things so that each one is kept comfortably busy throughout the day

In many cases the manager of an office is not capable; sometimes through recklessness because of his affiliation with the business, because of a money consideration, or for the reason that the cost of operating an office seems to be lost sight of. An office man who has not enough to keep him busy and lags and becomes indolent and loses his ambition What is the result? Mistakes. An inactive brain through the absence of anything to do never develops properly. There is no line of business where mistakes are made easier on account of not being kept busy than in an office.

You may be strict as to what your employes should and should not do, over-cautious that they do not talk too much to each other, exceptionally particular that they reach their place of business on the minute and stand for no nonsense, but if you are not genuinely capable of judging what a day's work is, you are bound to have an unbalanced working force.

One great fault can be found with the slowness in distributing the mail in the morning. If the man who has this in charge takes his time in the extreme, the distribution of the mail to the clerical help is slow, the best part of the morning is wasted and the employes are actually idle. The one who handles the mail should be vigorously on the job at the right time, and if the mail is exceptionally large he should have an assistant. All letters should be opened promptly and handed to those for whom they are intended.

Writing letters in an office should be done as early as possible, not fooling the time away in the morning and commencing this work in the afternoon. If the correspondence is put off until the afternoon the mail that should be answered today is not answered until tomorrow, and before you know it you have a vast number of letters a week old that have not been replied to. You suddenly find that there is an accumulation of such things, and in trying to catch up the whole office is in turmoil. Then it appears that you have not half enough help, whereas the trouble lies in not punctually replying to all communications. Punctuality means less help and better work because everything is fresh and taken care of in the proper manner. It is the indifferent way of doing things that causes all kinds of misunderstandings and creates the feeling that you actually require more help, whereas if the work were well done, you could do with less

In producing anything, costs are uppermost in the mind of the manager. If the costs are high an investigation is in order but in the office nothing of this kind seems to enter the minds of those in charge. Useless commands are given; the help in numerous cases please their own fancy as to what they should accomplish. If important things are delayed, the excuse is "I was too busy to attend to it" The office manager in many instances believes what is told him because unquestionably he is not in close enough touch to discriminate between the employe who is efficient and the one who is always dilatory It seems in many cases to be a do-as-you-please proposition There is satisfaction in cleaning up the desks every night. Without system time is lost and energy wasted.

*Vice-president and general manager, Cleveland Automatic Machine Co., Cleveland, Ohio.

Safety and Welfare Work in an Electrical Plant

By Chester L. Lucas*

THE General Electric Co. in all its plants has been particularly active in general welfare work and especially in the promotion of preventative work for the elimination of accidents. A central safety committee is maintained with headquarters at the Schenectady, N. Y., plant, and members of this committee are located in each of the other plants at Pittsfield, Mass., Lynn, Mass., Harrison, N. J., and Erie, Pa. This article will describe the activities in this direction at the Pittsfield plant.

The mediums by which the work is carried on consist of a safety inspector, whose duty it is to locate all dangerous spots and unguarded machines in the factory and see that they are properly guarded; lectures on safety to foremen and other employes, impressing the necessity of care in their particular vocations; a hospital where all minor injuries are treated and the general health of the employes is looked after; and a monthly newspaper giving the news of the factory in an interesting way, and at the same time weaving in matter to emphasize the importance of paying attention to safety measures.

The Safety Inspector

In a plant employing four thousand men, the duties of a safety inspector are manifold. There is the need of continually looking through the different factory buildings, locating the dangerous spots, and seeing that machines, gears, belts, and other moving parts are well guarded. In a factory where electrical apparatus is the principal product, danger of injury from shock must be guarded against, for in the different testing departments electric currents at high pressure are commonly used. The safety inspector must see that suitable protection against electric shocks is provided for.

Instruction in Accident Prevention

Each prospective employe of the General Electric Co., before being engaged, is subjected to a physical and medical examination to discover if he is afflicted with any contagious or infectious disease, or if he has any bodily weakness that would impair his facilities for doing his work. If such are discovered, he is given instructions as to proper treatment. On entering the employ of the company each employe receives a book in which are set forth instructions that, if followed, will safeguard him from most accidents. Incorporated therein is also a full description of the procedure for applying the prone method of resuscitation from electric shock.

But the instructive work does not stop after the employe has been engaged. From time to time lectures on safety are given to the foremen and general employes. These are suited to the particular classes of workmen to whom they are given; for instance, the foundrymen are given a lecture on the prevention of accidents in the foundry. One of these foundry classes is illustrated above. Other classes of employes are given talks in the same way. As shown in Fig. 1 demonstrations are frequently given to illustrate "first-aid" practice. A lecture room has been installed in which the foremen are given lectures, and at times halls are hired in the city of Pittsfield in which general lectures are given that are open to all employes of the company. For the benefit of the women employes of the plant, special lectures are given to emphasize the danger of catching the hair and clothing in moving parts of machinery. Treatment of cases of fainting and the method of employing the prone method of resuscitation from shocks are demonstrated from time to time.

The Company Hospital

An important feature of the work is the maintenance at the plant of a hospital with a graduate nurse and a steward in charge, where all accidents, even trivial ones, may be properly attended to. There is a men's department as shown in Fig. 4, and a woman's department as shown in Fig. 5, and all the modern surgical appliances are at hand for the treating of wounds. Besides the attention which is given to accidents, the nurse and steward will gladly consult with any of the employes in regard to medical or surgical treatment by outside physicians.

Ready for instant use is an automobile ambulance, as Fig. 2 shows, which can visit the scene of an accident at once and convey the patient to the emergency hospital or to the general surgical hospital of the city of Pittsfield if necessary. In the Pittsfield city hospital, the General Electric Co. also maintains a bed which is free to employes in case of sickness.

"Current News"—the Factory Newspaper

Not the least interesting of the methods by which the gospel of accident prevention is spread among the employes

* Associate Editor of MACHINERY.

Fig. 1. First-aid Demonstrations are frequently given

Fig. 2. The Hospital Ambulance is always ready for a Summons

of the plant is the little periodical called *Current News*. This is a monthly publication and about four thousand copies of each issue are printed and distributed gratis to the employes. The cost of getting out this publication is extremely low and it is distributed by being placed in a convenient location where the men may help themselves when leaving the factory after being paid off. Fig. 6 shows a copy of this paper in the hands of a workman leaving the factory. It is encouraging to note that very few copies are found scattered about after the men have left, showing that the paper is carried to the homes of the men in almost every instance. This is especially to be desired, as it then takes its place in the regular reading of the household and its effect is not spent on the employes alone, but on all others who pick it up and

Fig. 3. Women Employes being instructed in Prone Pressure Method of Resuscitation

read it, and some of these may be future employes. This little paper has a great deal of the news of the factory, changes of work, notices of new employes and those leaving, and any items of interest connected with the factory work. Sprinkled freely throughout its columns are illustrations showing the safety measures that are being taken and especially is mention made of any accidents that have been prevented. An employe who saves one of his fellow-workmen from accident is publicly commended.

The Company's Restaurant

While not properly classed as a safety measure, the company maintains a restaurant at which the employes may get wholesome food at a low price. The restaurant is a model of cleanliness and in it is incorporated all of the latest culinary appliances such as electric

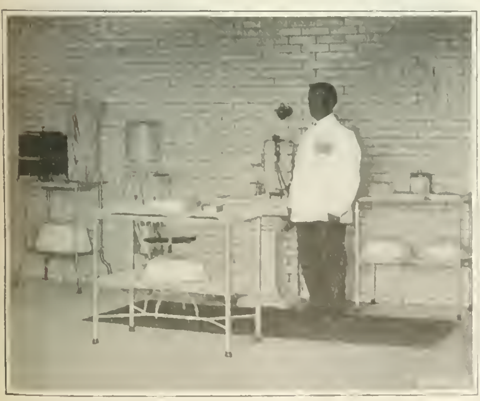


Fig. 4. A well equipped Hospital is maintained

Fig. 5. The Women Employes are cared for in a Special Ward

ranges, electric potato peelers, ice machines, food choppers, and dish-washing machinery. Unlike most other shop restaurants, this one furnishes breakfast and supper as well as dinner. A full course meal is served for twenty-five cents, and the office employes are taken care of at special tables. The best of good fellowship comes out at these noon-time gatherings, and it is a great improvement over the patronizing of the motley collection of restaurants which spring up around any large factory.

Classification of Accidents and Special Preventative Methods Employed

On taking up this work, the welfare department first secured the statistics of the past accidents of the company, and found that they readily classified themselves in importance into five distinct groups: First, and greatest in number, were the accidents due to electric shocks; second, the cases of foreign particles in the eyes; third, the foot-burns of the foundry; fourth, the punch press accidents; and fifth, strains and ruptures. The welfare department took up these groups of accidents successively, and the corrective measures that were adopted to apply to the different groups are as follows:


Fig. 6. Reading a Copy of "Current News"


Fig. 7. Demonstrating the Prone Pressure Method of Resuscitation


Fig. 8. The Wearing of Goggles has saved many Eyes of Employes

Electric Shocks

To combat the cases of electric shocks, all employes are instructed in the rules of the National Electric Light Association for the resuscitation of life by the prone method. These instructions are supplemented from time to time by demonstrations to classes of the method of applying this treatment as shown in Fig. 7. For the benefit of the women employes, special demonstrations of the prone pressure method are conducted. Fig. 3 shows one of these classes. Articles are also published from time to time in *Current News* illustrating how to apply this method. It is gratifying to note that since 1913 not a single life has been lost by shock at this plant, and there are several cases in which employes after receiving shocks have been brought to life again.

Eye Accidents

The cases of foreign particles in the eyes have been largely prevented by the provision of goggles for use in the foundry, grinding, and other departments where eye accidents have been frequent. These goggles are worn by male and female operators alike, as shown in Fig. 8, and it is estimated that in the foundry alone at least one eye is saved a month by the wearing of goggles. Their use is made compulsory on dangerous work, and an employe refusing to wear them is discharged. In the last year there has not been a single case of losing an eye, and but very few cases where foreign bodies have done injury to the eye. The right-hand view in Fig. 8 also illustrates the head covering that is used by women operators to protect the hair from catching in belts or machinery.


Fig. 9. Demonstrating the Wrong and Right Ways of lifting


Fig. 10. "Congress" Shoes for preventing Foot-burns in the Foundry

Foundry Foot-burns

Trouble from foot-burns was formerly frequent, the employes of the foundry, of course, being the victims. Molten metal, leaking or running over from ladles came in contact with the workmen's feet, and bad burns were the result. This trouble has been almost entirely obviated by instructing the employes in the benefits of wearing "congress" shoes while at their work in the foundry. A pair of these shoes is shown in Fig. 10. Most of the foot-burns of the foundry seem to have been augmented by the catching of the molten metal upon the lacing of the ordinary shoe. A laced shoe is particularly hard to free from the foot rapidly, and the result is that the metal catching upon the shoe burns through before the metal or shoe can be taken off. In case the employe steps into or on molten metal it is impossible to get a laced shoe off quickly enough to prevent serious burning. The surface of a congress shoe over the instep is perfectly smooth, it being

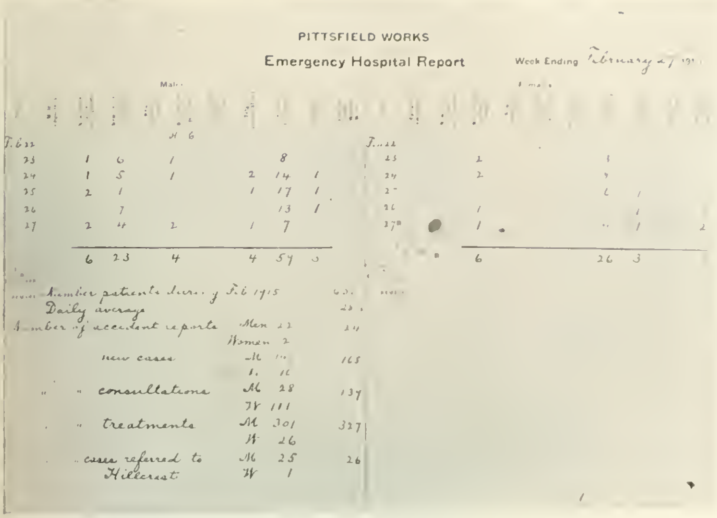


Fig. 11. A Weekly Report of all Accidents is made by the Hospital

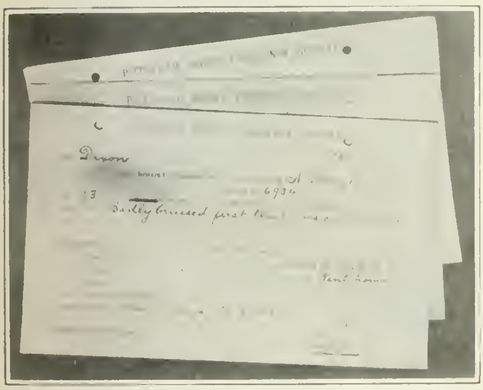


Fig. 12. Accident Reports are made out in Triplicate

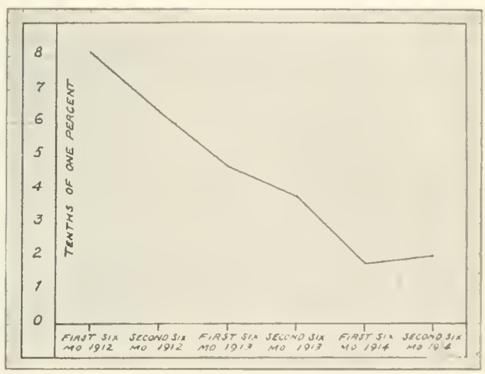


Fig. 13. The Accident Ratio Curve shows an almost Constant Drop for Three Years

held on the foot by elastic gores at the sides. Consequently, when molten metal strikes the surface of the shoe, it runs off, as nothing tends to make it cling. In case of stepping into molten metal, the shoe may be kicked off very quickly. By the use of congress shoes that may be quickly slipped on or off, these accidents have almost entirely ceased. During the three months previous to this writing, there was not one case of footburn.

Punch Press Accidents

The injuries to hands from punch presses are always a serious factor in the casualty list of a factory. These arise from one general source—the placing of fingers between punch and die. Contributory causes are the "repeating" of the press and the carelessness of the operator in tripping the press. To combat this class of accidents, the employes in the press department are continually cautioned against putting fingers under dies, and notices to this effect are conspicuously posted. Moreover, every punch press operator is provided with a pair of pliers like those in Fig. 15 before they were "caught" by the press, for a pair of fingers is worth more than the best pair of pliers made. Many of the presses are fitted with the Bliss non-repeating attachment to make doubly sure that the presses do not repeat and cause accidents.

Sprains and Ruptures

The injuries due to sprains and ruptures were found hardest of all to cope with. The activities have been directed along educational lines, giving frequent lectures to employes to show them the precautions to observe when lifting. At these lectures the services of physical instructors have been secured, and as illustrated in

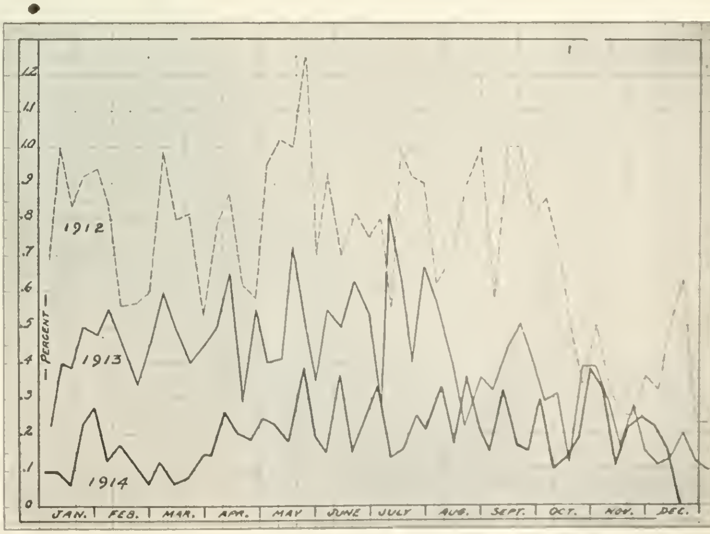


Fig. 14. A Chart of Three Years Accidents shows that Preventative Work pays

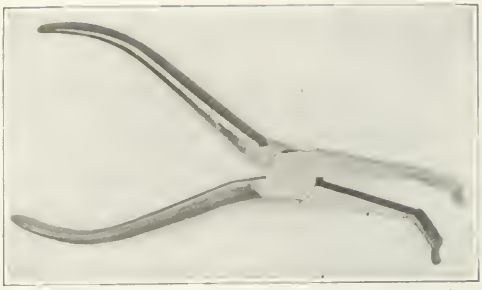


Fig. 15. A Pair of Pliers spoiled—but a Pair of Fingers saved

Fig. 9, the wrong and right ways of lifting are demonstrated. There is probably no more efficient way of impressing these precautions in lifting than by a demonstration of this kind.

Results of Accident Prevention Work

Since the inception of the preventative work, long strides have been made in reducing the number of accidents at the Pittsfield works. The general safety committee has gotten out rules and regulations for crane operators that have been standardized and adopted by other factories. From the records of accidents that have been kept, many interesting points have been brought out.

Every accident is reported in triplicate, and facsimile reports are shown in Fig. 12. One copy of this report is filed with the hospital, one with the safety inspector, and the third goes to the employment department where it is reported to the state. Also each week a summarized report, a facsimile of which is reproduced in Fig. 11, is compiled and filed with the same departments. From these data it is easy to see the progress that is being made in the work, and to note any new accidents that may have taken place.

Fig. 14 shows an interesting chart of the accidents for the past three years at the Pittsfield plant. This is plotted in proportion to the number of employes in order to allow for fluctuations. The upper dotted line shows the curve resulting from the accidents in 1912. The 1913 curve below shows a considerable decrease in the percentage, and the lowest curve, which is for 1914, shows a still better average. Fig. 13 shows the average of the ratios of all accidents for three years, and it is gratifying to note that the curve represents an almost constant decrease.

An interesting diagram is the one shown in Fig. 16 in which has been charted the combined accidents for a certain period and the hours between which they occurred. From this it will be seen that by far the greater number of accidents occur in the morning between the hours of 8 and 11. The reason advanced for this is that during this period the men have become fatigued during their long morning's work, and there is a rush to get work completed by the noon hour. The combination of this fatigue and the extra pressure exerted to get things accomplished is no doubt responsible for the increased accidents at this time.

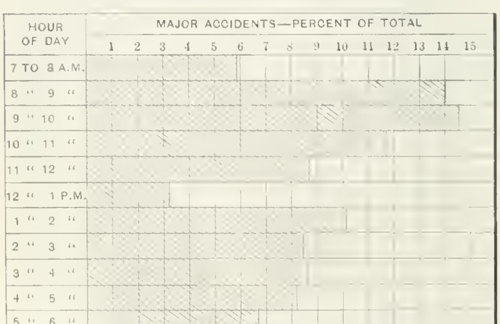


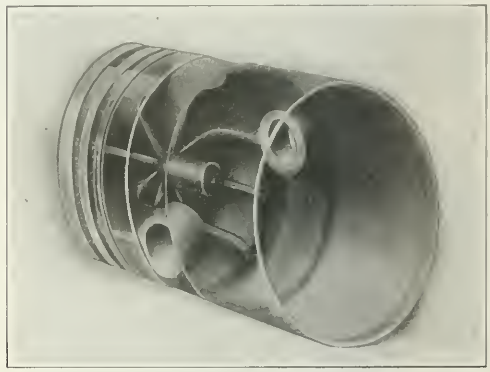
Fig. 16. The Greatest Number of Accidents occur between 8 and 11 A. M.

If the evidence of the past three years forms a criterion, it is certain that within a short time the safety inspectors, nurse and steward of the hospital, and even the ambulance driver at the Pittsfield plant of the General Electric Co. will have "worked themselves out of their jobs."

* * *

LEVETT MAGNALITE PISTONS

The accompanying illustration made from an "X-ray drawing" shows the internal reinforcing ribs of the magnalite pistons made by the Walker M. Levett Co., 10th Ave. and 36th St., New York City. Magnalite is a special aluminum alloy having a thermal conductivity several times that of cast iron, and a specific gravity slightly less than that of aluminum. Light weight pistons of high thermal conductivity are advantageous for modern high-speed internal combustion motors. Light reciprocating parts permit high rotative speeds to be attained, making possible the development of great power in comparatively small and light motors. The system of internal ribbing distributes the metal to the best advantage and increases the thermal conductivity so that danger of the alloy melting at the high temperatures obtained in gas engine cylinders is practically eliminated.



X-ray Drawing of Levett Magnalite Piston, showing Internal Ribs

* * *

WIRELESS TELEPHONY RECORD

A remarkable achievement in wireless telephony was accomplished September 30 when the human voice was transmitted from Washington to California, a distance of 2500 miles without wires. The message was transmitted from New York to Arlington, Va. by wire and thence to Mare Island, Cal. through the air. The following day conversation was held by wireless from the Atlantic seaboard to Hawaii, a distance of 4600 miles. The engineers of the American Telephone & Telegraph Co. and the Western Electric Co. have been working on the problem of wireless telephony for years. The success achieved probably insures the establishment of transatlantic wireless communication when the disturbed conditions in Europe are settled.

* * *

DAILY COMMERCE REPORTS

The Department of Commerce, Washington, D. C., has for some months been publishing a daily journal called *Commerce Reports*. E. E. Pratt, Chief of Bureau, has sent out a circular letter calling attention to the value of this publication to sales managers. He states that American business men cannot afford to overlook a publication which secures information from three hundred consular officials located in every part of the world. The publication contains special articles prepared by commercial attachés and agents of the Department of Commerce, stationed at the most important centers of foreign trade. Lists of firms in foreign countries anxious to buy American goods and represent American manufacturers are published daily. The subscription price of *Commerce Reports* is $2.50 a year.

OXY-ACETYLENE WELDING PRACTICE*

WELDING OF MALLEABLE IRON AND COPPER AND COPPER ALLOYS

BY S. W. MILLER†

Fig. 1. Graphic Illustration of Movement of Torch when welding Steel

THE melting point of ordinary machine steel is about 2650 degrees F., that of wrought iron about 2740 degrees F., while that of cast iron varies, depending on the composition, from 2000 to 2200 degrees F. Hence, the welding of wrought iron and steel presents a problem entirely different from that involved in the welding of cast iron.

Metallurgy of Iron and Its Relation to Welding

Iron is one of the chemical elements, existing in large quantities in nature in the form of ores. These ores are reduced by various processes and from them is produced, first, pig iron. In the production of ordinary castings, the pig iron is remelted and mixed with scrap castings and other materials, to produce what the foundryman desires. The metal, however, retains all the characteristics of pig iron, except that its constituents vary in quantity. All cast iron consists of pure iron mixed with different proportions of carbon, silicon, manganese, sulphur and phosphorus. There are other elements, but they exist in such small amounts and have such a slight effect on the quality of the metal that they need not be considered here. None of them requires serious consideration except carbon, silicon, sulphur, phosphorus, and manganese. These elements may be valuable or not, depending on conditions, but sulphur and phosphorus are always injurious in ordinary iron, and their percentage is kept as low as possible. They do not generally bother the welder, and therefore need not be further considered.

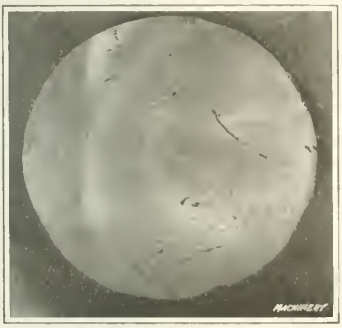


Fig. 2. Section of Defective Weld in Steel Bar

Carbon exists in pig iron, or ordinary cast iron, in two conditions, which are called "combined" carbon, and "free" or "graphitic" carbon. The combined carbon exists as carbide of iron, or in other words, it is alloyed with the iron forming a definite chemical compound. Graphitic carbon exists in the free state as graphite, and can be noticed in very soft pig iron, as it will blacken the fingers or make a mark on white paper. Cast iron contains a total amount of carbon varying from about 2½ to 4½ per cent. The percentage of graphitic carbon in a cast iron having a given total amount of carbon, varies in accordance with the size of the casting and the rapidity with which it is cooled. Slow cooling of a large casting increases the percentage of graphitic carbon, while the total amount of carbon remains the same. This graphitic carbon exists in the iron in the shape of plates between the grains, and it is evident that the larger these plates are, the weaker the iron. It is well known that large castings have less tensile strength per square inch than small castings poured from the same ladle.

There is a variety of cast iron known as "white" iron which contains no graphitic carbon. It is sometimes called "chilled" iron, because when iron is cast against a steel or iron chill plate, or other cold surface, it cools quickly and the quality of intense hardness which is desirable in certain castings is obtained. It is called white iron on account of its silvery appearance when broken. Iron suitable for chilling has a smaller percentage of silicon and a larger percentage of manganese than ordinary cast iron, because silicon has the property of preventing carbon from combining with iron, while manganese has exactly the opposite effect. It might be stated here that this is the reason why ordinary cast iron is unsuitable for welding rods. Ordinary castings do not require a high percentage of silicon, and a reasonable amount of manganese is not objectionable but is of some advantage at times in making the iron close-grained and strong and in counteracting the bad effects of sulphur. Therefore, welding rods are made from iron which is high in silicon and low in manganese, so the metal in the weld may be soft and readily machined.

On account of the size of the grains in a cast-iron fracture, it is well known to everyone handling it that it is crystalline. A magnifying glass will readily disclose this fact. It is not, however, so well known, and indeed not so well as it should be, that steel is equally as crystalline as cast iron; for instance, a piece of hardened tool steel does not appear to be so, and in the case of some high-speed steels, the fracture appears almost amorphous. It is very common to hear the expression, "that piece of steel broke because it was crystallized." It is still less commonly known, and indeed many metal workers do not believe, that wrought iron is of crystalline structure, but it is a fact. This is very readily seen by comparatively low power magnification under a microscope, of a properly prepared specimen. Every blacksmith knows that a piece of wrought iron nicked and broken across the anvil will show a more or less crystalline fracture, although it is frequently attributed to defective material or sudden shock, or some other more or less obscure cause.

Difference between Cast Iron, Wrought Iron and Steel

The essential difference between cast iron, wrought iron and steel is the percentage of carbon contained in them. As before stated, cast iron varies from 2½ to 4½ per cent, while steel contains from 0.05 to 2 per cent, wrought iron containing 0.05 per cent, or less. The essential difference between steel and wrought iron, using the terms in their commercial sense, is simply in the method of manufacture. Wrought iron is made by puddling cast iron in a reverberatory furnace until the carbon is burned out of it. The resulting pasty mass, which is full of slag, is then squeezed in a heavy press which forces the slag out of it, as it is more liquid than the iron. It is then reheated, passed through sets of rolls, and if a better quality is desired, cut in short lengths, piled together, heated and again rolled. However, it is impossible by this process to remove all the slag, and this can be detected with a magnifying glass and frequently seen by the naked eye in a bar of wrought iron. This slag tends to weaken the iron, not only because it has no tensile strength itself, but because it prevents the grains from coming into intimate contact.

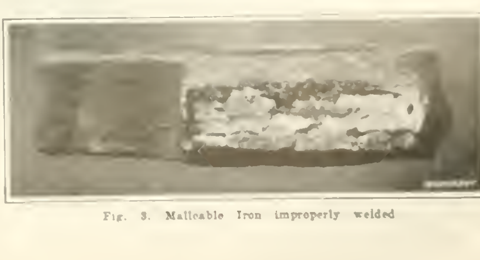


Fig. 3. Malleable Iron improperly welded

* For material on oxy-acetylene welding previously published in MACHINERY, see "Oxy-acetylene Welding and Cutting Equipment," "Preparation of the Work for Oxy-acetylene Welding," and "Practice of the Oxy-acetylene Welding Process," in the October, 1915, number.

† Address: Rochester Welding Works, Rochester, N. Y.

Steel is produced by melting cast iron, either in a Bessemer or open-hearth furnace for ordinary material, or, in the case of high quality materials for tools, etc., in crucibles. A Bessemer furnace operates by burning out the carbon entirely, leaving a mass of melted iron. The necessary amount of carbon is added by the use of ferro-manganese or other high-carbon material, and the steel poured into ingots which are rolled down to the various shapes and sizes desired. The open-hearth furnace is different from the Bessemer in that there is no air blast used to burn out the carbon and that a better mixture can be obtained, because the process is slower and under better control. It produces a better and more uniform grade of steel than the Bessemer furnace, and is universally used at the present time where the best quality is desired.

It is evident that the melting process eliminates nearly all possibility of slag in the metal. Slag is lighter than melted iron and tends to rise to the surface of the liquid mass, while in the puddling process the stirring up of the iron oxidizes part of it and mixes it with the body of the metal from which it cannot escape.

A crucible is in reality a small open-hearth furnace, and its use, as has been stated, is confined to tool steel which requires careful control of the carbon and other elements in it, small quantities of which materially affect the composition and action in service. It is also necessary to have great uniformity in the product which can be best obtained by handling small quantities of it at a time.

Welding of Steel

The steels which the welder will meet most frequently contain from 0.20 to 0.45 per cent carbon, and are called ordinary low-carbon steels, that is, they do not have any elements in them, such as chromium, vanadium, tungsten, nickel, etc., which have in the last few years been alloyed with ordinary steel to obtain very high tensile strength and elastic limit, and which are mostly used in automobile construction so as to obtain maximum strength and service with the least possible weight.

The carbon in ordinary carbon steels varies with the uses to which they are put. For instance, boiler sheets will run about 0.18 per cent, spring steel about 1 per cent, steel for railroad axles about 0.40 per cent. There are many varieties of steel having carbon between these points; it will be found in practice that the steels with the least carbon weld most easily and give the best results. The reason for this is that when steel is melted, as in the welding process, the carbon is more or less burned out of it, and unless great care is taken, the steel will be burnt. The greater the amount of carbon, the greater the danger. Steel may be overheated without burning, but if it is once burnt, it cannot be restored except by remelting it.

Burning of Steel

Some explanation in regard to the burning of steel may be of assistance in making clearer some things that the welder will encounter, and help him to avoid trouble. As stated, steel is composed of crystalline grains, which are smaller or larger according to the process of manufacture. These grains are separated from each other by thin membranes which vary in composition, their thickness and nature depending on the percentage of carbon, and the heat-treatment and working to which the steel has been subjected. During the process of melting steel with the torch, the metal is subjected to a very high temperature. If this temperature is high enough, and the steel is left in contact with the heat long enough, it has been found that atmospheric oxygen finds its way between the grains and combines with some of the carbon, forming carbon monoxide, forcing the grains apart, and making the metal brittle. This action is intensified by the film of oxide formed by the action of the oxygen. This makes it impossible to restore the steel by heating to a lower point and forging it, as the grains will not again cohere. In other words, burning is a mechanical separation of the crystalline grains.

The welding rod ordinarily used for welding steel contains very little carbon, being generally made of Norway iron. Inasmuch as the less the carbon the less the chance of burning, the metal added in welding is not burnt if ordinary care is used, but if the parts welded are of high-carbon steel, the metal next to the weld is damaged, with the result that while the weld itself remains intact, the piece breaks next to the weld. It is impossible to burn wrought iron, as it has practically no carbon. Another thing that should be realized is that while wrought iron, which has practically no carbon, melts at about 2750 degrees F., the melting temperature of steel decreases as the percentage of carbon increases, and steel with $1\frac{1}{2}$ per cent carbon melts at about 2300 degrees F. Not only is this true, but it is also a fact that the more carbon the steel contains, the longer time it takes to solidify after melting, the same as cast iron does, while wrought iron solidifies almost instantly. These two things, the lowering of the melting point and the length of time the metal stays melted, make high-carbon steel particularly susceptible to burning. It is therefore practically impossible to weld high-carbon steel, at least steel containing over 1 per cent carbon, and the larger the section, the more difficult the work is, as it has to be kept under the influence of a high temperature for a longer time.

What has been said does not refer to steel that has simply been overheated. This condition is brought about by heating to a very high temperature, but not above the melting point. Such steel can be restored, at least to a certain degree, by heat-treatment, and will also be helped by forging, if this is

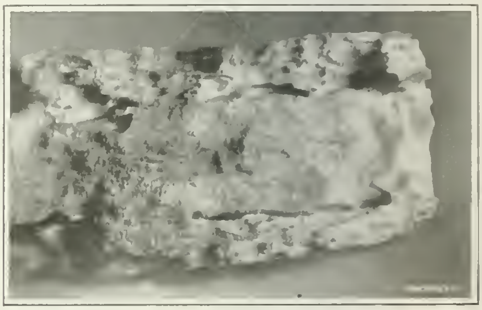


Fig. 4. One End of Piece in Fig. 3 magnified

possible. It is frequently claimed that burnt steel can be restored by the use of a flux or by various methods of treatment. It is evident from the explanation given that this is not possible, and that where so-called "burnt" steel has been restored, it has not really been burnt but simply overheated.

Methods for Welding Steel

The methods used in welding steel are somewhat different from those followed in the case of cast iron. The ordinary steels handled by the welder solidify quickly; there is therefore a greater danger of the metal not being thoroughly united at all points, resulting in cold-shuts. The welding wire is more likely to be burnt on account of its comparatively small section. Therefore, it is necessary that the method of handling the torch and welding rod suit these conditions. It is possible in the case of cast iron at times to use a V with an angle of less than 90 degrees; in fact, it is sometimes advisable to do so. In the case of steel, however, unless it is less than $\frac{1}{8}$ inch thick, the 90-degree angle must be maintained, or the bottom of the weld will not be sound or will consist of a series of cold-shuts and laps. Again, if the torch is used to widen the V, a series of craters, so to speak, is likely to be formed, which are exceedingly difficult to eliminate. These craters are caused by the metal in the center being colder than the metal around the edges, due to the conduction of the heat away from the bottom of the crater, or to the fact that it is not possible to get the point of the flame far enough into the hole to melt it. The only way to avoid them is to move the torch, giving the tip a circular motion around the hole, until the surrounding metal is brought to a temperature sufficiently high to prevent the conduction of

heat, when a sudden lifting of the torch will allow the metal to flow together. This circular motion of the torch has been found to be the most satisfactory way to weld steel. It is very difficult to describe, but once seen it is easy to understand. The author knows of nothing that it resembles so much as a helical spring crushed down sideways as shown in Fig. 1, the torch tip following the path of the spring wire, advancing a little, as from coil to coil, at each revolution. The speed of rotation and advance have to be made to suit the work. Of course, in heavy welds this cannot be done, as metal is added. In this case the wire should be used as a sort of a center around which the torch is oscillated, the path being somewhat more than a half circle. In this case the wire should never be removed from the pool of melted steel, as the tendency is then to burn it. The flame should not be turned directly against the welding wire, but kept far enough away from it so that while the wire is melted, the flame does not touch it; and the flame should not be kept on the metal any longer than is absolutely necessary.

Steel does not form a comparatively large melted pool as in the case of cast iron, and, therefore, it is necessary to be careful about welding the edges. As soon as the metal is brought to the melting point, if the torch be raised suddenly, the metal which has been blown into a shallow cup shape by the force of the blast, will at once become level and solidify. Hence a good steel welder keeps his torch constantly in motion, using the rotary movement and quick elevation.

From what has been said of the danger of burning steel, it is evident that it is important to use the right size of tip,

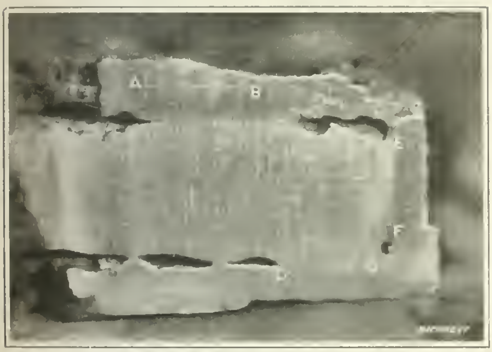


Fig. 5. The Other End of Piece in Fig. 3 magnified

neither too large nor too small, and also to provide sufficient sizes of wire to prevent the burning to which it is liable. The author finds that three sizes are sufficient for the majority of the work of an ordinary welding shop—1/16, 1/8, and 3/16 inch.

It is evident that on account of the affinity of iron for oxygen at a high temperature, the flame should be neutral, and not only this, but there should be no oxygen escaping from the torch where it can combine with the melted metal. This is particularly important in the case of steel. The writer knows of instances where it was impossible with a certain type of torch to produce satisfactory welds, while another, which used less oxygen, gave entirely satisfactory results. This emphasizes the importance of good apparatus.

It should be remembered that the weld is only a casting, and that it has received no forging or other treatment to refine the grain and to make the metal stronger. In a few cases an extra amount of metal can be added to the weld and the piece drawn out with a hammer, or otherwise worked to produce a stronger metal, but this cannot generally be done where the dimensions of a piece must be maintained. It is possible, however, by heat-treatment, to increase the tensile strength and elastic limit of the metal to a certain extent.

Heat-treatment of Welded Steel

In the case of a small piece, allow the steel to cool down after being welded until the color disappears. It can then be again heated with the torch, testing it with a magnet until the magnet is not attracted. It can then be allowed to cool. It has been found that this treatment makes the metal tougher. In the case of a large piece, if it is not too expensive, it can be heated with a torch, or otherwise in a forge to a temperature at which it will not attract a magnet. The important thing is to have the temperature uniform throughout, and allow it to cool uniformly The larger the piece, the less the rapidity with which it will cool when exposed to the air. Small pieces should be protected during cooling while large pieces may be allowed to cool in the open.

Another treatment which is of advantage at times, but which is difficult to apply to a small piece, is what is known as the "Coffin toughening process." In consists in heating the steel just above the recalescence point, or to the temperature where it will not attract a magnet, plunging it into cold water in a dark place, until the red color just disappears, when it is removed and allowed to cool in the air. It will be noted that this is approximately the same as the ordinary hardening and tempering process, but for toughening purposes it should never be applied to anything but comparatively low-carbon steels. It produces an intensely tough structure, and if properly carried out, gives very good results, although the best results are only obtained if the metal is forged before heat-treating

The heat-treatment of alloy steels is quite a complicated process, and can only be carried out with the proper apparatus. No welding shop with which the writer is acquainted has any facilities for doing this work, and as the ordinary welding rod does not have the necessary ingredients to make a truly homogeneous weld, and as at the best the weld is only a casting, the welding of alloy steels should be avoided. It is true that in special cases and where there is a knowledge of the character of the metal, fair results may be obtained, but this information is not possessed by the average welding shop doing repair work, and it is best to restrict the welding operation to materials which it is known can be welded successfully, because no good comes from attempting work beyond the limitations of the process.

General Considerations

It would appear perfectly feasible to use welding as a process for joining steel parts wherever riveting is now employed. In many cases it is possible to do so, but in many other cases it is not advisable. While a riveted joint is imperfect in many respects, and a poor mechanical construction, yet its strength and the practices followed in making it are so well known, that the riveted joint is certain to remain. The lack of knowledge of the technique of welding, the scarcity of competent welders, and the prices of the gases, often make the cost of welding prohibitive and the quality of the work uncertain, when an attempt to replace a riveted joint is made. The time will come when large structural work will be done by the oxy-acetylene process, but the time has not yet arrived when it can be relied upon as well as present methods. However, the welding of steel by this process is being extended every day, and things are done now which were not dreamed of a few years ago. Therefore the further extension of the possibilities may be reasonably expected.

Many of the defects which occur in a cast iron weld are likely to occur in a steel weld, some of them being more frequent and more difficult to avoid The most serious is a lap of the hot metal on top of the cool; this is an exceedingly common defect with new welders. It is much more likely to occur in a large piece than in a small one, in fact, the larger the piece of steel, the more difficult it is to obtain a sound weld. The difficulty is caused either by the addition of too much steel at once, so that it flows over onto the metal underneath without being welded to it; by dropping the metal from the welding wire onto the metal underneath, instead of keeping the end of the wire in the pool of melted metal; or by carelessness in not thoroughly welding the edges of the melted pool to the rest of the metal The metal is far more likely to bridge in the case of steel than in the case of cast iron, particularly where the pieces are V'd from both sides, when the weld is started at the bottom of the second V after turning the piece over

Fig. 2 shows an enlarged view of a defective weld, the original piece being $1\frac{1}{2}$ inch in diameter. A large number of laps and cold-shuts will be distinctly noticed. The polishing to which this piece was subjected has brought out the difference between the original metal and the added material, and it appears clearly that the weld was imperfectly made, because this added material shows on four sides. In making a steel weld, the edges of the weld should be built out somewhat beyond the sides of the original pieces, so that it will not be necessary to burn down any on the sides to eliminate imperfect work. The weld should be so made that any roughness left on it when ground off will leave sound metal all the way around. There is always great danger of laps or cold-shuts when any other course is followed. This is particularly applicable to round pieces, which are more difficult to weld than rectangular ones.

Welding Malleable Iron

Those who have tried to weld malleable iron know that the results are usually unsatisfactory. The metal either becomes so hard that it cannot be machined, or it is brittle, or both. The reasons for this lie in the nature of the metal, which is not generally understood, because of the comparative lack of knowledge of its method of manufacture. To explain sufficiently for the present purpose why these difficulties exist and how they may be overcome, it is necessary to consider somewhat the metallurgy of cast iron and the changes which take place during its conversion into malleable iron.

It is necessary in making malleable iron to use white-iron castings, because graphite, being an inert substance and not acted on by the malleablizing process, cannot have its condition changed by this process, so that the carbon in iron from which malleable castings are to be made must all be in the "combined" condition, and not "free," as in gray-iron castings. Cast iron has a larger percentage of carbon than steel, and it would appear that if enough of the carbon could be removed from cast iron, so that it had about as much as ordinary steel, a product resembling steel, if not identical with it, would be the result. This was the aim of the inventor of malleable iron, Reaumur, and the process was carried out by packing the white cast-iron pieces in decarbonizing matter, such as oxide of iron, and subjecting the pieces so packed to a high temperature for a long enough time to reduce the percentage of carbon to the desired point. It was found that the time required to carry the action entirely through a piece was considerable, and therefore the cost was excessive; so that only thin pieces are now subjected to this process. Inasmuch as it was desirable to treat heavier pieces, it was found by experiment that it was not necessary to reduce the percentage of carbon all the way through the piece, but that by proper treatment in the annealing oven, the carbon could be changed into a third form to which has been given the name "temper" carbon, to distinguish it from "combined" and "free" carbon, although temper carbon is identical with graphite as far as can be determined. The first kind of malleable iron can generally be welded with steel, as it is really a crude steel. The second form, however, is the one that presents the difficulties spoken of above, and it will now be evident why these difficulties exist. Cast iron, when changed into steel, cannot, by melting under the torch, be changed into cast iron again; but in the second kind of malleable iron, the carbon is not removed, but only changed into another form. Therefore when melted, all the conditions are favorable to the reformation of chilled iron, which is exactly what occurs; so that the resulting weld is, as previously stated, hard and brittle.

Malleable iron can be welded with cast iron and a sound weld obtained, but it is not homogeneous. In some cases it may be entirely satisfactory; for instance, where special strength is not required, or where no finishing, except by grinding, is to be done. For all ordinary work, it has been found that the use of manganese bronze as a welding rod with a little borax used as a flux will make a weld, which, while not homogeneous, will answer the purpose. The precautions to be observed are as follows:

1. Malleable iron must not be melted, but only brought to a temperature at which the bronze will alloy with it. This is somewhat above a good red heat, and is easily ascertained by a few trials. A neutral flame must be used, and it is generally wise to add surplus metal to the weld.

2. It is a good thing for the welder to observe the action of the second kind of malleable iron under the torch. It will be noticed in a fresh break that the outside shell, say 1/32 inch deep, is white, and under the torch acts like steel, but the further in toward the center the flame is used, the more will the action appear like that of cast iron, and it will be found that steel cannot be used in welding. The metal also tends to become full of blow-holes. If the torch is used to melt such a piece, and it is then allowed to cool off and the surface ground and polished, it will be found to consist of white iron, except the thin outside shell. If a weld is made using a malleable iron welding rod, it will be found that the weld is very brittle, and when broken, will show the characteristic appearance of white iron. Of course such a weld may be made into malleable iron by putting it through the regular process, but this is not possible in repair work, although it is in certain manufacturing processes. Therefore the use of bronze appears to be the only present solution of the difficulty, and it would seem that the metallurgy of malleable iron makes impossible any other solution.

Figs. 3, 4, and 5 are good illustrations of the structure of malleable iron and of the damage done to it by improper welding. Fig. 3 shows the section nearly full size, while the others are enlarged to show the defects more clearly. There is considerable difference in appearance between the outside and inside of the piece. The piece was originally welded with steel.. The second break occurred outside the weld, because the added steel at the first weld was considerable in amount, and therefore stronger than the section shown.

In Fig. 5, the difference between the center and the outside of malleable iron is very clear, the outside being darker and of steel, while the inside is of cast iron, but with the carbon changed to the "temper" form. Wherever the added steel is welded to the steel casing, the metal at the junction of the cast iron and steel has been seriously damaged, causing holes; and where there is no added steel, or where the weld between the two steels has been defective, as from *A* to *B*, no apparent damage has occurred. An examination of the piece shows that no extra metal was added from *C* to *D* or from *E* to *F*, and that on account of the defective weld between the two steels at *A* and *B*, no apparent damage is done to the metal below.

In repairing the break, it was found impossible to cut the defective pieces out with a hacksaw, as hard spots were encountered as soon as the added steel was cut through. It was therefore necessary to grind the defective parts away. This left a space which had to be filled up, which was done with manganese bronze, the weld being made and heavily reinforced with the same metal. The hard spots were caused by the malleable iron changing back to white or chilled iron under the high heat used.

Welding Copper and Copper Alloys

Under this heading will be treated the welding of pure copper and also the various kinds of brass and bronze which are made with copper as the principal ingredient. Copper is not a difficult metal to weld, if precautions are observed to avoid several peculiarities in its action when under a high temperature. It has the property, when melted, of absorbing gases to a very considerable extent. On cooling, these gases are given out and make the weld porous. Copper also oxidizes readily when melted and this oxide alloys with the copper, making it brittle and spoiling the weld. There is also a tendency, as in the case of steel, for oxide to form between the grains and make the copper weak. Inasmuch as copper cannot be welded by hammer blows or by pressure, it is impossible to work this oxide out, and methods must be used during the welding to eliminate it, or preferably, to avoid it altogether.

It has been known for a long time that a small percentage of phosphorus added to copper or copper alloys eliminates blow-holes and makes a sound, dense casting; hence, the

welding rod for copper should contain the proper percentage of phosphorus. Traces of phosphorus do not injure copper, but an excess is not good, so proper care and accurate knowledge are necessary to produce the proper welding material. Copper has great heat-conducting power—more so than any of the other common metals. It is therefore necessary to use a larger tip than for iron and steel, and preheating of the parts is more necessary in order to reduce the gas consumption, than in the case of other metals. On account of the affinity of copper for oxygen, and on account of the fact that an excess acetylene flame produces blow-holes in the weld, even with good welding material, it is necessary to use a neutral flame, although it will be found that instructions are sometimes given to the contrary.

Another peculiarity of copper is its brittleness at a temperature somewhat above a dull red, while below this temperature it can be readily forged. The welder must therefore be careful to look out for contraction strains as the metal is cooling down. Full and uniform preheating will help to avoid this difficulty. It is not often, however, that a repair welding shop is called on to work with copper, and when it is, the work is generally the simple welding of rods or bars together. In such cases enough metal should be added to make a considerable "swell" around the weld, and after heating to a dull red it should be forged. Care should be taken not to heat it too hot, and after the forging is done, the work should be allowed to cool off slowly, unless it has to be bent, when the whole piece should be heated to a dull red and annealed by plunging it in water, this operation being repeated frequently if the piece requires much working, as the working of the metal causes it to become brittle.

Copper Alloys

Copper alloys are divided into two general classes, brasses and bronzes. The principal ingredients in the former are copper and zinc, and in the latter, copper and tin. There are a great number of these alloys differing materially in composition, and as the welder cannot know the exact composition of each, and as, even if he did, it would be impossible to make the proper mixture to produce a truly homogeneous weld, a welding material should be kept in stock that will cover all of the cases with which he meets. It is the general experience that manganese bronze or tobin bronze is very satisfactory for all brasses and bronzes. It is the practice in the author's shops to use manganese bronze, as he has found that if more than one welding material is used for brasses and bronzes, it is difficult to keep them separated, their appearance being so similar, and that the slight practical difference in results obtained from different materials does not warrant their use.

In welding brass, when the metal is brought to a certain temperature by the torch, white fumes suddenly disengage themselves, and in the case of a large piece, these will chill and condense on the cooler surfaces. This is due to the volatilization of the zinc, the fumes being white zinc-oxide. The proper point at which to add the metal is just as the surface of the piece begins to boil and bubble, and as manganese bronze contains a large percentage of zinc, any zinc that may be lost in heating will be replaced by the metal in the welding rod. In the case of bronze, the zinc loss does not occur, but the bubbling of the surface of the heated piece occurs and determines the temperature at which the metal should be added. Manganese bronze is quite fluid and flows well, uniting nicely with the broken parts. It is advisable to use a small amount of borax as a flux to clean the surface, although no more than necessary should be used.

A neutral flame is the proper one to use for both brass and bronze. These metals are both good heat conductors, although not as good as copper. Generally the same size tip as for cast iron will be satisfactory. Care should be taken to avoid laps or cold-shuts in a weld, which is readily done if the metal is kept at the proper temperature. These metals are generally easy to weld, and as manganese bronze is exceedingly strong, the weld is generally the strongest part of the piece.

INTERNATIONAL ENGINEERING CONGRESS

The International Engineering Congress, held in the Auditorium Bldg., San Francisco, September 20-25, inclusive, was opened with an address of welcome by the mayor, followed by addresses by General Goethals and distinguished delegates. The John Fritz medal was presented to Dr. James Douglas, past president of the American Institute of Mining Engineers. The program comprised sessions on the Panama Canal, waterways, irrigation, municipal engineering, railway engineering, materials of engineering construction, mechanical engineering, electrical engineering, mining engineering, metallurgy, naval architecture, marine engineering and miscellaneous subjects. The papers presented at the mechanical engineering sessions were as follows:

"Recent Advances and Improvements in Founding," by Thomas D. West.

"Forgings from Early Times until the Present," by C. von Philip.

"Recent Progress and Present Status of the Art of Forging with Special Reference to the Use of Quick-Acting Forging Presses," by A. J. Capron.

"Permanent Shops, Pacific Terminals—Panama Canal," by H. D. Hinman and A. L. Bell.

"Machine Shop Equipment, Methods and Processes," by E. R. Norris.

"Machine Shop Equipment, Methods and Processes," by H. F. L. Orcutt.

"Automatics," by R. E. Flanders.

"High Temperature Flames in Metal Working," by H. R. Swartley, Jr.

"Power Plant Design," by H. S. Putnam.

"The Internal Combustion Engine of the Year 1915—The Gas Power System—A Survey of its Status in the Year 1915," by Prof. Charles E. Lucke.

"The Development of the Construction of Turbines in the Netherlands," by D. Dresden.

"The 1915 Steam Turbine," by E. A. Forsberg.

"The Diesel Engine in America," by Max Rotter.

"Developments in Modern Water Turbine Practice," by Dr. H. Zoelly.

"Water Wheels of Pressure Type," by Arnold Pfau.

"Hydraulic Power Development and Use," by J. D. Galloway.

"Water Wheels of Impulse Type," by W. A. Doble.

"Canadian Hydraulic Power Development," by Charles H. Mitchell.

"Safety Engineering," by F. R. Hutton.

"Motor Vehicles—Passenger Type," by Ethelbert Favary

"Motor Vehicles—Utility Type," by A. J. Slade.

"Motor Tractors," by F. S. Davis.

"The Boiler of 1915," by Arthur D. Pratt.

"Compressed Air in the Arts and Industries," by W. L. Saunders.

"Equipment, Process and Methods for Boiler Shop," by E. C. Meier.

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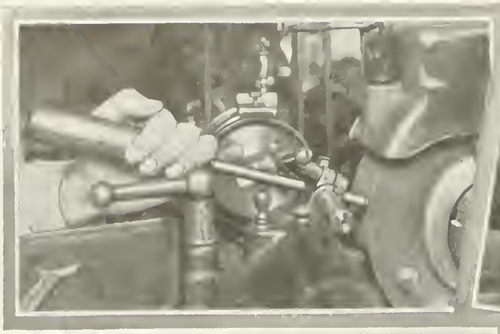
WESTINGHOUSE SAVINGS FUND FOR EMPLOYES

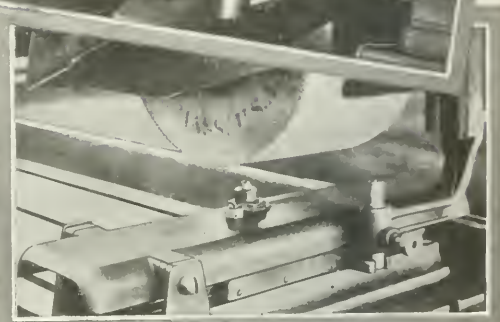
The Westinghouse Electric & Mfg. Co. recently established a savings fund which offers facilities to the employes for the handling of their savings accounts. The fund is open to any employe of the company wherever he may be located, and he may become a depositor at any time and may withdraw his deposits at any time. The amount of any deposit cannot be less than ten cents, and it may be any multiple thereof; the deposit must be made from each regular pay. The deposit is limited to one account, the amount of which in any one year cannot exceed $500. The reason for this limitation is that the plan is intended to encourage the employe to save his earnings and when he has been successful up to this point, to allow him to handle his own finances thereafter. Interest is paid on the deposit at the rate of 4½ per cent, and is credited semi-annually. The Westinghouse Electric & Mfg. Co. acts as trustee and guarantees the deposits and interest. The rules provide that the amount of $100 or less may be withdrawn without notice, but an interval of two weeks must elapse before subsequent withdrawals can be made, and for withdrawals of more than $100 notice of one week must be given. An auditing committee not exceeding seven is to be elected by the depositors from among their own number. This committee will be given the opportunity of examining the condition of accounts at semi-annual interest periods, and its findings will be published.

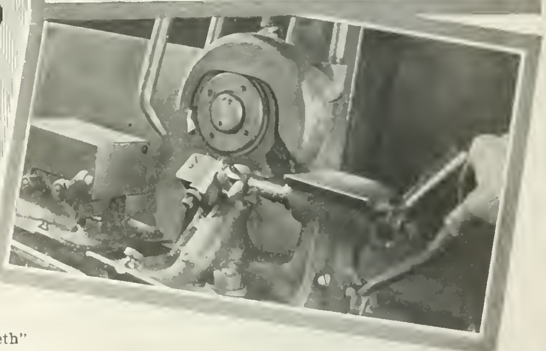


Grinding Wheel Truing Devices*

Attachments for Holding and Methods of Applying Diamond Tools

by Douglas T. Hamilton†





As is the case with all cutting tools, a grinding wheel, to give the greatest efficiency, must be kept in good condition—true and free-cutting. A modern grinding wheel may, be considered as a milling cutter having an infinitely greater number of "teeth" or cutting points; these, however, are kept sharp in a different manner. In a milling cutter the teeth are resharpened when they become dull, whereas in a grinding wheel it is necessary to remove the dull "teeth" or grains of abrasive in order to present fresh and sharp cutting points to the work. This is generally done by means of a diamond tool held in various attachments as will be described later. There are two chief conditions which make it necessary to "resharpen" a grinding wheel—one is "loading" and the other "glazing."

"Glazing" and "Loading" of Grinding Wheels

The difference between "glazing" and "loading" of a grinding wheel is not always clearly understood. A "loaded" wheel is one whose cutting face has particles of the metal being ground adhering to it—one in which the openings or pores of the wheel face have been filled up with metal, leaving no room for clearance. It is not necessary that all the pores or openings between the cutting particles on the face of the wheel be filled up or loaded to prevent the wheel from free-cutting. The presence of a number of these pieces of metal on the face of a wheel prevents the wheel from cutting into the work and the "loaded" places will, of course, create heat.

A "glazed" wheel is one whose cutting particles have become dull or worn down even with the bond, the bond being so hard that it does not allow the dulled cutting particles to tear out. In a glazed wheel the cutting particles and the bond at the extreme surface of the wheel are of the same radius. Continued work with a wheel that glazes increases the smoothness of the wheel face and consequently decreases its cutting capacity.

On cylindrical grinding, loading may be caused by using a wheel of too hard a bond and running it at too slow a speed. It also may be caused by crowding a hard wheel to a great depth of cut—greater than the size of the grains. When a hard wheel is revolved at too slow a speed with plenty of power, the grains withstand this crowding action without breaking away and thus pick up the metal. One remedy for loading is to increase the speed of the wheel. Glazing takes place when the wheels are too hard and revolve at too fast a speed. The remedy for this is to decrease the speed of the wheel. If the speeds are right use a softer wheel. Loading and glazing of the wheel make excessive truing necessary and this, of course, means greater wheel wear. For truing a hard wheel, a sharper diamond is used than for truing a softer wheel. The reason for this is that a sharp diamond leaves the surface of the hard wheel with more clearance, and consequently this surface will cut for a greater length of time. Increasing the work speed also makes the harder wheel, or one having a tendency to glaze, cut more freely.

* For information on grinding previously published in MACHINERY, see "Selection of Grinding Wheels," in the October, 1915, number, and articles there referred to.

† Associate Editor of MACHINERY.

The sample of ground work shown in Fig. 1 illustrates clearly the kind of finish produced by a wheel under various conditions. To the left of this illustration is shown a section of the work, enlarged about eight times, which indicates the finish secured when the face of the wheel is not true; in the center is shown the finish secured when the wheel face is true and sharp; and at the right is shown the effect produced by a dull or glazed wheel. For a commercial finish the wheel should be kept true and sharp, and the best way to accomplish this is to make frequent use of the diamond tool.

Selecting Diamonds

For truing and sharpening wheels used on automatic grinding machines, the most satisfactory tool is the diamond. Carbon, carborundum, alundum blocks, etc., are used to some extent to remove the glazing effect from the face of a wheel, but for truing, the diamond is the most satisfactory. The question of selecting diamonds is an important one, and there is considerable difference of opinion as to which is the best stone to use. The diamonds generally used in tools for truing grinding wheels are of two kinds, the carbon or black diamond and bort. The black diamond is non-crystalline in structure; its color varies, but it is often of a dark purple brown. The bort is a semi-transparent stone or an imperfect "brilliant." It is not as hard as the black diamond, and is also considerably lower in price. For truing soft wheels, bort can be used, but as a general rule, the black diamond is cheaper in the long run.

One prominent manufacturer states that it has been his experience that the Brazilian bort or brownstone, sometimes called "South African premiers," are the best for truing wheels. These stones are considerably cheaper than the black diamond. For instance, a brown diamond can be purchased for fifteen dollars, equal in size and weight to a black diamond costing between seventy and seventy-five dollars. In selecting the diamond, care should be taken to see that no seams appear, as such stones are likely to crack, and the smooth skin stone is the one most likely to prove satisfactory. Of course the more points a stone has, the better it is adapted for truing grinding wheels.

Setting Wheel Truing Diamonds

In order to present the diamond to the work, it is necessary that it be held in a holder. Various materials and methods are employed for this purpose. Copper, brass or soft steel rods are generally used, and the diamond is either held in place by peening over the end of the bar or pouring in melted spelter. When spelter is used, it should be poured into the hole first before the diamond is inserted. If the diamond is inserted first, it is impossible to get the spelter to flow beneath it and hold it rigidly. The best method is to drill the hole slightly deeper than the highest point of the diamond, and of a size that will admit the diamond freely. Then the hole should be closed in just enough to make it out of round. The spelter is then poured into the hole, filling it completely, and the diamond, held in a pair of tweezers, is put into the liquid spelter until it strikes the bottom of the hole. In doing this, an amount of spelter equal to the size of the diamond is pushed out, and when this excess of spelter makes its appearance it is certain that there are no vacant spots under the stone. After the spelter has cooled, the end of the rod in which the diamond is located can be shaped in the customary manner.

Another quicker method that is also in general use is to drill a hole in a piece of soft steel slightly larger than the diamond and of a depth sufficient to completely cover the stone. The diamond is then inserted and the end of the rod peened over to entirely cover it. The peening is done by means of a small flat-headed chisel or a set, and should be done carefully to avoid breaking the stone. As the result of peening, the diamond is covered entirely by the metal, and this is removed by grinding, exposing the diamond and making it ready for use. Copper rods are also used for holding diamonds and the same method of peening is adopted.

Still another method of setting a black diamond, which differs slightly from that just described, is as follows: A hole is drilled in the end of a ⅜-inch soft steel rod just large enough to admit the diamond. The diamond is then placed in the hole with the largest end at the bottom, and the metal is subsequently peened around sufficiently to hold the stone in place. The diamond and the holder are then heated to a white welding heat, and by light blows, using a small hammer, the metal is completely closed around the stone. The holder is then taken to an emery wheel and ground until the diamond touches the wheel. The welding heat does not appear to affect the diamond and the light blows close the metal completely around it, holding it rigidly in place.

Methods of Applying Diamonds to the Truing of Grinding Wheels

The terms "dressing" and "truing," as applied to grinding wheels, are sometimes confused; they indicate two entirely different operations. "Dressing" a wheel is done to rough it up, or in other words, remove the dull grain from the bond. This is done with a wheel dresser, and is applicable more particularly to grinding wheels used for snagging castings, etc. Truing a grinding wheel, as understood by users of wheels for cylindrical and accurate work, is not the roughing of the wheel but the making of an accurate and concentric face. Truing may be divided into two classes: first, that done for the purpose of sharpening the wheel, as well as

Fig. 1. Character of Work produced by a Wheel that is not True, by one that is True and Sharp, and by one that is Dull—Circular Sections enlarged about Eight Times

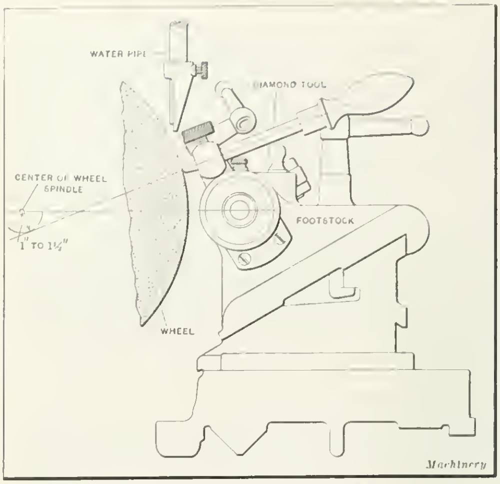


Fig. 2. Relation of Diamond Point to Grinding Wheel Face

making it perfectly true, and second, that done to dull the wheel, which, while making it perfectly true, produces a smooth surface on the face of the wheel. Accurate truing is done with a diamond which should always be held in a fixed toolpost, and never in the hand. There should always be a liberal supply of lubricant or water flowing on the diamond while the truing is being done. Keeping the diamond wet only part of the time wears it unduly and also prevents the operator from securing a perfectly smooth-face wheel.

Different Methods of Truing Grinding Wheels

On modern cylindrical and surface grinding machines, a relatively coarse grain soft bond wheel is commonly used for

Fig. 3. Truing Face of Grinding Wheel by Means of Ordinary Diamond Holder

removing the greater part of the material, especially in commercial grinding, and this wheel is usually of so coarse a grain that it will not produce a fine enough finish when the wheel face is sharp, as for roughing. For finishing, the method adopted is as follows: After removing the greater amount of the material, leaving enough for finishing, the face of the wheel is trued with a diamond that does not have a very sharp point, but preferably has a slightly rounded or perhaps a considerably rounded point. Then by traversing this diamond slowly across the face of the wheel, holding it in the fixed post, a surface is produced which is smooth and at the same time perfectly true. This surface is a temporary one on the otherwise coarse wheel; by carefully bringing the wheel in on the work, so as not to disturb the surface, a fine finish on the work is secured. In other words, the quality of the finish on the work depends largely on the quality of the surface on the wheel. When a second piece is to be ground, that is, roughed out, the wheel is brought in rapidly on the work, taking a heavy cut, and the previously smooth surface entirely disappears.

The method of truing a hard bond fine grain wheel is just the reverse from that described. Instead of using a blunt rounded point diamond, it is necessary to use a diamond with a sharp point in order that the surface may be roughed up. Water must flow on the diamond continually, and instead of a very slow traverse of the diamond across the wheel, the diamond is traversed rapidly, taking light cuts. For accurate cylindrical grinding, all other factors being considered, the most profitable wheel to use is often one which requires frequent truing.

Relation of Diamond Point to Center of Wheel-spindle

In truing the average grinding wheel, and especially when using a comparatively hard bond wheel on a cylindrical grinding machine, it is necessary to keep fresh cutting facets on the diamond presented to the wheel. In order to do this, the diamond point must be presented at a certain angle to the face of the wheel. The diagram shown in Fig. 2 illustrates a standard diamond truing tool being applied to a grinding wheel. In this case, it will be noticed that the holder is presented at such an angle to the face of the grinding wheel that by continuing the line representing the axis of the dia-

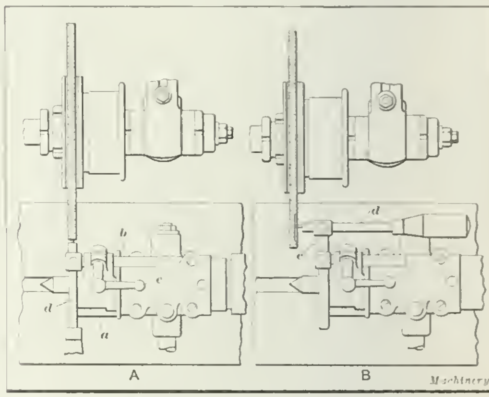


Fig. 4. Common Method of truing Face and Sides of Grinding Wheel

mond holder, it coincides with an arc of from 1 to 1½ inch radius scribed from the center of the wheel-spindle. By presenting the diamond in this manner, it is possible to secure new cutting facets, which is necessary in the truing of comparatively hard bond wheels. For truing soft bond wheels, it is sometimes advisable to use a diamond that has a rounded point, and in this case it need not be presented at an angle, but can be held in a horizontal position.

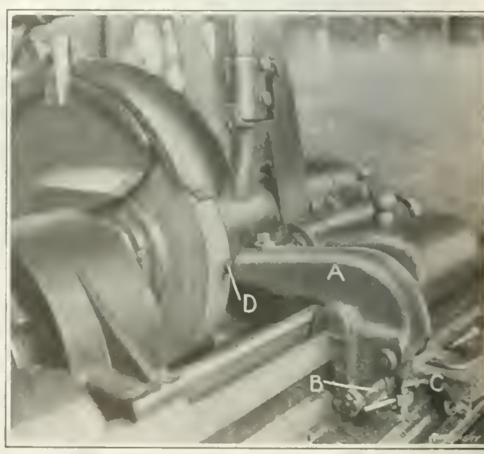


Fig. 5. Wheel Truing Device that can be used without changing Position of Wheel-slide

Common Method of Truing Face and Sides of Grinding Wheel

Fig. 4 shows the conventional method of applying a diamond tool to the face and sides of the grinding wheel. At *A* is shown the truing of the face of the wheel. In this case, a diamond holder *a* is held on the footstock of the grinding machine and carries a bolt *b*, which is clamped in position by means of lever *c*. Extension holder *b* carries a diamond holder *d*. To apply this type of wheel truing device to the side of the wheel, it is necessary to insert an additional holding rod *e*, as shown at *B*, which occupies the same position as the diamond holder shown at *A*. Grinding wheels are only trued on the side when it is necessary to face a shoulder. When the opposite side of the wheel to that shown in the illustration is to be trued, the wheel is brought over further and the position of diamond holder *d* is reversed in holder *e*.

Fig. 3 shows the wheel truing device illustrated in Fig. 4 being applied to the face of the grinding wheel. In this case it will be noticed that the diamond holder is held as close as possible to the diamond. This is necessary in order to retain the holder rigidly and prevent chatter and chipping of the diamond point. In applying the diamond where an ordinary finish is desired on the face of the wheel, usually the power feed is thrown in to traverse the diamond across the wheel, and a copious supply of cutting lubricant or water is provided to keep the diamond point cool, and to give an even finish on the surface of the wheel.

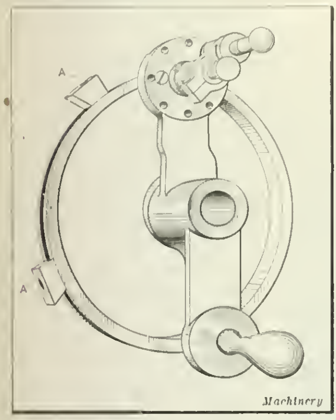


Fig. 6. Special Index Crank designed for Use on Norton Plain Grinding Machines for truing Different Diameters on Wheel Face

Parallel Wheel Truing Devices for Cylindrical Grinding Machines

One of the most necessary requirements for accurate work is to keep the wheel face true and free-cutting. It is therefore essential that the wheel truing device be capable of quick application in order to reduce the time necessary for truing. With some of the wheel truing devices on the market, it is necessary to change the position or location of the wheel in relation to the work, in order to true its face. This takes considerable time and necessitates resetting each time the wheel is trued. A wheel truing device that overcomes this objectionable feature is illustrated in Fig. 5. This comprises

Fig. 7. Simple Wheel Truing Device used on Landis Crankshaft Grinders

Fig. 8. Multiple Diameter Wheel Truing Device for Use on Brown & Sharpe Plain Grinding Machines

a cast-iron bracket *A* which is fitted to and held to the front of the table of a Norton plain grinding machine.

The method of clamping is simple, there being a small shoe *B* hinged in the lower portion of the bracket, and against which an adjustable clamping bolt *C* rests. This device is effective in holding the bracket rigidly in position. The diamond holder proper *D* is held in the front end of the bracket by a set-screw, as shown. In using this device, the work is removed from the centers and the wheel truing device clamped in position. After the face of the wheel has been trued, the fixture is removed and the work again inserted. In setting up the machine, however, the diamond point is located so that it trues the wheel in such a position in relation to the centers that the work when placed on the centers is ground to practically the required diameter. The setting of the diamond

Fig. 9. Radius Wheel Truing Device for Use on Norton Plain Grinding Machines

is not changed after this, and as the wheel is worn down by frequent truing, its relation to the centers is approximately maintained. In this way, very little adjustment of the wheel-slide is necessary which, of course, reduces the time usually spent in truing the wheel. In order to take care of small and large-diameter work, brackets *A* are made in several lengths so that it is not necessary to have the diamond holder project too far from the bracket, which would be objectionable.

Another wheel truing device that is used quite extensively on Landis crankshaft grinders is shown in Fig. 7. This comprises a very simple holder *A*, which is provided with an elongated slot through which a set-screw passes that clamps it to the face of the steadyrest casting. With this device, it is not necessary to remove the work from the centers at all to true the face of the wheel. In use, the diamond holder *A* is released and pushed in between the throws of the crankshaft; the wheel-slide is then traversed to true the face of the wheel. After truing, the set-screw is released and holder *A*

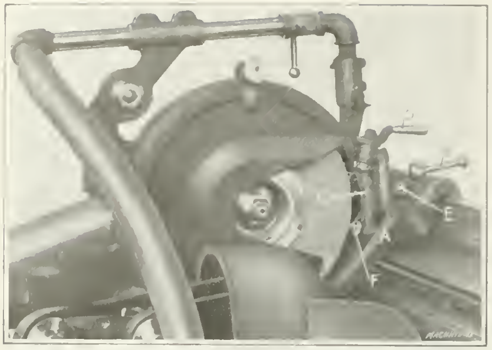


Fig. 10. Another Radius Wheel Truing Device for Use on Norton Plain Grinding Machines

pulled back out of the way. This device has proved very effective and rapid in truing the wheel on Landis crankshaft grinding machines.

Multiple-diameter Wheel Truing Attachment

The application of wide-face grinding wheels to the production of shoulder shafts or other multiple-diameter work, has made necessary the designing of attachments for either bringing the wheel into different positions accurately, or truing the face of the wheel to different diameters, without the usual trouble of manipulating the index stop. When the sum of the lengths of all the diameters to be ground is less than the width of the wheel, it is most economical to true several diameters along the wheel face. The work is then ground in the ordinary manner, by simply feeding the wheel straight in on the work without any lateral traverse, until the correct diameter is reached. If the difference in size between the various diameters is small, it does not pay to produce these different shoulders in the rough-turning operation; it is preferable to turn the several diameters straight and depend on the wheel to produce the slight differences. This imposes a little more work on some parts of the wheel, and the truing will be more frequent, but this usually is cheaper than producing the slight differences in the diameter by turning.

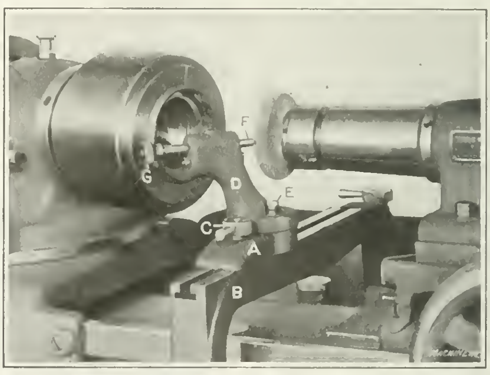


Fig. 11. Radius Wheel Truing Device for Use on Heald Internal Grinding Machines

When various portions of a shaft are of such a length that the entire face of the wheel does not cover them, the work must be traversed and means must be employed for accurately locating the wheel on each diameter. One method of accomplishing this is shown in Fig. 6. This device in use is attached to the regular index crank of a Norton plain grinding machine. It comprises a metal ring in which a dovetailed slot has been turned, and in which small blocks *A* are held by means of screws. These are located around the periphery of the ring in the desired position. By numbering or lettering these blocks and correspondingly numbering or lettering the working drawings, the operator knows just how far in to bring the wheel for the various diameters on the work.

In order to true the wheel so as to grind two diameters at one setting, the proper procedure is to first true the wheel straight across the face, with the first block resting against the stop arm on the machine. Then the ring should be turned around until the second block rests against the stop arm. The wheel has therefore been advanced toward the diamond by a certain predetermined amount. If now the diamond is traversed along the wheel face for the required distance, a small portion of the wheel will be smaller in diameter than the remainder of the wheel; therefore, if the wheel is brought straight in on the work it will produce two diameters, the larger of these being made by the smaller diameter on the wheel.

Another multiple-diameter wheel truing device which was designed for a particular job is shown in Fig. 8. This is attached to the footstock of a Brown & Sharpe plain grinding machine. The fixture consists of a block *A*, which is bored out and encircles the front end of the footstock; it is clamped in position by means of bolts. The top face of this block is machined out with a dovetailed groove to receive a second block *B*. This second block, which is provided with a dovetailed slide, is held to the first block as shown, and carries two separate holders *C* and *D*. These are adjusted by means of graduated collar screws *E* and *F* so that movements of 0.001 inch can be obtained. In use, this wheel truing device is brought over in contact with the face of the grinding wheel, and then a stop on the front of the machine is set and the table traversed back and forth until the wheel is trued. The relative positions of the diamond points take care of the two diameters on the wheel.

Radius Wheel Truing Devices

In grinding certain classes of work it is necessary to produce a fillet near a shoulder or other circular surface, and for this requirement a radius wheel truing device is generally provided. Fig. 9 shows a simple but effective wheel truing device for truing the radius on the grinding wheel, which can be set, in addition, for truing the wheel parallel with the axis. It comprises a bracket *A* clamped to the footstock center by means of a clamping-screw *B*, and a projecting arm for fastening it to stud *C*. The radius wheel truing fixture proper comprises a bracket *D*, capable of swiveling in the seat provided in the lower end of bracket *A*. Bracket *D* carries the diamond holder *E* that is held in place by a set-screw as shown. It is also provided with a slot in which a plug *F* fits.

In using this device for producing a radius, thumb-screw *G* is released and plug *F* pulled back. This allows a free movement of bracket *D*, and by gripping holder *E* the operator can true a radius on the wheel. To true the face parallel with the grinding machine centers, plug *F* is pushed in, thumb-

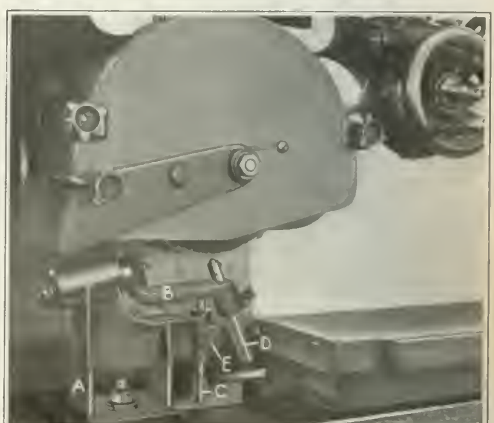


Fig. 12. Radius Wheel Truing Device for Use on Norton Surface Grinding Machines

screw *G* tightened and then the table traversed, moving the diamond point back and forth in front of the wheel. A somewhat similar device was shown in Fig. 71 in the April number of MACHINERY.

The radius wheel truing device shown in Fig. 10 differs from that shown in Fig. 9 chiefly in the method of clamping it to the machine and in the manner in which the diamond holder is held and rotated. This device consists of a bracket *A* clamped to the Norton plain grinding machine table by a clamping lever *B*. The lower portion of bracket *A* is yoke shaped and carries the diamond holder bracket *C* in the manner illustrated. This bracket can then be swung by operating lever *D* when it is necessary to true a radius on the wheel. For parallel truing of the grinding wheel face, plug *E* is pushed in and fits in a hole provided in bracket *C*, holding the bracket rigidly in position for parallel truing. The diamond is held in the holder *F*, the external diameter of which is threaded to receive a nut used for adjusting purposes.

Radius Truing Device for Internal Grinding Wheel

A simple device for truing wheels for internal grinding on a Heald internal grinding machine is shown in Fig. 11. It comprises a bracket *A*, provided with a locating key and held to the standard yoke or bracket *B* by means of a clamping bolt and nut *C*. The diamond holder proper is held in a bracket *D* that is free to swivel on the base when plug *E* is lifted up. When this plug is pushed down, the device can be used for truing the wheel parallel with the axis of the spindle. The diamond is held in a holder *F*, the rear portion of which is threaded, enabling it to be adjusted back and forth by turning knob *G*, in order to true the wheel to various radii.

Radius Wheel Truing Device for Surface Grinding Machine

An interesting wheel truing device for use on the Norton surface grinding machine is shown in Fig. 12. As the illustration shows, this comprises a main bracket *A* provided with two extension members, one of which acts as a fulcrum point for the wheel truing holder *B*, whereas the other holds plug *C* to adapt the device for truing the wheel straight. The diamond holder *D* is held in bracket *B* and is adjustably mounted. In using this device to true a radius on the corner of a wheel, thumb-screw *E* is released and plug *C* pulled down. This allows a free oscillating movement of holder *B*. When a straight face is to be trued on the wheel, plug *C* is pushed up until it contacts with a hole in bracket *B*, then screw *E* is tightened, and the wheel-head moved back and forth in order to true the wheel parallel with the axis of the wheel-spindle.

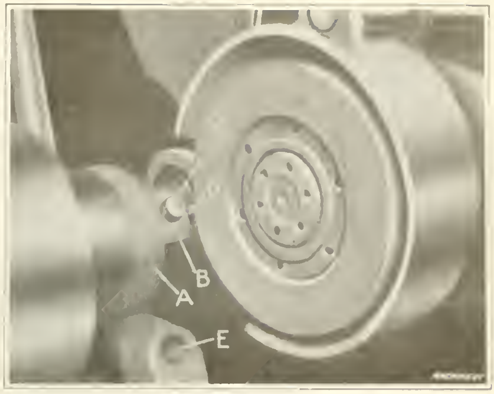


Fig. 14. Simple Wheel Truing Device for Use on Bryant Two-spindle Chucking Grinder

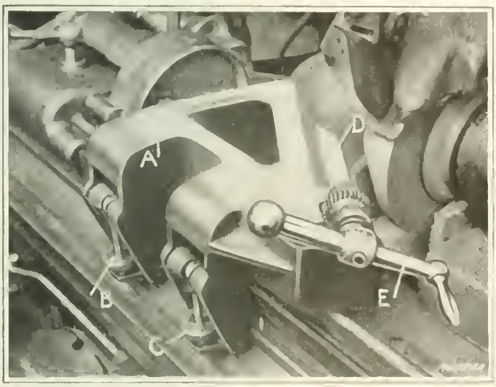


Fig. 15. Angular Wheel Truing Device for Use on Plain Cylindrical Grinding Machine

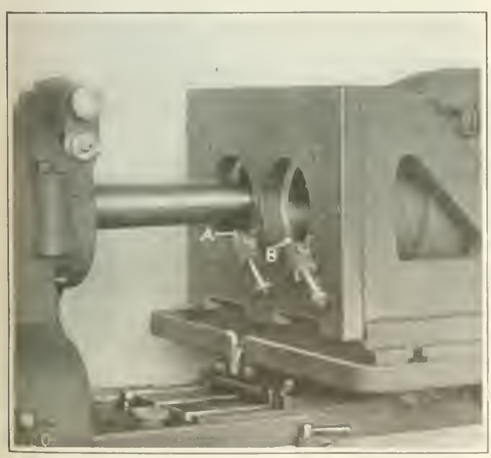


Fig. 13. Devices for truing Grinding Wheel on Heald Cylinder Grinding Machine

Wheel Truing Device for Cylinder Grinding Machines

In the grinding of cast-iron cylinders for automobile engines, which must be finished to accurate dimensions and also have a good finish, it is necessary that the grinding wheel be kept in good condition, which requires frequent truing of the wheel. The two small devices shown at *A* and *B* in Fig. 13 do this work satisfactorily. It will be noticed by referring to this illustration that the front of the work-holding fixture carries two brackets which hold split bushings that are acted upon by set-screws. Screwed into these bushings are two threaded diamond holders carrying a diamond at their points. With these devices, it is possible to true the wheel quickly, after taking roughing cuts from each cylinder bore, thereby obtaining a good surface on the wheel for finishing. In operation, the work-table is traversed so that the diamonds are carried forward and backward past the face of the grinding wheel, the oscillating movement of the wheel-head, of course, being stopped while the truing is being done.

Wheel Truing Device for Use on Bryant Two-spindle Chucking Grinder

A simple but effective means of holding a diamond for truing the external grinding wheel on a Bryant two-spindle chucking grinder is shown in Fig. 14. It is usually quite difficult to apply the diamond for this work; but this [illegible] taken care of in this particular case by making a holder of the same shape as the work to be ground, and then holding it on the fixture in which the work is held. To the front face of this piece *A* is attached a small bracket *B* in which the diamond holder *C* is held by screw *D*. This device proved very effective and is easily put on and taken off. The wheel working on the internal diameter of the work is trued up by an ordinary diamond held in bracket *F*.

Angular Wheel Truing Device for Use on Plain Cylindrical Grinding Machine

Fig. 15 shows an angular wheel truing device for truing the wheel to a bevel shape, or in this case, to an angle of 36

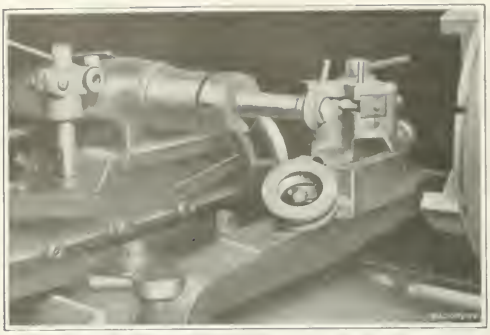


Fig. 16. Double Angle Wheel Truing Device shown set up and in Operation on Heald Internal Grinding Machine

degrees with the axis of the grinding machine centers. The fixture is of comparatively simple design. The bracket *A* is fastened to the table of a Norton grinding machine by clamps *B* and *C* that are similar in construction to those shown in Fig. 5. Bracket *A* carries a slide *D* in which the diamond holder is retained. This slide is operated longitudinally by means of a rack and pinion, receiving motion from handle *E*. The fixture shown here can only be used for truing the bevel; for truing the straight portion of the wheel the ordinary wheel truing device must be used.

Angular Wheel Truing Device for Cone-shaped Ball Races

An interesting double-angle wheel truing device for use in forming a wheel for making a cone-shaped ball race is shown in Fig. 16 and in detail in Fig. 17. Referring to the latter illustration, it will be seen that this device comprises a base *A* whch is machined out to fit a bracket *B* that is adjusted by screw *C*. The operating mechanism of this device is quite interesting: an eccentric bolt *D* passes down through block *B* and is prevented from pulling out by means of a pin fitting

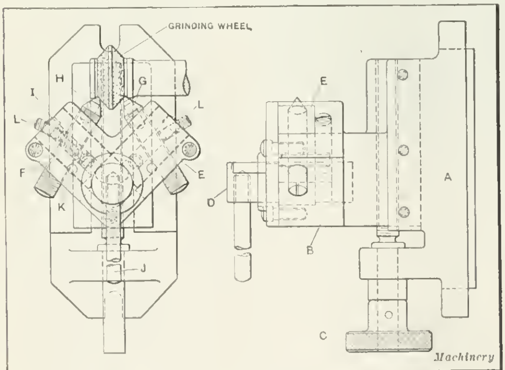


Fig. 17. Detail of Double Angle Wheel Truing Device shown in Fig. 16

in a groove in the lower end. Opposite the eccentric portion of this pin are located two slides *E* and *F*, carrying the diamond holders *G* and *H*. The rear ends of these slides are curved slightly to conform to the cam, and are kept back in contact with it by means of two coil springs *I*, only one of which is shown in the illustration.

The method of operating the fixture is to swing handle *J* in one direction, say to the left, thus forcing out the slide carrying diamond holder *G*, which travels along the angular face of the wheel until handle *J* strikes stop *K*. The handle is then forced in the opposite direction and the other diamond holder comes into play. Screw *C* is operated to bring both holders into the correct working position relative to the wheel. The diamond holders, which are provided with a thread and are screwed into the slides, are set by means of a gage of the same shape and size as the work. They are then clamped in position by set-screws *L*.

Attachment for Use on Cylindrical Machines for Truing Grinding Wheels to Irregular Form

For some classes of work it is necessary that the wide face wheel be trued not only to different diameters but also to irregular form. For accomplishing this it is necessary to use a device in which the form is controlled by means of a cam or other mechanism of a similar nature. Figs. 18 and 19 illustrate such a device, Fig. 18 showing it attached to a Norton plain grinding machine, whereas Fig. 19 shows it removed and partly dismantled.

Referring to the latter illustration, which shows a front

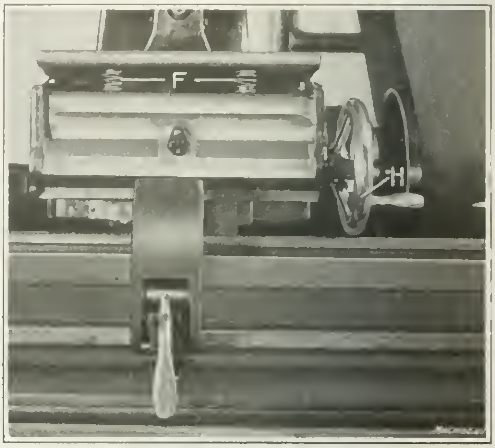


Fig. 18. Cam-controlled Device designed for forming Irregular Shapes on Face of Grinding Wheel on Norton Plain Grinding Machines

view of this device, it will be seen that it comprises a former plate *A*, which in this case is perfectly plain, a diamond holder or plate *B*, and a diamond holder *C*. Carriage *B* is held on pivots *D*, and as shown in Fig. 18, is kept in contact with the cam by means of coil springs *F*. Cam *A* is held in a carriage or slide *G* that is traversed laterally by means of a screw to which handwheel *H* is attached. By rotating this handwheel, the carriage carrying cam *A* is traversed and the face on the cam imparts the desired in and out movement to the plate carrying the diamond. The entire device is clamped on the table of the grinding machine with a clamping device as shown in Fig. 18. A wheel truing device of simpler construction than that shown in Figs. 18 and 19 was illustrated in Fig. 72 in the April number of MACHINERY.

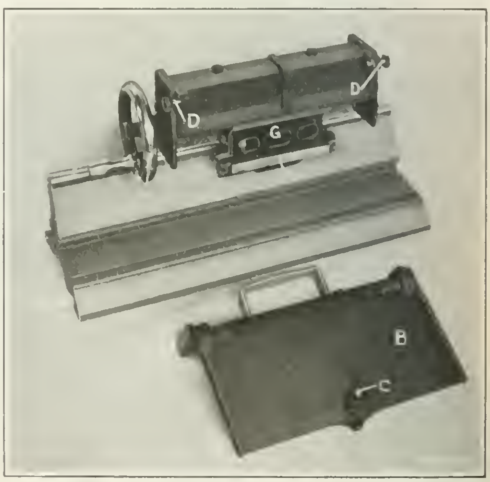


Fig. 19. Wheel Truing Device shown in Fig. 18, dismantled to show Construction

Wheel Truing Device for Surface Grinding Machine

In applying a diamond holder to a wheel held in a surface grinder, the holder should, when possible, be held on the table under the wheel and not up at the side of the wheel in the same horizontal plane as the wheel-spindle. Holding the diamond truing device on the table reduces the chances of chatter, and it is also much more easily applied in this way. Fig. 20 shows a simple diamond holder for use on a Heald piston ring grinding machine. Referring to this illustration, it will be noticed that this consists simply of a plate *A* in which the diamond holder *B* is retained, plate *A* being held on the magnetic chuck. The diamond holder is presented to the wheel by traversing the wheel back and forth past it, the work-table remaining stationary.

Fig. 20. Simple Wheel Truing Device for Use on Heald Piston Ring Grinding Machine

Wheel Truing Attachment Used on Wilmarth & Morman Surface Grinding Machine

The wheel truing device shown in Fig. 21 is held on the wheel guard or hood as illustrated, and has several slides. Slide *A* which holds diamond holder *B* is adjusted up and down along the face of slide *C* by means of screw *D*. Slide *C*, in turn, is moved along the gibbed slide on bracket *E* by means of handle *F*. The screw to which handle *F* is attached is of coarse pitch, enabling slide *C* to be traversed rapidly. The vertical screw *D* is of fine pitch, enabling accurate adjustment of the diamond to be made. With this contrivance it is unnecessary to remove the wheel truing device in order to grind the work.

Wheel Truing Device for Crowning Pulleys

The attachment shown in Fig. 22 is used chiefly for truing the face of the grinding wheel when it is desired to use it for crowning pulleys by feeding straight in on the work. This consists primarily of a bracket *A*, fastened to the grinding machine table by clamp handle *B* as shown, and carrying an adjustable slide *C* in which the diamond holder is retained. Slide *C* is held on bracket *D* clamped to bracket *A*,

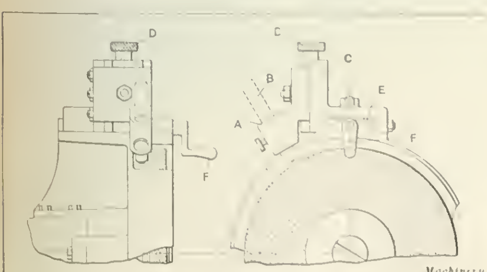


Fig. 21. Wheel Truing Device used on Wilmarth & Morman Surface Grinding Machines

Fig. 22. Wheel Truing Device used in producing Concavity in Face of Wheel for crowning Pulleys on Norton Plain Grinding Machines

and is free to swivel when the clamping bolt is released. The boss on bracket *D* is graduated so that the required amount of inclination of the slide in relation to the axis of the wheel-spindle can be obtained. The degree to which the wheel truing slide is tilted determines the amount of concavity on the wheel face which, of course, governs the height of the crown on the pulley. Slide *C* carrying the diamond is moved back and forth by means of a rack and pinion operated by handwheel *E*.

Reference to the diagram Fig. 23 will show the manner in which the face of the grinding wheel is trued concave. Line *A* shows the path that the diamond takes when the holder is set off at an angle of 30 degrees with the axis or center line of the wheel-spindle, and at the top of this illustration will be seen the amount of concavity produced with the slide set in this position. The reason for this concave form is that the diamond in passing across the wheel is closer to the axis of the wheel when passing over the center line; consequently, the wheel is trued concave when the diamond is traversed back and forth. Different degrees

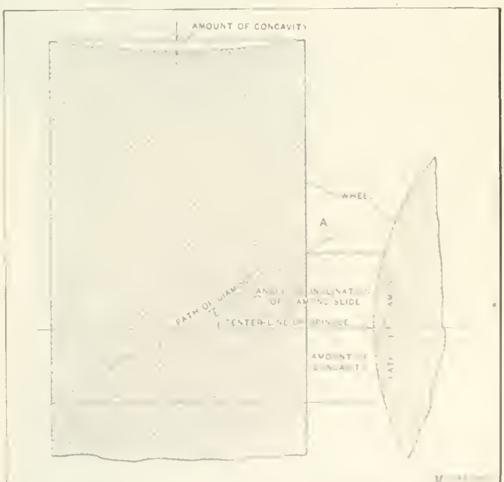


Fig. 23. Diagram showing Principle upon which Wheel Truing Device illustrated in Fig. 22 operates

of depth can be obtained by changing the angle of the path that the diamond makes in traveling across the wheel face. This particular attachment provides for truing from a straight surface to a concavity having a depth of 1/4 inch. In width, this attachment will true wheels up to 12 inches.

Device for Truing Wheel to Irregular Form on Surface Grinding Machine

Figs. 24 and 25 show a wheel truing device that is used on a Norton surface grinding machine for truing the face of

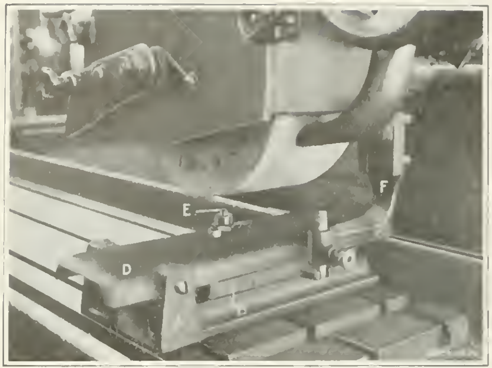


Fig. 24. Device for truing Face of Wheel to Irregular Form on Norton Surface Grinding Machine

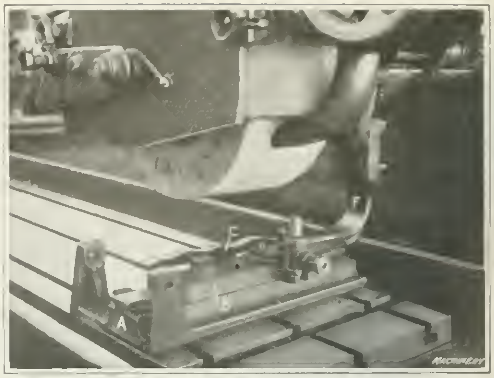


Fig. 25. Device shown in Fig. 24 partly dismantled to show Construction

the wheel either to straight or irregular form, depending on the shape of the guiding cam used. It consists principally of a bracket *A* held to the table of the surface grinding machine. This bracket is machined on its top surface to provide for an angular way, on which is fitted slide *B* that, in turn, carries cam *C* which operates plate *D* carrying diamond holder *E*. Slide *B* is operated by arm *F*, which it will be noticed is attached to the wheel-slide and consequently moves with it. As slide *B* is operated back and forth, cam *C* moves plate *D* up and down, thus raising and lowering the diamond in accordance with the shape of the cam. By simply changing the shape of the cam, this device can be used for truing the wheel to various shapes.

Attachment for Truing Wheel for Grinding Spline Shafts

An interesting attachment used on a Bath No. 20 multiple keyshaft grinding machine for truing the grinding wheel both to a radius and a bevel on the sides is shown in Figs. 27 and 28. This attachment consists of a bracket *A* fastened to the grinding machine table, and carrying three diamond holders, one of which is used for truing the radius, as shown in Fig. 27, and the other two for truing the bevel on the sides, as shown in Fig. 28. Referring to Fig. 27, it will be seen that the spindle *B* carries a diamond holder *C* which is set to give the desired radius by an adjusting screw. Spindle *B* is rotated by means of lever *D*, and in this way the curved surface is formed.

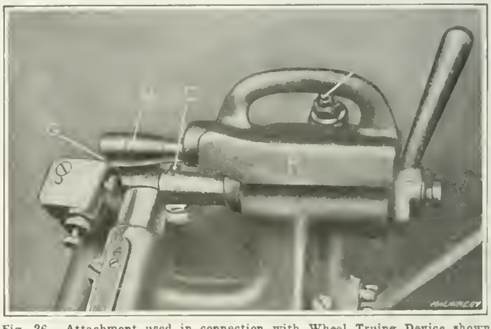


Fig. 26. Attachment used in connection with Wheel Truing Device shown in Figs. 27 and 28 for setting Diamond Tools

For truing the angular surfaces on the wheel, two separate holders *E* and *F* are used, as shown in Fig. 28. These holders carry separate diamond holders *G* and *H* which are adjusted by means of a screw and lock-nut as shown. These two holders are operated independently and alternately by means of a spindle, to which handle *I* carrying a cam is attached. The holders are kept down constantly in contact with the cam by means of springs, and as the handle is moved in first one direction and then the other, it operates the diamond holders. In this way, both sides of the wheel are trued in the proper relation to each other.

It is evident from the foregoing that diamond holders *G* and *H* must bear the same relation to each other, and also that some means must be provided for setting the diamond for truing the circular portion of the wheel. The device used for this purpose is shown in Fig. 26. As is shown in Figs. 27 and 28, the top face of bracket *A* is machined to form a dovetail slide and is adapted to receive the additional attachment *K* shown in Fig. 26. This is simply slipped over the top of the fixture and clamped in place by means of bolt *L*. A plug gage *M* provided with two diameters is used for setting the diamond points. In setting diamond holder *C*, the diamond is brought in contact with the smallest diameter of the plug, whereas for setting holders *G* and *H*, the diamonds are brought in contact with the largest diameter of the plug. With this device it is possible to secure very accurate work.

There is a large variety of devices and attachments used for truing grinding wheels for various purposes, but those given represent typical designs and illustrate principles of comparatively wide application.

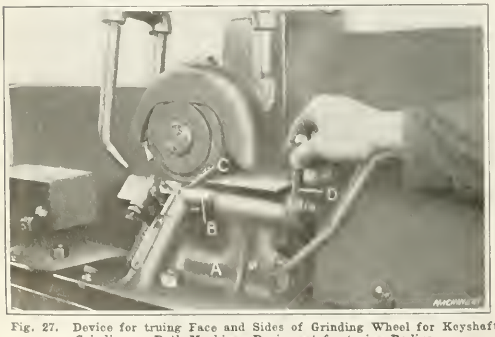


Fig. 27. Device for truing Face and Sides of Grinding Wheel for Keyshaft Grinding on Bath Machine—Device set for truing Radius

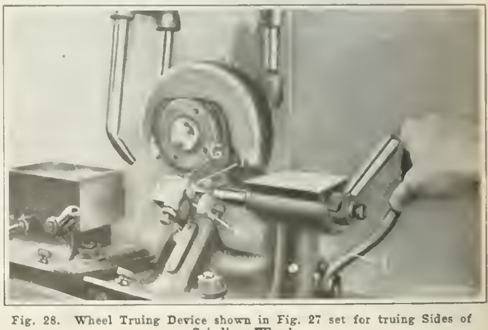


Fig. 28. Wheel Truing Device shown in Fig. 27 set for truing Sides of Grinding Wheel

LETTERS ON PRACTICAL SUBJECTS

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WHAT WOULD HAVE HAPPENED IF THERE HAD BEEN NO GUARDS?

The illustrations show two accidents that occurred in the grinding department of the Pierce-Arrow Motor Car Co. and that would undoubtedly have had fatal results if the wheels had not been so effectively guarded. Figs. 2 and 4 show the guards thrown back to reveal the fractures and Figs. 1 and 3 show the guards in place. In the second case, no one was hurt and in the first case the operator was only slightly injured by the fragment of the wheel A that broke off. The guards probably were the means of saving his life. It is a significant fact that these two cases are the first instances in the history of the concern of a solid wheel breaking in the grinding department and yet they occurred within a week of each other. This shows how essential it is to guard all solid wheels and to make sure that the guards provided are in place and not swung back, at all times. If for any reason a guard is to be swung out to make repairs or change the wheel, it should be replaced without fail before starting the machine. Every operator should observe this precaution not only to insure his own safety but for the protection of those around him as well.

Fig. 1. Grinding Wheel that burst and Guards that prevented Serious Injury

Fig. 2. Guards thrown back to show Fractures in Wheel

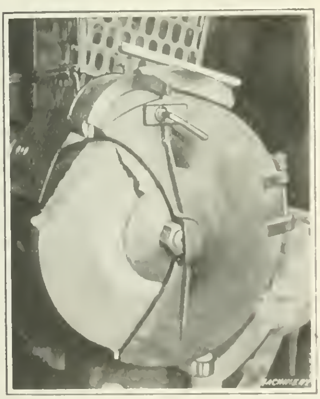


Fig. 3. Another Case illustrating the Necessity of guarding Grinding Wheels

Fig. 4. Wheel shown in Fig. 3 with Guards thrown back

These wheels were 20 inches in diameter, 2½ inches face, grade 30 P. It will be noted that the fractures in the two wheels are almost identical. The cause of the rupture is a question. The grinding lathes were in good condition and the operators were careful and experienced workmen. The speed employed was only 5800 surface feet which was well within the 6000 feet surface speed allowed. Before leaving the manufacturers all wheels had been tested at a 50 per cent greater speed than maximum, and when received they had been subjected to the ring test to detect any possible injury in shipment. These tests failed to disclose any flaw in the wheels. The foregoing facts illustrate how vital a matter it is to guard all grinding wheels even when the chances of accident seem very slight.

Kenmore, N. Y. GEORGE B. MORRIS

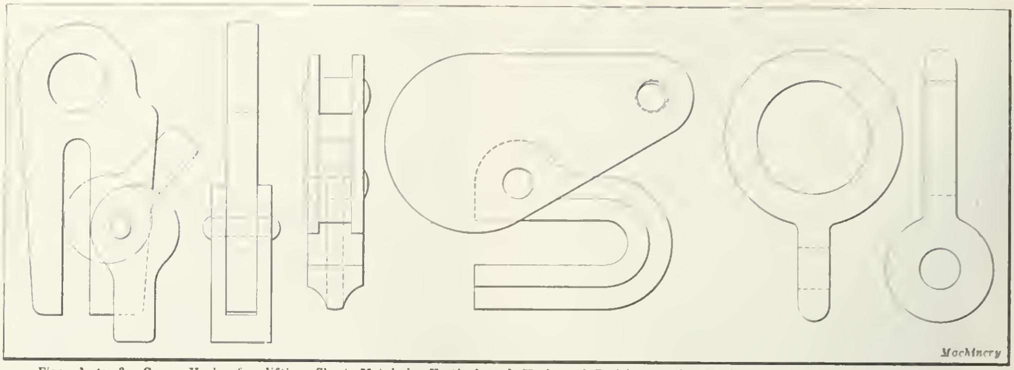
[An article giving dimensions for grinding wheel safety devices was published in MACHINERY, February, 1915.—EDITOR.]

SHORT-PAID POSTAGE

For twenty-five years the subject of short-paid postage on foreign letters has been discussed, and our consuls abroad have repeatedly called attention to the fact that it is a cause of much dissatisfaction and of injury to our foreign trade. Of course, no one believes that postage is short-paid on letters going abroad because those who pay the postage wish it to be so. It happens because the people who send these letters out think they have no control over it, and they cannot cure the difficulty. There is evidence tending to prove that they really cannot, and I know of one instance in which a foreign correspondent protested strongly against the receipt of so many letters from an American machinery manufacturer on which the recipient had to pay double postage. He received a reply apologizing and assuring him that steps had been taken to prevent his receiving any more letters on which postage was not fully prepaid, and that identical letter was short-paid, and the recipient had to pay a penalty for the privilege of reading it.

Anyone who knows something of American business office methods can easily find out what is generally the reason for short-paid postage to foreign countries. Large numbers of letters are dictated, mostly late in the afternoon, the [illegible] signs them hastily and gets away, [illegible] ing the stenographer and the office boy to get the mail off before going home. It is often pretty late before they get away and there is every incentive to get the work off their hands as rapidly as possible. It is hopeless to expect an office boy to read addresses, look up the amount required for foreign countries in case he has foreign letters and [illegible] foreign postage. In many cases, perhaps, he has no stamps for foreign postage, and the simplest thing for him to do is to put on a two-cent stamp for every letter, without reading addresses to find out if they are foreign or not.

When a business man receives a protest about underpaid foreign letters, he may go to the office boy and "jack him up." The office boy professes to be very sorry and promises to look after it, but we all know that he will not, and those of us



Figs. 1 to 3. Crane Hooks for lifting Sheet Metal in Vertical and Horizontal Positions, and Special Link for connecting to Crane Chain

who will face facts know that he cannot. And supposing we were to get the present office boy educated so that he will do it—we shall have a new office boy after a while and the educational process must be gone over again.

Like everything else that is done in a manufacturing establishment, this matter of mail to foreign countries needs to be studied and the method of handling adapted to the results sought. There are various ways of doing it, but one way is to have foreign letter envelopes of a distinctive color kept in a separate pigeon hole of the stenographer's desk. The stenographer when she writes an address may be supposed to be able to know whether it is foreign or not; may select the foreign envelope, which by its color, its shape, or by a black-faced figure printed on the envelope to be covered by the stamp, will notify the office boy that stamps for foreign postage must be attached. To scold or fire the office boy for under-paid foreign letters has been demonstrated to be a failure. F. J. M.

CRANE HOOKS FOR LIFTING SHEET METAL

It is the purpose of this article to describe two forms of crane hooks which we have found useful for lifting sheet metal when held in a horizontal and in a vertical position, respectively. Fig. 1 shows the hook used for lifting a sheet held vertically, the capacity of which is for stock from 1/16 to 7/8 inch in thickness. It will be seen that this hook is simply an inverted U-shaped member with a U-shaped cam riveted to it. The solid lines show the position of the cam when the hook is being dropped into place on a sheet of metal, and the dotted lines show the position assumed by the cam while the stock is being lifted. The contact surface of the cam is serrated so that it secures a firm grip on the metal, and the heavier the load to be lifted the greater the grip secured by the cam; consequently there is no danger of the sheet being dropped.

Fig. 2 shows a useful form of hook for use in lifting sheet metal held in a horizontal position. It will be seen from the end view that this hook consists of two wrought-iron plates which are riveted together in such a manner that the U-shaped hook is supported between them. The way in which the hook is used is shown in Fig. 4, and the illustrations make the method clear without requiring more than a brief description. The hook will lift sheets up to 3/4 inch in thickness, and it will be evident that the cam-plates at each side of the hooks adjust themselves for the thickness of the stock as soon as the operator starts to raise the hoist. The cams are riveted together at the small end and a bushing is provided to keep them the required distance apart. This bushing fits through the small eye of a special link of the form shown in Fig. 3, and the rivet that holds the cam-plates together fits through the bushing. The large eye of the link receives the chain as shown in Fig. 4. Both of these hooks have been in use for some time in the shop where the writer is employed, and have given very satisfactory results. L. K.

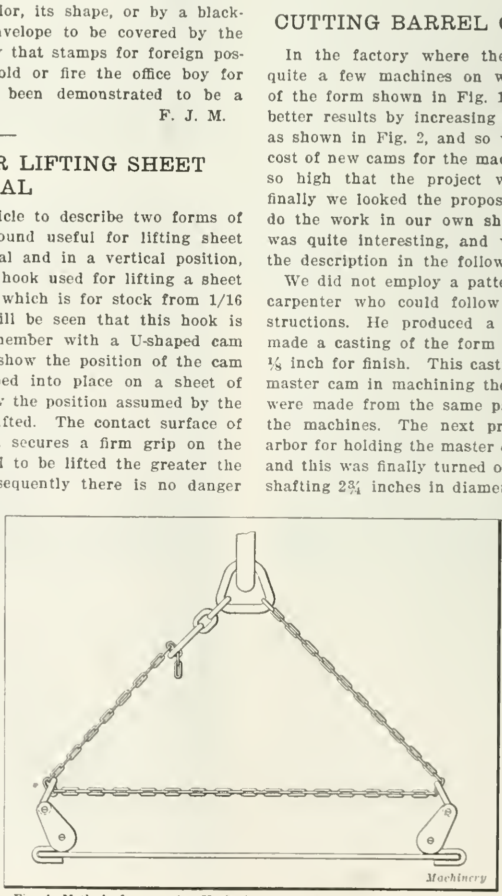
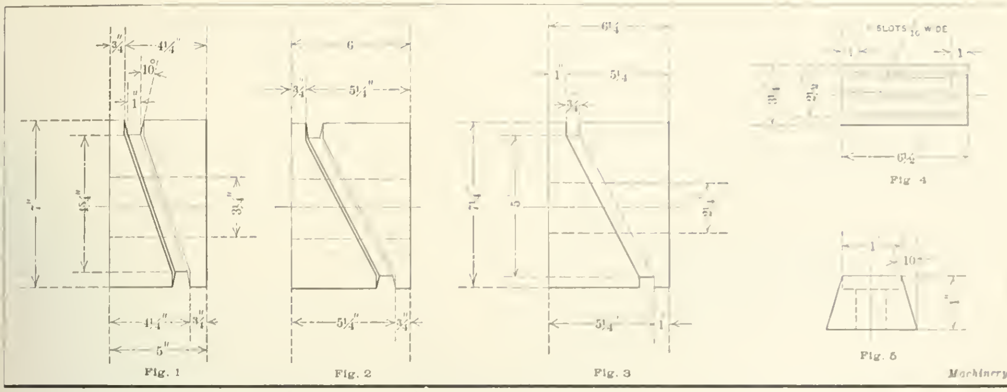


Fig. 4. Method of connecting Hook shown in Fig. 2 to Load Chain of Hoist

CUTTING BARREL CAMS ON THE LATHE

In the factory where the writer is employed there are quite a few machines on which cams are used which are of the form shown in Fig. 1. It was thought we would get better results by increasing the pitch of the cams one inch, as shown in Fig. 2, and so we asked for an estimate on the cost of new cams for the machines. The bids submitted were so high that the project was temporarily abandoned, but finally we looked the proposition over and decided we could do the work in our own shop. The method finally adopted was quite interesting, and will be readily understood from the description in the following article.

We did not employ a patternmaker, but had an intelligent carpenter who could follow rough sketches and verbal instructions. He produced a rough pattern from which we made a casting of the form shown in Fig. 3, allowing about 1/8 inch for finish. This casting was finished and used as the master cam in machining the seventeen other castings which were made from the same pattern, to be finished for use on the machines. The next problem was to make a suitable arbor for holding the master cam and the casting to be turned, and this was finally turned out from a piece of machine steel shafting 2 3/4 inches in diameter by 3 feet long. The shafting was centered and turned down to 2 1/2 inches in diameter with a taper of 0.005 inch per foot. Next we took a piece of machine steel 4 inches in diameter by 7 inches long, which had a hole 1 1/2 inch in diameter bored through it. We set this up in the lathe chuck and bored out a hole 2 1/2 inches in diameter; the piece was next put on the arbor and turned to a diameter of 3 1/4 inches on the outside, after which it was faced off to a length of 6 1/2 inches. By cutting eight slots 1/16 inch in width in this piece, a satisfactory expanding sleeve was made, as shown in Fig. 4.



Figs. 1 to 5. Original Cam, Redesigned Cam, Cam Casting, Split Bushing to hold Cam on Arbor, and Roller to engage Master Cam

For use as a master cam, we took one of the castings and filed the groove on both sides to make it fit the roller shown in Fig. 5, which is 7/8 inch in diameter. After this had been done, we set up the casting in the lathe chuck and bored out the hole to a diameter of 2½ inches, and also drilled and tapped a hole ½ inch in diameter to receive the set-screw *H* which was used to secure the master cam to the arbor, as shown in Fig. 6. The next step was to forge a cutter to the desired shape and dimensions for machining the cam grooves; and to fasten a flat piece of machine steel to the carriage of the lathe, on which the cam roller to engage the master cam was carried by a stud.

After this preliminary work had been completed, we were ready to proceed as follows: The castings were first placed in the lathe chuck where the hole was bored out to 3¼ inches in diameter. One of the castings was then put on the arbor *F*, Fig. 6, where it was held in place by means of the split bushing *G*. The outside of the cam was then turned to reduce its diameter to 7 inches, after which a ½-inch hole was drilled and tapped in the same position as on the master cam. The master cam was now mounted on the arbor and held in place by means of the ½-inch set-screw *H*, and engaged by the roller *B* carried on the stud *C*, which fits into the machine steel bar *D* on the carriage, this bar being held in place by the bolts and dowel-pins *E*. The tool is fastened in the toolpost in the usual way, and the carriage is disengaged from the feed mechanism in order that it may be moved along the bed through the action of the master cam and roller.

In setting up the work there should be a difference in angle of 90 degrees, *i. e.*, when the set-screw in the master cam is over the cam roller *B*, the set-screw in the casting to be machined should be opposite the cutting tool *I*. It must be borne in mind that the metal is to be removed all around on both sides of the cam groove, and so the casting must be driven onto the arbor tight enough so that it will be held in place. When cutting the groove the tail of the lathe dog should be tightly wedged in the slot of the faceplate to prevent lost motion. After the groove in all of the cams had been machined, the master cam *A* and the strip *D* holding the cam roller *B* were removed so that the cams could be set up on the arbor to have their ends faced. After this work had been done, it was merely necessary to cut the keyway, after which the cams were ready for use. M. H. Chase

THE BREAKING OF A SPRINKLER HEAD

The old saying "Experience is sometimes a dear teacher" was brought home to us very forcibly the other day when an overhead belt broke and knocked off a sprinkler head in our grinding department, which resulted in the water coming down altogether too fast for comfort. Nobody seemed to know just where the shut-off valve was located, and by the time it was finally shut off some special machinery on the floor below that was almost ready for shipment became thoroughly drenched. We now have signs in every department that tell just where the shut-off and draw-off valves are located, and every foreman and assistant foreman, besides two or three reliable operators in each department, know just where the valves for their respective departments are.

Superintendent

A SAFETY HINT TO DIEMAKERS

One of our diemakers met with a rather painful accident the other day while he was trying out a set of tools in a

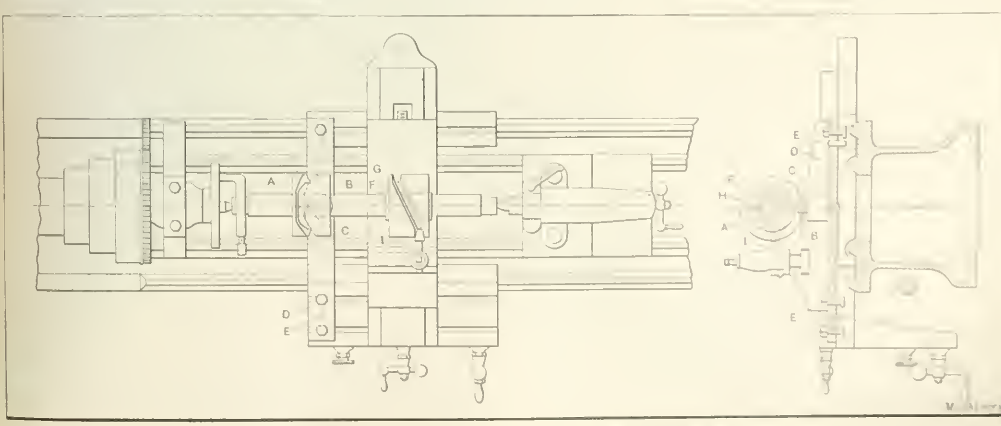


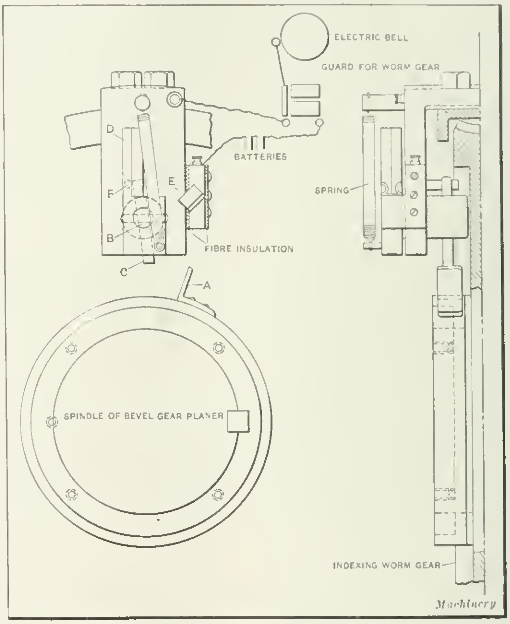
Fig. 6. Engine Lathe equipped with Fixture for machining Barrel Cams

power press. He had the belt off, but had brought the gate of the press one-quarter of the way down. While placing the punch in position, which he tried to do by holding the punch in his left hand (something every diemaker has done), the gate suddenly descended of its own accord, due to a loose friction. The result was a badly squeezed hand which required several weeks of rest and treatment. If the press had been larger, the accident would have been more serious. It hardly seems necessary to say that our diemakers now see to it that the gate of the press is up before fastening the punch in position.

SAFETY FIRST

ELECTRIC ALARM FOR BEVEL GEAR GENERATOR

In the operation of a Gleason bevel gear generator, it is necessary for the attendant to stop the machine after the last tooth has been completed; and if he fails to do so the tools will start taking a light cut over the finished teeth, making them under size. When one operator is running four or five machines, it is difficult for him to always be on hand at exactly the time when each machine has finished cutting its gear, and to avoid having the machine run over, the operator is likely to wait for the last five or six teeth to be cut rather than run the risk of spoiling the work. To avoid the trouble which we had experienced from this source, the writer designed an electric alarm system, which is shown in the accompanying illustration, and applied an outfit of this kind to each of the bevel gear generators, with the result that the only objection which we had to an otherwise excellent machine has been overcome. Not only does the alarm prevent spoiling any of the work, but it also increases production, as the time spent by the operator in waiting for the machine to finish the job is cut down to a minimum.



Electric Alarm for Gleason Bevel Gear Generator, which notifies Operator that Gear is finished

By referring to the accompanying illustration, it will be seen that two concentric rings are mounted at the rear end of the spindle behind the indexing worm-wheel. The inner ring is fastened to the spindle by means of a key and set-screw, and this ring carries four set-screws for holding the outer ring in any desired position relative to the spindle. The outer ring carries an adjustable trip-block A, the position of which can be adjusted with respect to the spindle; and when the correct adjustment has been obtained for a given set-up, the position of the trip-block need not be changed until a new set-up is made. A piece of ½ by 2-inch flat cold-rolled steel was bent to the form shown, and fastened to the worm-gear guard by means of cap-screws; and the contact mechanism was carried on this bracket. A shoulder pin B carries the trip-pin C which is located at the rear side of the bracket, and the shoulder pin passes through the bracket and carries the contact block D. The contact block is beveled as shown in the illustration, and when tripped will make contact with the copper spring contact E which is mounted at an angle on a piece of cold-rolled steel separated from the supporting bracket by fiber insulation. Electric wires run from the bracket and contact block to the batteries and electric alarm bell.

In the normal or "non-ringing" position, the upper end of the trip-pin C rests against a stop-pin F and is held in position by a spring. As the gear is indexed, the adjustable trip-block A rotates, and as soon as the work is finished the trip-block comes into contact with the trip-pin C and pushes it past the center point. When this happens the spring acts on the opposite side of the center line and snaps the contact block D down against the copper spring contact E. This closes the circuit and the bell rings until the operator raises the contact block to the normal position. The alarm is then ready to start ringing again after another gear has been completed.

Rockford, Ill. E. K. MORGAN

"WHAT'S THE MATTER WITH THE FOUNDRIES?"

We note the article written by Mr. Brophy in the October number of MACHINERY in which he criticises the foundries and wants to know what is the matter with them. May it not be possible that the fault lies with the users of the castings? Is it not a fact that in the large majority of cases the patterns are made without consulting the foundry? The designer produces a machine; then we hunt for some way to core the patterns with the least trouble to ourselves and the foundry. To illustrate, a shaper table may have an opening in one side only. The natural position for the core to rest in would be the bottom of the drag, but this brings the dirt in the mold if there is any, next to a finished surface of the casting. If the core were hung on the side of the mold by means of an arbor the finished portion of the casting could be placed in the drag. Similar instances of this sort are usually brought to our attention by the foundries after the patterns are made, and sometimes they are acted upon but usually not. We always condemn the foundries first because that is the easiest place to lay the blame.

Would it not be better to pay a little more for our castings to enable the foundries to rig up properly to make them? Is it not a fact that we spend much time and money in laying out and carrying through each operation of building our machines? When it comes to the foundry we expect it to do what we admit is a very difficult job, with a stick, a string and a rag. What foundry has been successful that has attempted to employ all the modern means in competition with the lower grade foundries? The lower grade foundry simply passes the responsibility and the expense of its operations along to the casting users.

Do the casting users in their dealings with the foundries see to it that the foundry has chemists, laboratories, means for drying all molds, several cupolas, inspectors and the proper material before closing a contract? Would the casting users pay the price? The usual question is, at how low a price per pound can we get the castings. If the price given is not as low as others quote, then the patterns are transferred to another foundry quoting a lower price—where new flasks have to be made and the work has to be experimented with before proper results are obtained. The flasks and rig-

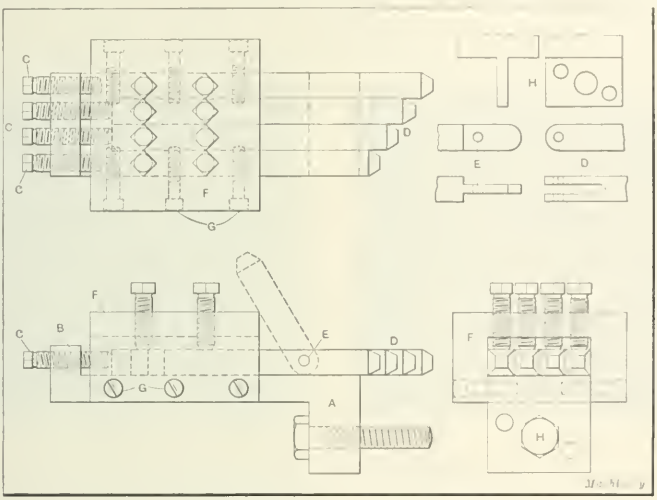
ging are made as cheap as possible because it is not known how long the job is going to stay, and the risk of preparing for it properly cannot be taken. (We have been getting castings from the same foundry for eleven years.) Those concerns operating their own foundries cannot show a heavier operating expense than those of the outside foundries, because the casting user will not give the foundry credit for the better product.

The fault with the foundries seems to lie with the casting users, as they are satisfied to accept castings and take chances that they will be all right, or if bad that the expense of correcting them will not be as much as the additional price that must be paid if all the improvements of modern foundries are used. N. B. Chace, Supt.,

Cincinnati, Ohio. Cincinnati Shaper Co.

MULTIPLE THREAD CHASING FIXTURE

The lathe fixture which is illustrated and described herewith was originally designed for use in chasing the quadruple threads of brass worms, but like many other tools of a similar nature its original purpose has been lost sight of. At the present time it is being used for a variety of multiple thread chasing operations, and is giving very satisfactory results. In the design of this attachment there were two primary requirements to be fulfilled. First, to relieve the mechanic of the tedious and sometimes perplexing task of advancing the carriage for taking a fresh cut by disconnecting the gears; second to overcome the difficulty sometimes experienced where a piece of work is left unfinished for the night and the operator forgets how far he had progressed toward the completion of his work.



Lathe Fixture for Use in chasing Quadruple Threads

This fixture is not intended to be used as a standard equipment for each lathe; the purpose is to have it on hand in the tool-room so that it can be adjusted by one of the tool-makers and checked out, leaving the lathe-hand nothing to do but attach it to the carriage of his machine. In some shops, and especially in shops handling experimental work, the provision of two of these fixtures—one for small and one for large sized standard lathes—would satisfy all the requirements that are likely to be met. It will be well to have several lathes of each size provided with holes which are tapped and reamed to receive the fastening screw and taper dowel pins, as there will then be no trouble in finding a machine for use in handling a rush order.

The body *A* of the fixture is made of cast iron and the anchoring lug and lug *B* for the adjusting screws *C* are made in a single piece, the length of which is such that when the fixture is set up ready for use the shortest of the stop-pins *D* will be nearly flush with the square end of the body of the fixture. It will be seen that the stop-pins *D* are pivoted at *E* so that they may be swung up out of the way. The housing *F* is also made of cast iron and fastened to the body *A* by six fillister-head screws *G*. The adjustable stop-pins *D* are made of machine steel and beveled on the contact ends, while the adjusting screws *C* should be of fine pitch to facilitate making very fine settings of the stop-pins.

In laying out the holes in the fixture and in the cross-slide of the carriage, the opposed templet *H* was found useful; one face of this templet was marked "carriage" and the other face was marked "fixture". The fixture should be attached to the lathe so that the contact pins *D* clear the top of the cross-slide to enable the compound rest to be swung through an angle of 90 degrees. After the chasing tool has been set in position for taking the cut, the slide is brought up to the first stop *D*—using a tissue paper feeler to prevent jamming—and one of the threads is cut. The stop which locates for this thread is now raised, as shown by the dotted lines, and the slide is brought up to engage the second stop for cutting the second thread. This process is repeated until all the threads have been cut. The cost of this fixture is slight when its value is taken into consideration, and it will be found a great saver of trouble when cutting multiple threads.

Stillwater, Minn. R. C. MacLachlan

FLASHBACK IN THE WELDING TORCH

I read with much interest the article on "Flashback in the Welding Torch" by M. K. Dunham in the September number of Machinery. It would have been interesting if Mr. Dunham had given the difference in principle of the two welding torches used on the two large gears, and shown the principle used in a correctly designed torch.

While the writer has not experimented with very many torches, he has never seen one that on heavy hot work will not flash back if the temperature of the head and tip is allowed to become high enough. This is most likely to occur in deep welds where it is difficult, if not impossible, for the welding flame to get away from the head and tip, thus heating it more rapidly than when the same weld becomes shallower. Upon cooling the head and tip, flashing back will not occur until they again become heated to a high temperature, and I question if it is possible to avoid flashing back under such conditions. The use of water-cooled torches for such work is common and these torches do not flash back, although they may back-fire due to the end of the tip touching something and thereby momentarily reducing the velocity of the gases as explained by Mr. Dunham. This, however, is not caused by the design of the torch, as is very clearly explained in Mr. Dunham's article.

The only serious trouble that the writer has ever experienced with flashing back is, as explained above, in the case of heavy deep welds. The same torch with the same tip and the same operator will not flash back in welds of lighter section. Therefore the cause for such flashbacks must lie in the overheating of the head and tip, and would appear to be due to the burning of the acetylene inside the tip, caused by the excessive heat. In other words, the acetylene is ignited before it gets to the tip. There is no question about the expense or danger and annoyance caused by flashing back. Mr. Dunham has covered these points very clearly and forcibly.

I also want to add my word of accordance with Mr. Dunham in his stand against the too common practice of manufacturing and selling oxy-acetylene welding apparatus that is unec

onomical, wrong in theory and unsatisfactory in practice. Anyone who really has the interests of the oxy-acetylene welding industry at heart will condemn such practices.

There are, however, one or two points in his article that I do not understand. The statement is made that an injector torch should not be used with dissolved acetylene for the reason that it does not take advantage of the available pressure to avoid flashbacks, while it is exactly what is required for a low-pressure generator. It is also stated that for the same reason the medium-pressure torch should not be used with dissolved acetylene. It does not appear to me that the reasons assigned are sufficient to make the use of either of these torches with dissolved acetylene undesirable. The regulating valves provided for use on tanks containing acetylene under pressure will furnish the required low pressure and medium pressure, respectively, if used on the two types of torches mentioned, and if a torch of any design is economical at the pressure for which it is designed and is used at that pressure, I fail to see what the storage pressure of the acetylene has to do with the operation of the torch. The whole question of torch economy and performance is one that is in great need of scientific investigation. The most economical type of torch has probably not yet been developed. At any rate, the writer does not believe that anything whatever is accurately known as to the pressure conditions under which any torch operates. The pressure on the gage as ordinarily used is no criterion of that in the torch. The heating of the head in heavy welding, the unavoidable commercial variation in the sizes of the passages in the torch and tip, the irregularities in different gages and regulating valves, and many other things, all combine to cause serious discrepancies in the performance of torches.

The writer believes that there is no accurate information in regard to the relative proportions of oxygen and acetylene in any torch, on account of the difficulty of measuring the quantities of gas consumed, particularly in the case of acetylene. It is admitted without argument that the best torch manufacturers have succeeded in producing apparatus which gives remarkably good results, but it has been done largely by cut-and-try methods, which, of course, directed by intelligence and skill, will continually produce better results. However, the writer believes that the time is nearly here, if indeed it has not already arrived, when something more is necessary, and he feels that investigations must now be made with the most accurate apparatus available and under the most stringent conditions, so that having as nearly as possible absolute knowledge of the facts, the effect of any variation from the correct principle and practice may be determined. This involves the control of conditions so that any number of tests can be made and results duplicated within the limits of errors of observation. This in itself is no mean task. As just one illustration, it has never been determined, to the writer's knowledge, what a neutral flame is, although it is talked about familiarly and frequently as if it were something very readily obtained. There are reasons, however, for questioning if it is possible to produce a neutral flame, or at least to determine the neutrality by the eye alone. According to the writer's estimate, there are twelve vitally important things which will have to be investigated, in addition to many more minor conditions. It will be readily seen that the subject is one of vast extent and one which will require the best efforts of those interested in the matter for a long period of time.

In conclusion, these statements are not made with the view of discouraging experimenting, but to show the importance and necessity of using only the best available apparatus, which is that manufactured by concerns who have the greatest knowledge of the facts, the best facilities for testing and who are the soundest financially.

Rochester, N. Y. S. W. MILLER

SAFETY DEVICE FOR HANDLING WORK ON THE CIRCULAR SAW

Fig. 1 illustrates a common cause of serious accidents in the patternshop. It will be noticed that the operator has placed a straight piece of wood *A* between the work and the saw guide to get the correct distance in making cuts for lap. The distance piece *A*, having nothing to hold it, slipped back in moving the work across the saw, causing the bracket to fly out and bind on the saw. This resulted in the saw's kicking back, knocking the operator's hand down onto the revolving teeth, and cutting his fingers. The man was fortunate not to lose his fingers entirely. At *B* in Fig. 1 is shown a piece that was made to prevent the recurrence of such an accident. In Fig. 2 this piece is shown in use at *C*. It will be noted that it is made with an enlarged end which fits around the corner of the bracket and does away with the possibility of slipping. It takes only a few minutes to make this piece and the operation is made much safer by its use. In this case, it was impossible to use the regular metal guard provided.

Fig. 1. Dangerous Method of spacing Saw Cuts with Circular Saws

Fig. 2. Gaging Strip that eliminates Danger of Work slipping

Kenmore, N. Y. GEORGE B. MORRIS

MEETING THE EMPLOYE HALF WAY—A CHALMERS PRINCIPLE

One of the most important lessons now being mastered by the captains of modern industry is the necessity for conserving health and contentment among employes. An intricate machine will not work efficiently without intelligent care. A trained worker is the most valuable asset of the manufacturer. Forgetting the humanitarian side entirely, he cannot afford, economically, to permit his employe to work amid surroundings detrimental to mind and body. The most significant index to this fact is the stringent legislation against long working hours. "Safety First" is a slogan that has brought widespread reforms in factory precautionary equipment in the past two years. Those companies which have recognized the importance and need for the awakening have progressed rapidly. Now they are being heralded, not only as philanthropists, but as far-sighted business captains as well.

An inviting factory site is just as important as a roomy and hygienic interior. If the workman trudges up a dirty cinder path every morning, entering forbidding prisonlike walls that shut him off from the out-of-doors, his mind is likely to be hostile from the beginning of his day's work. If, on the other hand, everything is done to make his surroundings attractive, his attitude toward his employer will be more kindly. When plans were made for the erection of the Chalmers plant, Hugh Chalmers selected a spot far away from the factory centers of Detroit. At that time the grounds of his choice were almost in the country. Thirty-two acres of ground were plotted out and work begun. The buildings, which are a combination of the unit and group types, are of reinforced concrete and are distributed so as to afford the maximum of light and air. The four main buildings are each four stories high.

Sanitary drinking fountains are conveniently located throughout the works and offices. The water is cooled at some points by earth coolers, thirty feet deep, and at others by ice-cooled coils. In the departments where men are exposed to great heat, as in the heat-treating department and the power house, shower baths are provided. A large and well equipped "serveself" restaurant is maintained in a building especially erected on the Chalmers grounds. At a minimum cost the employes can get good wholesome food. Eighteen or twenty cents will buy a hearty meal for a hungry laborer. A modernly equipped hospital with a graduate surgeon in constant attendance is maintained on the grounds. In the case of injury to any employe, the patient is at once taken to the doctor's office and such first-aid administered as is necessary. A factory ambulance is ready to take any one seriously injured to a hospital.

Before any employe is hired he is given a thorough physical examination. If he is afflicted with any contagious disease that would be a menace to other employes he is not admitted. If, however, he is found to be suffering from a slight affliction that does not destroy his capability for work he will be given the employment that he can do best under his handicap. For instance, if a man's eyesight is subnormal he will be assigned to tasks where eye-strain will be least likely to develop. If weak lungs show under the physician's examination, out-of-door work will fall to his lot.

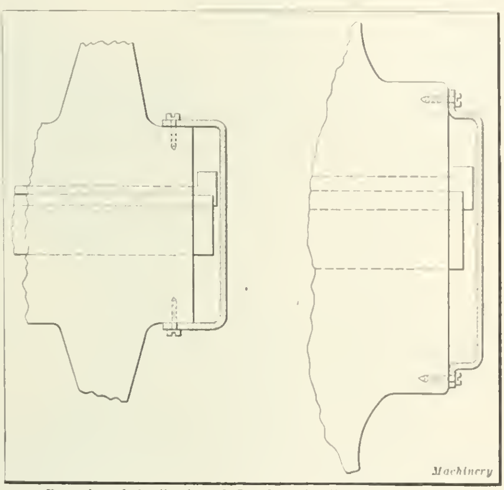
Special attention is paid to the question of accident prevention. Inspectors are maintained whose business it is to see that every dangerous machine is effectually guarded. An educational safety campaign is constantly being carried on among the employes by means of a series of bulletins, suggestions and instructions posted on "Safety First" bulletin boards.

One of the most inviting features of the Chalmers plant is the landscape gardening. Spacious lawns, bordered with shrubbery and flowering plants are tastefully laid out. Instead of the cinder heap and the slag pile, green grass and stately maples meet the eye. A regulation tennis court and a ball diamond have been provided for the noon hour entertainment of the employes.

Detroit, Mich. Owen B. Winters

GUARDING THE HEADS OF GIB KEYS

Gib keys of the kind commonly used in the flywheels of blanking presses and other machines where the shaft runs continuously, are likely to cause accidents when the machines are located near passageways, by the head of the key catching the clothing of someone passing by. The accompanying illustration shows a simple form of guard which is in quite general use for eliminating this hazard in machine shops. It consists of a metal shell fastened to the hub of the flywheel, and the illustration makes the idea quite clear without requiring further description. Two methods of fastening the shell to hubs of different sizes are shown. The advantages of this guard are simplicity and low cost combined with absolute protection. Safety First



Examples of Application of Guard on Small and Large Hubs

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ELECTRICALLY-PROPELLED BATTLESHIP "CALIFORNIA"

The keel of the dreadnaught *California*, the first electrically-propelled battleship, was laid in Brooklyn Navy Yard, October 14. The new addition to the navy will have a length of 624 feet; width, 97 feet, $4\frac{1}{2}$ inches; draft, 30 feet; displacement, 32,000 tons; speed, 21 knots and an armament of twelve 14-inch guns in four turrets, a secondary battery of twenty-two 5-inch rapid-fire guns and four submerged tubes capable of firing the largest types of torpedoes. The cost of the vessel complete will be about $15,000,000. The *California's* electrical drive is the result of experience gained by the U. S. Navy with the collier *Jupiter*, a vessel of 20,000 tons displacement. The especial advantage of the electrical drive is that the steam turbines may be run at high speed while the propellers are run at a slower speed best suited to their diameter and pitch. The drawback to all direct-connected turbine drives is that the steam turbines must either be run at an inefficient speed to accommodate the propellers or they must be made of enormous size. The designer compromises between the two extremes with the result that neither the steam turbines nor the propellers are worked at their best efficiency. Mechanical reduction gears or electrical motor drives are expedients designed to eliminate the loss of efficiency by making possible the operation of the turbines and the propellers at their most efficient speeds.

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NEW YORK ELECTRICAL EXPOSITION

A feature of the New York electrical exposition, held in the Grand Central Palace, from October 6 to 16 inclusive, was the daily demonstrations of the transcontinental telephone by the American Telephone & Telegraph Co. Telephonic conversation was carried on giving the news of the day and happenings at the Panama-Pacific Exposition. Other features that made the demonstration of striking interest were the transmission of music and the roar of the Pacific surf.

The exhibit as a whole demonstrated some of the many uses to which electricity is being put in the home and factory. The progress in electrical lighting was strikingly [illegible] by comparison of the modern lamps with the early carbon lamps. An exhibit made by the U. S. Government included the first Blanchard gun-stock turning lathe built in [illegible] and a modern gun-stock turning lathe embodying the [illegible] principles. A gun barrel rifling machine was also shown.

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German silver that is to be used for machined castings should contain from [illegible] to 2 per cent lead, as this makes it easier to machine. The lead content increases the whiteness of the alloy.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PRODUCING CHEAP BRASS AND COPPER STAMPINGS

D. L. A.—As manufacturers of medals, name-plates, etc., we are trying to find a metal suitable for making impressions, to be used with embossing dies in producing cheap metal stampings of brass and copper in about 20 to 24 gage metal. We have been using steel forces for doing this work, but find it expensive. We have heard that there is a metal especially employed for this purpose abroad. This metal, we understand, is similar to bronze and is first struck up into the dies and repeatedly struck until it cools, as there is practically no shrinkage, and the metal is nearly as hard as hardened steel. Any information relating to this metal, or to any other method for doing the work in a less expensive way, will be appreciated.

This question is submitted to our readers for comment.

PROPER SURFACE FOR HARDENING

W. S. R.—A subject that has been of interest to the writer and some of his toolmaking friends is: What is the proper surface to give steel tools that are to be hardened and ground? A difference of opinion exists as to the relative merits of a smooth surface almost polished and a surface left by a lathe or shaper tool when it is said to be cutting smoothly. If the smoother surface is not of any advantage it should not be produced, as it represents wasted time. Some toolmakers claim that a polished surface is a positive disadvantage in securing uniform hardening.

A.—The general impression seems to be that tools harden best when the surface is true but not smooth. A polished condition is disadvantageous, as steam bubbles collect in larger masses and tend to produce uneven hardening. The experiences of readers in regard to the best condition of steel for hardening are solicited.

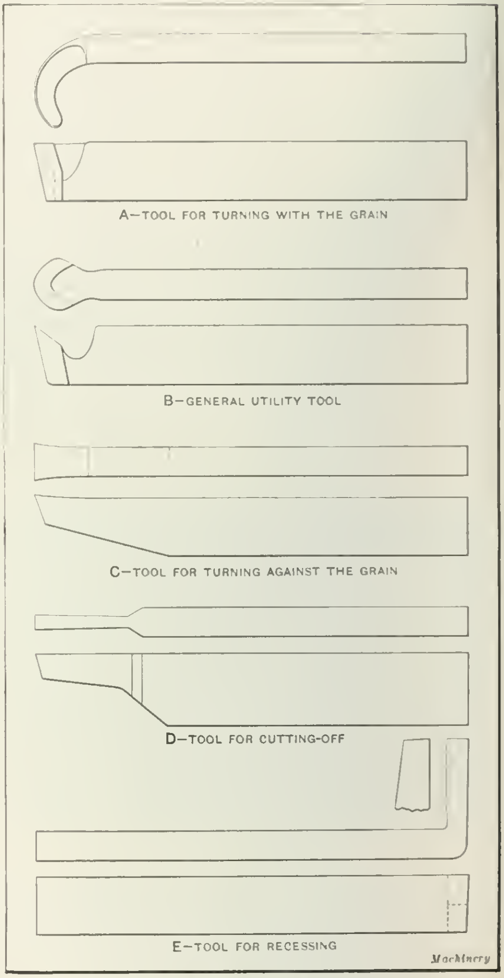
DEEP-HOLE DRILLING

H. A. D.—Will you explain why a more accurate hole can be drilled in a gun barrel by rotating the barrel than by rotating the drill? Why will not the drill produce as straight a hole when rotated as when held stationary and the work rotated?

A.—The basic principle of deep-hole drilling is that of developing an axis of rotation in the part to be drilled and making the drill follow this axis. When a gun barrel is drilled it is held firmly in a chuck at one end and in a bushing at the other. Thus an axis of rotation is developed which is a geometrically straight line connecting the two supports and coinciding with the center line of the barrel. The drill is started at one end of this axis, and as it is forced through the barrel it tends to follow the axial line, as that is the course of least resistance and the direction in which it is guided; any deviation from the axial course deflects the drill and thus causes it to meet with more resistance. If the drill were rotated while the work stood still no axis of rotation would be developed in the larger and stiffer work-piece, and while the drill would in a general way tend to cut a hole in line with its axis, the hole would not be straight because of insufficient support for the drill and the difficulty of starting it dead in line with the axis of the work-spindle and work-piece. Any deviation no matter how slight would deflect the drill axis from the axis of the hole that should be drilled and as the drilling proceeded the deflection would tend to become greater and greater. The result in drilling a hole thirty inches or more in length is that it would surely vary considerably from the true axis of the barrel and besides be crooked. Rotating the work develops a geometrically straight path which the drill tends to follow, whereas rotating the drill and letting the work stand stationary develops no path and hence has no guiding tendency.

TOOLS FOR TURNING WOOD

E. B. E.—We wish to get some information on tools for wood turning. We are not conducting a wood-working shop, but occasionally have to turn up a piece for a base for apparatus and at times have a little cylindrical pattern work to do. We are especially desirous of learning what are the ordinary shapes used for turning wood both with and against the grain.



Shapes of Wood-turning Tools

A.—Your question can best be answered by illustrating somes of the types of wood-turning tools most commonly used. The tool illustrated at *A* is hook-shaped with the cutting edge sharply relieved for the entire distance of the sweep or curve. This tool is used principally for rough-turning parallel with the grain, and can be fed in either direction. Another general utility tool is illustrated at *B*, and this is used either with or against the grain, and from its shape it will be seen that it can be fed in either direction. The tool illustrated at *C* is used for turning against the grain and can be used in either direction and also as a facing tool. The tool shown at *D* is a typical cutting-off tool. This is relieved for about half its depth on the under side as no particular strength is required. The last tool, that illustrated at *E*, is for recessing in the face of a block or for cutting grooves or other work that is held on the chuck or faceplate. These shapes, of course, are for tools held in a toolpost and not for revolving cutters of the Blanchard lathe type.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THOMSON THREAD MILLING MACHINES FOR SHELLS AND RIFLE BARRELS

These machines are special thread milling machines of the "single-purpose" type. One is of the duplex design for threading high-explosive and shrapnel shells, and under average conditions will thread about 50 shells per hour. The other is for threading rifle barrels and receivers. Both are semi-automatic, the disengagement of the spindle-feeding movement and lowering of the cutter from the working position at the completion of the threading operation being controlled by positive and accurate trip mechanisms.

When high-explosive shells are made from bar stock a disk-shaped plug, commonly known as a "gas plug," is screwed into a recess in the base of the shell to prevent the possibility of premature explosion due to any minute seam which might exist in the center of the stock. The thread must extend to the bottom of the recess so that the plug can be screwed in against it. A special machine designed for threading shell bases and also the "nose" or open-end is illustrated in Figs. 1 and 2. This machine is manufactured by A. Morris Thomson, Harrison, N. J., and has been placed on the market by the Walter H. Foster Co., 50 Church St., New York City. As will be seen, it is of the duplex type, there being two independent heads so that one man can readily attend to what is practically two machines. The general arrangement of one of these heads is indicated by the sectional diagram Fig. 3.

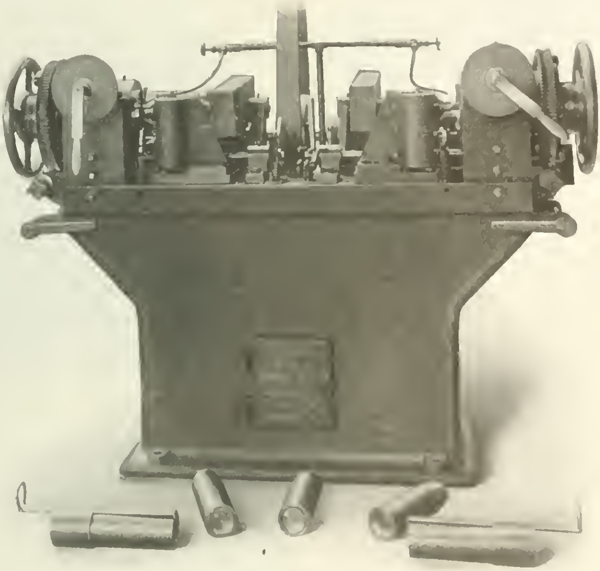


Fig. 1. Thomson Semi-automatic Thread Milling Machine for threading Shells

The shell itself is held inside collet *A* which is opened or closed by operating handwheel *B*. The collet is located inside of hollow spindle *C* which is splined to a driving worm-wheel *D* so that it is rotated by the worm-wheel but is free to move axially. The worm *E* that drives the worm-wheel is connected through bevel gears with a shaft at the rear of the machine, which may be driven by a belt from an overhead shaft or motor belted direct. This rear shaft and the arrangement of the gearing for driving both the work-spindles and the cutter-spindles, is shown in Fig. 2. The cutter-spindles are driven by silent chains and they can be stopped independently by means of clutches on the belt pulley shaft, which are engaged by levers seen in Fig. 1 at the right and left.

When the machine is in operation the spindle *C* moves longitudinally as soon as the segment nut *F* comes into engagement with it. This vertical movement of the nut is effected by means of an eccentric on shaft *G*; the latter extends to a point near the center of the machine and has a lever attached to its end as shown in Fig. 1. At *H* there is another eccentric which moves the cutter-slide and cutter up to the working position at the same time that nut *F* is engaged with the spindle. When the shell is to be threaded, it is inserted through the collet and up against positive stops at the end of the spindle. After being clamped in position in the collet chuck, the spindle *C* is moved forward toward the cutter until the bottom of the recess in the shell comes against a fixed stop attached to the cutter-slide. The end of this stop is practically in line with the end of the cutter, there being just enough difference in the positions to prevent the cutter from marking the bottom surface of the recess to be threaded. This longitudinal movement of the spindle is effected by means of a lever which is located in front of a large graduated dial as shown in Fig. 1. The shaft upon which this lever is mounted carries a small pinion at *J* which meshes with the thread of the spindle, thus moving the latter axially.

When the shell has been placed against the stop previously referred to, it is in position for milling; the cutter, which operates on the upper side of the hole, is next moved up into the working position by rotating shaft *G*, as previously mentioned, and nut *F* engages the spindle simultaneously. The spindle now moves to the left at a rate dependent upon the pitch of the thread engaging nut *F*, which corresponds with that of the thread being milled. Thus it will be seen that the cutter begins at the inner end of the hole, and as the work moves to the left the thread is milled. The graduated dials in front of each head enable the operator to engage the spindle nuts at a time when they will mesh properly with the spindle threads.

This machine is equipped with multi-threaded cutters or those having several rows of annular teeth. These cutters are $1\frac{1}{4}$ inch in diameter, whereas the recesses in the shells are $2\frac{3}{4}$ inches in diameter, in the case of the 18-pound British shell for which this machine was designed. The cutters operate at a surface speed of 125 feet per minute and the shells make one revolution a minute. The thread, which is a Whitworth standard of 14 pitch, is completed in $1\frac{1}{4}$ revolution of the work-spindle. As soon as the thread is finished an automatic tripping mechanism serves to drop the cutter-spindle and also the nut which engages the work-spindle. Each cutter-spindle is carried by a supplementary slide so that it can be adjusted vertically independently of the vertical movement obtained from eccentric *H*. This vertical adjustment is only needed when setting up the machine. The cutter is, of course, set to conform with the helix angle of the thread and it is fixed in the proper angular position, since this is a "single purpose" machine. Cutting lubricant is supplied to the cutters by means of a pump which is driven from the rear shaft as shown in Fig. 2. Some of the shell blanks are shown in the foreground of the illustra-

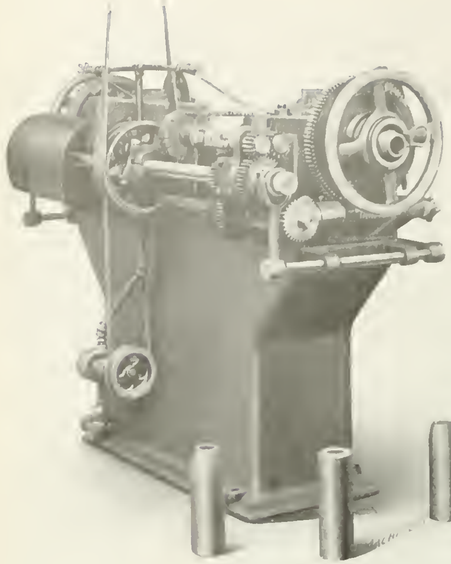


Fig. 2. View of Thread Milling Machine illustrating Driving Mechanism for Cutter- and Work-spindles

tions; two of those illustrated in Fig. 1 have attached to them flat hook-shaped handles which are used for withdrawing the threaded shells from the machine spindles. The actual threading time with this machine is approximately one minute, and the output from both heads varies from 40 to 60 shells per hour, the number naturally depending upon varying conditions.

Another interesting design of thread milling machines is illustrated in Fig. 4. This type is used for milling the threads on the ends of rifle barrels. With a slight rearrangement it is also adapted for the internal threading operation on rifle receivers. As those familiar with rifle construction know, both of these threading operations need to be done very accurately. This machine is simple in its construction and operates on somewhat the same principle as the one previously described. The barrel to be threaded is inserted through and clamped in a hollow spindle of the machine, in which it is located either by a positive stop or by means of a special gage, the exact method depending upon the type of rifle barrel to be threaded. The work-spindle is rotated by means of worm-gearing, the shaft on which the worm-wheel is mounted being driven directly by a belt. The axial feed movement of the work-spindle for milling the thread is obtained by engaging a nut with a thread of a corresponding pitch on the exterior of the spindle, the same as in the case of the shell thread-milling machine. The cutter-spindle is also driven by a silent chain from a shaft at the rear carrying a belt pulley.

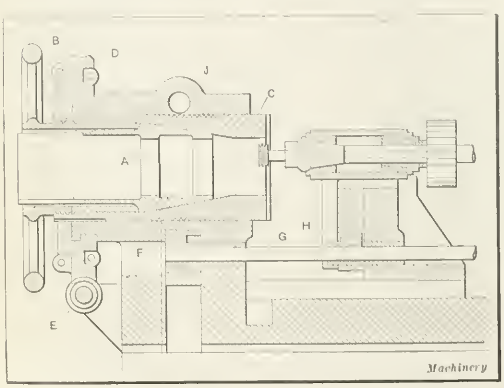


Fig. 3. Diagram illustrating General Arrangement of Cutter- and Work-spindles of Thread Milling Machine

One of the important features of this machine is the automatic tripping mechanism which is so arranged that it can be adjusted to stop the threading operation at a given point within very close limits of accuracy. In connection with this automatic trip, there is an arm mounted on the spindle just in front of the left-hand spindle bearing. This arm engages a second arm located on the shaft seen extending along the center of the bed. When this engagement occurs, the nut meshing with the threaded part of the work-spindle and also the cutter-spindle, drops down, thus stopping the threading operation instantly. The thread has a pitch of 1/16 inch and the arm of the spindle is so adjusted that it just misses the tripping arm of the shaft when beginning the last revolution; consequently, when this revolution is completed it engages the tripping arm, thus rotating the shaft and lowering the nut and cutter-spindle, as mentioned. As soon as the nut is disengaged from the spindle the latter is thrown to the left by the bellcrank and weight shown to the left of the machine, thus bringing the spindle into position for threading another barrel. When this machine is used for threading receivers, a special fixture is attached to the end of the spindle for accurately locating the receiver by means of certain surfaces which are previously machined for that purpose.

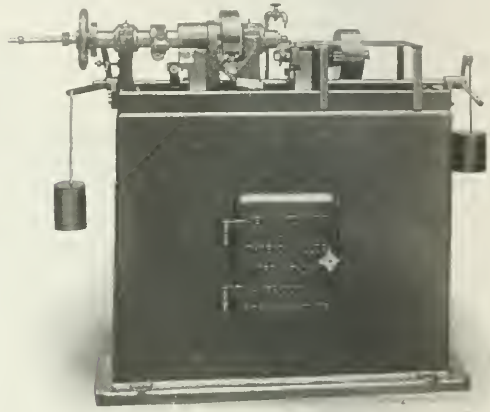


Fig. 4. Semi-automatic Machine for milling Threads on Ends of Rifle Barrels

NATIONAL-ACME STUD AND BOLT THREADING MACHINES

These machines have been developed for performing such operations as threading studs and bolts, and other second operation work on various screw machine products. In each case the illustrations show the entire machine and also a close view of the tools and means provided for feeding the work to the machine. It will be seen that the machines are of the single- and multiple-spindle types; and they are semi-automatic and automatic in operation. The machine shown in Figs. 7 and 8 is a combination tapping and threading machine. In addition, a special grinding machine is illustrated which has been developed by the National-Acme Mfg. Co. for use in sharpening the chasers of the threading dies.

For threading studs and bolts, and for second operation work on different screw machine parts, the National-Acme Mfg. Co., Cleveland, Ohio, has designed several interesting types of machines for bolt and stud threading. These are of the single- and multiple-spindle types, and are semi-automatic and automatic in their operation. Figs. 1 and 2 show one of these machines, having a capacity of from ¼- to ½-inch studs, inclusive, which is known as Size No. 1, Style TM stud threading machine. This is a high-speed automatic machine and is designed for the rapid threading of studs. The construction is comparatively simple, the machine being

driven by a single belt. The speeds of production are controlled by a system of change-gears, and the operating mechanism is controlled by cams mounted on drums, these operating the chuck opening, closing and extracting mechanisms, and also the die-heads for threading. Safety frictions are provided to prevent breakage of vital parts, and the control of the machine is through a single hand lever located at the front of the machine. A pump is provided for forcing cutting lubricants to the tools at work.

In operation, the pieces are dropped into a horizontal magazine, from which they are fed through the receiving tube by means of a push-rod. One of the special features of the machine is the method of feeding and extracting the work. It operates in the following manner: When the die is opened, the jaws holding the threaded piece recede, allowing the piece to drop out, and instantly a new piece is fed up to the stop. The stop is supported in the die spindle and is held stationary; it is adjusted from the rear of the spindle by a lock-nut. Inasmuch as the extracting and feeding operations are practically simultaneous, much of the idle time is saved that is generally required for forcing the piece in and out of the chuck, and oscillating the stop.

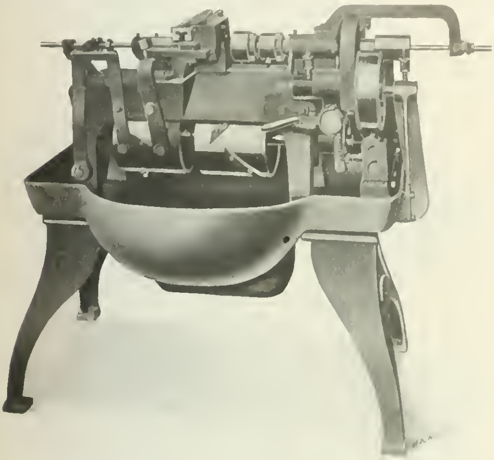


Fig. 1. National-Acme Size No. 1, Style TM Stud Threading Machine

The threading of the work is accomplished with a standard National-Acme self-opening die-head, the work being held stationary while the threading tool revolves. The tool is never forced on, but follows the lead of the thread until the die comes in contact with the stop that is set for the threading length, whereupon it is automatically tripped open and backed off without reversing. Upon the backward movement, the die chasers are closed. Table I gives the change-gears supplied with this machine, together with the possible production in ten hours secured by the different gears; and this production, of course, is worked out on the basis that the machine is operated continuously for the time specified. Table II gives a list of the back-gears that control the spindle speed for various diameters of work, the spindle speed being based on a cutting speed of 35 surface feet per minute. This machine works very efficiently and when fitted up with a National-Acme self-opening die makes possible a large production of accurate work.

National-Acme Automatic No. 2 Stud Threader

The automatic stud threader shown in Figs. 3 and 4 has a capacity for handling studs varying from 1/2 to 1 inch diameter, inclusive. This machine can be used for threading both ends of the stud, either from the blank form or for second operation work; and also other classes of work of the same general shape and size. The construction of this machine resembles very much the National-Acme automatic multiple-spindle screw machine. The power is supplied to the machine through a single belt and a change-gear mechanism to cam drums, one controlling the feeding operation of the machine and the other the advance of the slide carrying the opening die. The magazine, in this case, is of the vertical type.

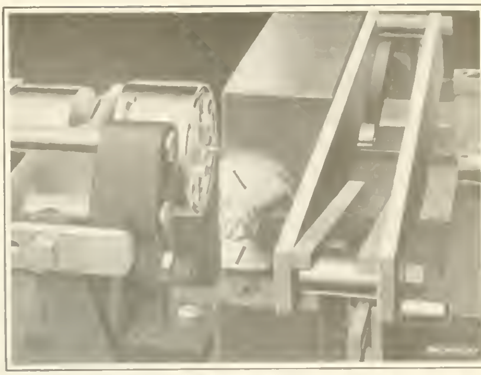


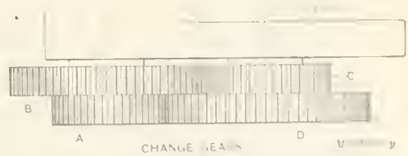
Fig. 2. Close View of Threading Die and Magazine Feed on Machine shown in Fig. 1

In operation, the stud blanks are placed in the magazine by the operator and pass from the bottom of the magazine, one at a time, into a receiving tube located at the back of the chuck, by means of a cam-controlled movement of the feed-in slide. From this tube, each blank is chucked in turn by a push-rod. In feeding in a new blank, the finished stud is automatically extracted as the die recedes; and since the spindle and chuck holding the work do not revolve, there is no tendency to clog or wind the blank in the spindle tube. Adjustment for various sizes of studs consist in expanding the guide walls of the magazine for the length of piece and substituting a chuck of the required capacity. The spindle tube is changed for extreme sizes only. The National-Acme self-opening die of the revolving type is used on this machine as well as the standard stock shaper.

National-Acme Two-spindle Bolt Threader

Figs. 5 and 6 show a special two-spindle machine designed by the National-Acme Mfg. Co., which is known as the No. 2 bolt threader. This machine has a capacity for threading bolts varying from 3/16 to 5/8 inch in diameter of V or

TABLE I. CHANGE-GEAR TABLE AND PRODUCTIVE CAPACITIES OF NATIONAL-ACME NO. 1 STUD THREADER



Gears on Worm Shaft		Gears on Stud		Number [illegible]
A	D	B	C	
59	29	29	59	[illegible]
53	29	[illegible]	59	[illegible] 400
50	29	[illegible]	59	[illegible]
47	29	41	59	[illegible]
41	29	44	59	[illegible]
41	44	32	29	18 500
47	35	32	44	17 [illegible]
53	41	[illegible]	47	16,500
41	32	35	44	15 400
53	44	44	[illegible]	14 900
35	29	53	59	12 800
35	32	50	53	11 100
29	29	41	44	9 550
29	35	47	41	6,900

Machinery

TABLE II. LIST OF BACK-GEARS AND DIE SPINDLE SPEEDS FOR VARIOUS DIAMETERS OF STUDS

Diameter of Work, Inches	Gear on Pulley Shaft	Speed in R. P. M.
1/4	71	535
5/16	59	440
3/8	47	350
7/16	41	305
1/2	35	265

Machinery

U. S. S., or S. A. E. thread up to 1 inch diameter. In addition to being capable of threading screw blanks, whether forged or turned to shape, this machine can also be used for threading bars of different lengths. The threading mechanism consists of two spindles for carrying the thread cutting dies, the spindles being driven through change-gears by a single belt. Located in line with the threading spindles are two slides upon which blocks are fastened for carrying the work to and from the dies. Lubricant is forced into the threading tools by means of a pump and the machine can be operated either in a right- or left-hand direction.

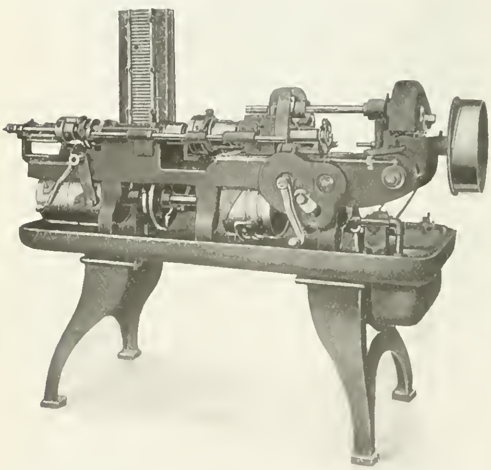


Fig. 3. National-Acme Size No. 2, Style TM Stud Threading Machine

In operation, the blanks are pushed into the holder by hand and held rigid for threading without locking, thus reducing the operating time. The slide is then fed forward by a hand lever shown, until the die begins to cut. The lever is then released and the work advances by the action of the lead of the thread itself. When National-Acme self-opening dies are used, it is not necessary to reverse the threading spindle. After the proper length of thread has been cut, the adjustable stop engages a fork fitted into the spool of the die and trips it automatically. The backward movement of the slide for extracting and reloading also closes the die. Holders

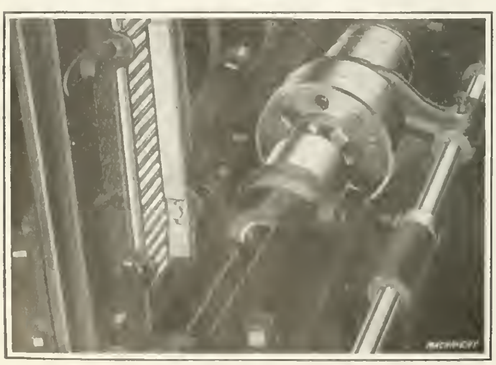


Fig. 4. Close View of Die and Magazine Feed on Machine shown in Fig. 3

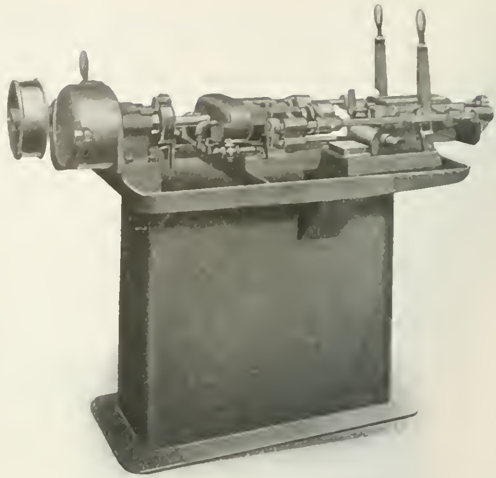


Fig. 5. National-Acme Two-spindle No. 2 Bolt Threader

with interchangeable grips for standard sizes of hexagon and square head screw blanks are furnished from stock. For special work, of course, it is necessary to make up grips that will hold the work satisfactorily. For bar threading, ways are cut in the blocks used and a stop operated from the rear holds the bar in place. Table IV gives the productive capacity of the bolt threaders shown in Figs. 5 and 7. It will be noticed that this table covers threads varying in diameter

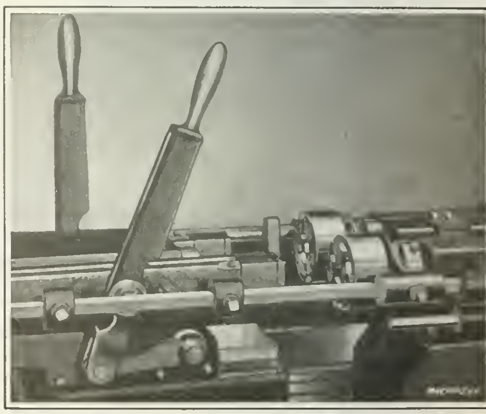


Fig. 6. Threading Dies and Feed Mechanism on Machine shown in Fig. 5

from 1/4 to 3/4 inch, and in pitch from 20 to 10 threads per inch. For finer threads than those given in the table, multiply the production by 4/3. The length of thread given here varies from 1/4 to 4 inches. The production figures, of course, are based on continuous operation of the machine and do not take into account stoppages for sharpening, setting, etc.

TABLE III. CHANGE-GEARS USED FOR VARIOUS DIAMETERS OF BOLTS AND DIE SPEEDS

Diameter of Bolt	Gear	R. P. M. of Die
1/4 x 20	24	450
5/16 x 18	29	370
3/8 x 16	35	310
7/16 x 14	41	265
1/2 x 13	47	230
9/16 x 12	53	205
5/8 x 11	59	185
3/4 x 10	71	150

Machinery

Table III gives the change-gears used for different sizes of threads, and the resulting revolution of the die secured by their use. These die speeds are based on a cutting speed of 30 surface feet per minute. For fine pitch threads, take the next highest gear in the table. For instance, for 5/16 by 25, gear 24 instead of 29 would be used.

TABLE IV. AVERAGE ESTIMATED PRODUCTION OBTAINED ON NO. 2 AND NO. 2A NATIONAL-ACME BOLT THREADERS

Diameter and Pitch of Thread	Length of Threaded Portion in Inches										
	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	3	4
	Average Production in Ten Hours										
1/4 x 20	15,000	14,500	14,000	13,500	12,500	11,500	10,500	9750	8500	6750	
5/16 x 18	......	14,000	13,500	13,000	12,000	11,000	10,000	9250	8000	6250	...
3/8 x 16	......	13,000	12,500	11,750	11,000	10,000	9,000	8250	7200	5500	...
7/16 x 14	......	......	12,000	11,250	10,750	9,500	8,750	8000	6750	5250	4250
1/2 x 13	......	......	11,500	11,000	10,250	9,500	8,500	7750	6250	4750	3750
9/16 x 12	......	......	......	11,000	10,000	9,250	8,500	7500	6000	4500	3500
5/8 x 11	......	......	......	10,800	9,750	9,000	8,000	7000	5500	4250	3250
3/4 x 10	......	......	......	......	9,500	8,500	7,500	6500	5000	4000	3000

Machinery

National-Acme Two-spindle Bolt Threader and Tapper

Figs. 7 and 8 show what is called the No. 2A tapper and threader. This machine has a capacity for threading V or U. S. S. threads from 3/16 to 5/8 inch in diameter, inclusive, and S. A. E. threads up to 1 inch diameter. For tapping, it

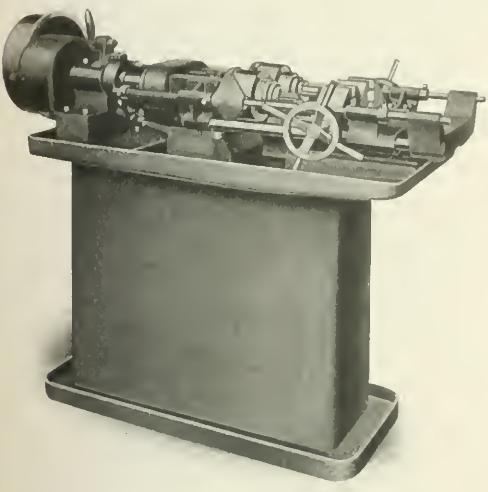


Fig. 7. National-Acme No. 2 A Bolt Threader and Tapping Machine

would handle V or U. S. S. threads, 15/32 to 5/8 inch diameter, inclusive, and S. A. E. threads up to 1¼ inch diameter. It is adapted, of course, for threading bolts and screw blanks, spring clips and bars of any length; also for tapping, in which case collapsible taps would be used. The general design of this machine is similar to the No. 2 bolt threader just described, except that the work-holders are of slightly different design. In place of blocks mounted on tool-slides and carrying standard or special work-holders, this machine is provided with two double-grip vises in which

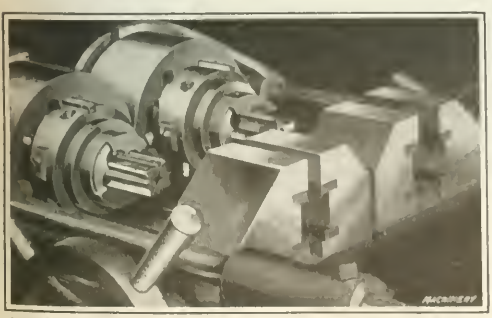


Fig. 8. Close View of Tools and Work-holding Fixtures on Machine shown in Fig. 7

special jaws are inserted for different shaped work.

In operation, the work is placed in the holding jaws and locked in alignment with the collapsible tap by means of the turnstile wheel which closes the vise jaws. The slide is then advanced by hand to engage the die or tap, after which the lead of the thread is depended upon for further movement, which insures an accurate pitch of thread on the work. The threading or tapping operation continues until a gage lever comes into contact with the adjustable stop, when the

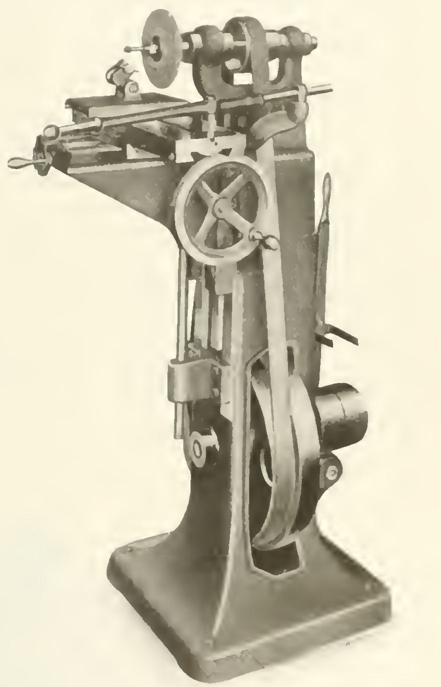


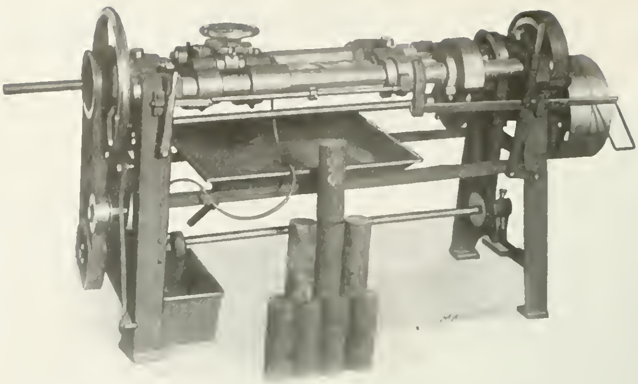
Fig. 9. Special Grinding Machine for sharpening Chasers of Threading Dies

die or tap is automatically tripped and freed from the work. The backward movement of the slide sets the die or tap ready for the next feed. Feeding and extracting are alternate operations, so that the production rate is dependent upon the operator's skill as well as the class of work. The dies used on this machine are the National-Acme self-opening dieheads, and the taps are those made by the Manufacturers Equipment Co.

A. R. WILLIAMS DRILL FOR HIGH-EXPLOSIVE SHELL BILLETS

The machine which is illustrated and described herewith is known as the Boyd heavy-duty horizontal drilling machine;

it has been developed for use in drilling the billets for 18-pound high-explosive shells and is sold by the A. R. Williams Machinery Co., Ltd., 64-66 Front St., W., Toronto, Canada. Reference to the illustration will make it evident that the machine is of simple design and rigidly constructed to stand up under the severe service for which it is intended. The billet to be drilled is held in a vise which is equipped with a quick-return mechanism to reduce non-productive time to a minimum. An automatic trip is provided on the side of the machine which disengages the feed when the billet has been drilled to the required depth. The trip can be set to disengage the feed at various points, and the rates of feed available are 0.012 and 0.016 inch per revolution. The power is transmitted to the spindle through a single set of reduction gears which provides a drive of high efficiency. Owing to the fact that the drill works in a horizontal position, the chips clear themselves quite readily and there is no tendency for the drill to bind in the hole. Approximately 5 horsepower is required to drive the machine, and its weight is 1200 pounds.



A. R. Williams Heavy-duty Drilling Machine for drilling 18-pound High-explosive Shell Billets

BESLY WIDE-FACE RING WHEEL GRINDER

This machine is of similar design to the Besly single-spindle lever-feed disk grinder, but in the present case one end of the spindle is equipped with a pressed steel chuck for holding a wide-faced vitrified ring wheel. This wheel has from 8 to 10 inches of grinding face so that work may be allowed to "float" in the same manner as on the disk wheel. This arrangement of the ring wheel is the means of greatly increasing production on those classes of work where it is necessary to remove scale and a considerable amount of excess stock. On former designs of Besly grinders equipped with a ring wheel chuck for rough grinding, the face of the wheel was comparatively narrow, making it necessary to clamp the work in place before starting the grinding operation.

Charles H. Besly & Co., 120B N. Clinton St., Chicago, Ill., have just placed on the market an improved flat surface grinder called the Besly wide-face ring wheel grinder. This machine is similar to the single-spindle, lever-feed Besly disk grinder except that for roughing off scale and excess stock one end of the spindle is equipped with a pressed steel chuck holding a wide-face vitrified ring wheel. This grinding wheel has 8 to 10 inches of grinding face, so that work may be allowed to "float" on its broad face while grinding in the same manner as on the usual steel disk wheels covered with cloth abrasive disks. These vitrified grinding wheels are more efficient and economical than cloth-back abrasive disks for heavy rough-grinding on scale; in fact, large rough work may be accomplished on the wide-face ring wheel grinder which cannot be done at all on the ordinary disk grinder.

Fig. 1. Besly Wide-face Ring Wheel Grinder

Besly grinders have heretofore been equipped with ring wheel chucks for rough-grinding, but with comparatively narrow-faced ring wheels which made it necessary to rigidly clamp any work that was to be ground. The advantage of the wide-face ring wheel, as compared with the ordinary narrow-face ring wheel, is that much work may be "floated" against the wide-face wheel as in disk grinding, and ground without clamping. This saves time in chucking. There is a further saving in the time of grinding because with the wide-face ring wheel more cutting points are in action, as it grinds all over the face of the work at once. The opposite end of the spindle is equipped with the usual steel disk wheel set up with cloth back abrasive disks for finish-grinding.

Construction of the Pressed Steel Chuck

The construction of the pressed steel chuck is clearly shown in Fig. 2. The chuck body is made of pressed steel, double riveted to a cast-iron center; and the construction of this center is such that the spindle bearing projects into the chuck, thereby minimizing overhang. The chuck body is drilled and tapped from the back to receive headless threaded plugs for balancing. The grinding wheel is held in the chuck by pressure over its periphery, this pressure being applied by means of a wrought steel tapered clamping ring passing around the grinding wheel. This ring is drawn into the tapered chuck body by means of clamp screws operated from the back of the chuck body. A suitable steel plate is provided to fit the center hole of the grinding wheel and guard the heads of the screws which hold the chuck on the grinder spindle; so there are no external projections. This makes the chuck especially safe. As the grinding wheel wears away, it may be set out in the chuck by means of the laminated wooden plate supplied with the chuck, which is shown in Fig. 2. The Besly wide-face ring wheel grinder is built in two sizes: one of these is a No. 17 machine carrying a vitrified grinding wheel 24 inches in diameter by 8 inches width of grinding face; the other is a No. 16 machine carrying a vitrified grinding wheel 30 inches in diameter by 10 inches width of grinding face. All ring wheels are 3 inches thick when new, and may be worn down to 1 inch in thickness.

Work Done by Grinder

This new grinder competes with planers, millers, and shapers; and examples of economical surfacing are shown in Figs. 3 and 4. Fig. 3 shows the grinding of pillow-blocks and caps; the 6 by 13 inch surface of these cast-iron pillow-blocks was formerly machined on a variable-speed, motor-

driven shaper, using high-speed steel tools to the limit of their capacity. In order to make this piece suitable for grinding instead of shaping, the pattern was changed. Very little stock was left for finish, and the surface was recessed in molding to facilitate grinding. By a little care on the part of the molder, these castings came to the grinder with a maximum of 1/16 inch of stock left for finish. The No. 17 Besly wide-face ring wheel grinder roughed and finished these surfaces to size and flat in less than two minutes. The former time on the shaper was about twenty minutes. Allowing for careless molding, necessitating the removal of 1/8 inch of stock, the No. 17 Besly grinder accomplishes the work in three minutes as against twenty minutes for the shaper. The time given covers all work, floor to floor, including the making of a surface plate test to determine the accuracy of the work. It will be noted that these heavy pillow blocks and caps are ground without rigid chucking, *i. e.*, the work "floats" against the grinding wheel both in the roughing and finishing operations.

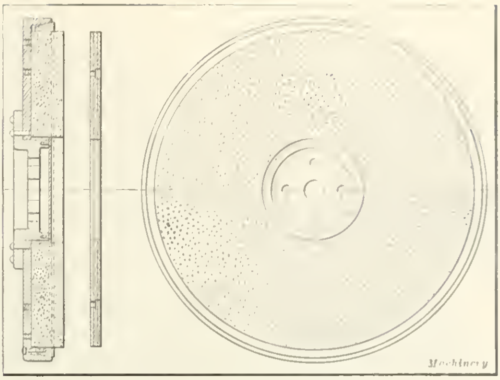


Fig. 2. Construction of Pressed Steel Chuck used on Besly Grinder

Fig. 4 shows the grinding of automobile gear shifter covers; these castings are of malleable iron and rather frail. As they are ground without rigid chucking, there is no chance to distort the casting as in cases where they must be rigidly clamped for milling. The grinder work-holder is very simple. The work rests loosely on three studs projecting from the face of the angle-plate, and the work is located and supported on this three-point bearing by means of four studs projecting from the angle-plate. The time on this job is 200 grinding operations per hour per operator, or 100 castings roughed and finished per hour per operator. As each machine accommodates two operators, the production per machine is double that mentioned, or 200 castings roughed and finished per hour.

Geared Lever-feed Table

The geared lever-feed work-table used on this Besly grinder gives the operator a leverage of 20 to 1, so that with a very slight pressure of the operator's hand, the work is forced against the grinding wheel with sufficient pressure to secure maximum grinding efficiency. The work-holders used on these machines are simple and inexpensive. The grinding wheels are also cheap as compared with the high-speed steel cutters required by other types of machine tools, and the tool-making and upkeep expense is practically nothing. The machines are operated by comparatively cheap and easily replaced labor. Fast production and extreme accuracy may be maintained. To secure the best results, it is necessary to use care in designing, patternmaking and molding, so that the work may come to the grinder with the minimum amount of stock left for finish, and large surfaces should be relieved to facilitate grinding.

Fig. 3. Grinding Pillow Blocks and Caps on Besly Wide-face Ring Wheel Grinder

BAUSH RIFLING MACHINE

One of the latest products of the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., is the rifling machine which is illustrated and described herewith. The driving pulley is located at the far side of the machine, and the power is transmitted through a positive clutch which provides for disengaging the drive. The remainder of the transmission consists of a pair of spur gears and a pair of elliptical gears, the arrangement being such that a practically uniform motion is provided for the rifling bar. The "twist" is obtained from an adjustable pattern bar, the shoe being fastened to the lower end of the rack. This rack drives an intermediate spindle which, in turn, drives the rifling spindle. Each of these spindles has a loose gear at the rear end, and there is a spiral spring, the ends of which are connected to the gears on the spindles, to provide for taking up back-lash in the gears and the rack and to hold the shoe down in firm contact with the pattern bar.

A brush is located at the end of the barrel to wipe the chips off the cutter just before it comes to the end of the stroke. The feed mechanism and the index mechanism are operated by a cam, through bellcranks connecting with rods at the back of the machine. The pump is driven by a sprocket chain on the crankshaft; and a rod at the front of the pattern bar provides for disengaging the clutch when it is required to stop the machine. An idea of the rate at which this machine operates may be gathered from the fact that a rifle barrel 32 inches in length, with four grooves 0.005 inch in depth and making one turn in a length of 7½ inches, has been completely rifled in about 18 minutes. The work was done with a "hook cutter," experience having shown that a

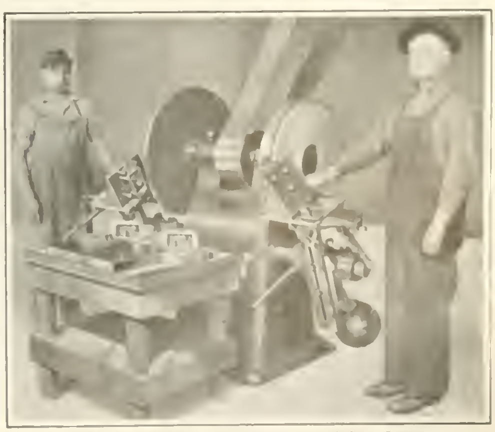
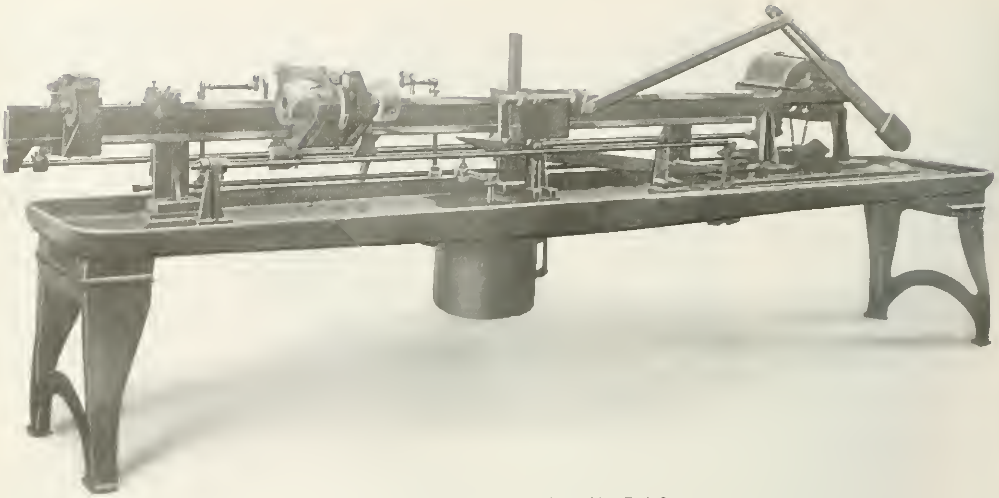


Fig. 4. Grinding Automobile Gear Shifter Covers



Rifling Machine made by the Baush Machine Tool Co.

"scrape" cutter did not work as rapidly or give as good results on the particular class of steel used for the rifle barrel referred to. A feature of this machine is that if the cutter jams, the belt is thrown off without damaging the tool. It was found that a mixture of kerosene and lard oil was the best cutting lubricant, this being far superior to clear lard oil.

DEANE HIGH-PRESSURE HYDRAULIC PUMP

A 250-gallon horizontal duplex hydraulic pump capable of developing a pressure of 3000 pounds per square inch, is shown in the accompanying illustration. This unit was recently built by the Deane Steam Pump Plant of the International Steam Pump Co., Holyoke, Mass., for use in connection with hydraulic drawing presses. All of the water-end parts which are subjected to internal pressure are made from solid steel billets, and all valves are separately accessible through individual hand-holes. The high-speed pinion-shaft bearings are of the multiple ring-oiler type, and the crankshaft bearings are of the quarter-box type with wedges provided on both sides so that the gear centers may be maintained. The crank disks are open-hearth steel castings and the pins are cast integral with the disks.

Both the inside and outside cross-heads are also steel castings, the inside cross-head being fitted with adjustable shoes running in a bored guide. To insure accessibility of the cross-head shoe adjustment, the shoes are adjustable from the front or connecting-rod end of the cross-head, instead of having this adjustment made from the rear or plunger end. It will be noticed that the girders underneath the pinion shaft bearings are cast integral with the pedestal hearings or frame, this construction being employed to obtain the maximum rigidity and permanent alignment of all parts.

KANE & ROACH STRAIGHTENING, SIZING AND REELING MACHINE

Kane & Roach, Syracuse, N. Y., have added to their line a machine for preparing the stock ready for use in nut machines. It provides for rolling the material down to correct size, straightening it both flatways and edgeways and recoiling it ready for use. Practically any shape and size of material can be handled by the machine, and the rolls are made of carbon tool steel and so designed that passes can be provided for three or four different sizes or shapes of stock on each set of rolls. The rolls have bearings at both ends which are massively constructed to prevent the probability of deflection, with the result that the stock is rolled down to within a limit of 0.001 inch of the required dimension. The stock is fed through the machine at from 50 to 60 feet per minute. The machine illustrated takes stock from 1/4 to 7/8 inch in width by 3/8 inch in thickness.

The stock comes to the machine in rough coils in the condition that the metal leaves the rolling mills, and runs between the guiding rolls into the sizing rolls; there are two sets of sizing rolls, the first of which reduces the material almost to the required size while the second set reduces it to size and produces the required finish. Between the two sets of sizing rolls there is a set of rolls which straighten the material edgeways, and after it has passed through the second set of sizing rolls it enters still another set of rolls which straighten it flatways before being wound on the reel. The reels used on the machine are 30 inches in diameter and have a width of 5½ inches between the forks; 1000 pounds of stock can be wound on each reel. Change-gears are provided on the machine for varying the speed of rotation and travel of the reel.

In winding up the material the reel travels up or down while it is revolving, so that the line of travel of the stock

High-pressure Hydraulic Pump built in the Deane Steam Pump Plant of the International Steam Pump Co.

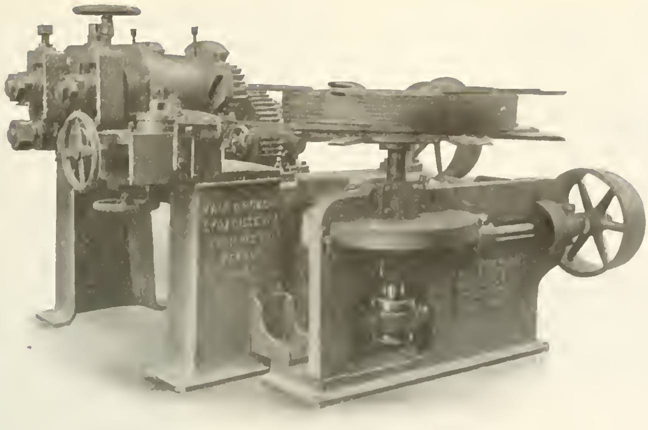


Fig. 1. Kane & Roach Straightening, Sizing and Reeling Machine

remains constant while it is being wound up, *i. e.*, the reel moves to the stock instead of having the stock move to the reel. The change-gear box provides for regulating the rate of travel of the reel according to the width of material which is being handled. It is stated that the material is wound on the reel with the same degree of perfection with which cotton or silk is wound up on a spool. The reel can be quickly lifted off the machine and placed on the spindle in front of the nut machine from which it is fed into the machine and made into nuts. The use of one of the Kane & Roach machines enables nut manufacturers to buy the stock in the form in which it comes from the rolling mills, *i. e.*, with considerable variation in size and with the stock quite crooked; they can then pass it through the straightening and sizing machine to put it in condition for feeding to the nut machine.

Experience has also shown that it is a great advantage to have a 3-degree bevel on the edges of the material, because in punching the nuts there is a tendency for them to swell at the bottom. By beveling the stock before it is fed to the nut machine, this difficulty is overcome, as suitable compensation has been made for this tendency to swell. In addition to sizing the stock and straightening it both flatways and edgeways, the Kane & Roach machine also provides for rolling the required 3-degree bevel on each edge. The weight of the machine is about 5 tons, and it is arranged for individual motor drive, the motor being geared direct to the machine.

AUTOMATIC ELECTRICAL TOOLS

The Automatic Electrical Tool Co., Western Ave. and Bank St., Cincinnati, Ohio, has recently been incorporated to engage in the manufacture of portable electrical tools. The outfit illustrated in Fig. 1 is one of the products of this firm, and is known as a combination lag screw drilling and driving machine; it was originally developed for the class of work indicated by its name, but other uses have since been found for the tool, the scope of which will be gathered by referring to the group of auxiliary tools shown in Fig. 1. A feature of the design is that the tool is equipped with a mechanically operated quick make-and-break switch which enables it to be used for practically any purpose without danger of overloading the motor and burning out the windings. This switch also acts as an automatic stop for the feed when a screw, tap, reamer or other tool has been driven to the required depth.

The tool is driven by a 1 horsepower series reversible motor which can be used on 110, 220 or 500 volt direct current; or a universal motor may be provided which is adaptable for use on either alternating or direct current. The reversible motor drive makes it possible to perform tapping or threading operations, or to use the tool for backing out screws; and the automatic switch disengages the feed at the required point. The tool has also found favor in the shipping rooms of machine tool building factories where it is employed for crating machinery. Still other applications are for use in facing the ends of bearing boxes after they have been assembled in a machine and for driving staybolts.

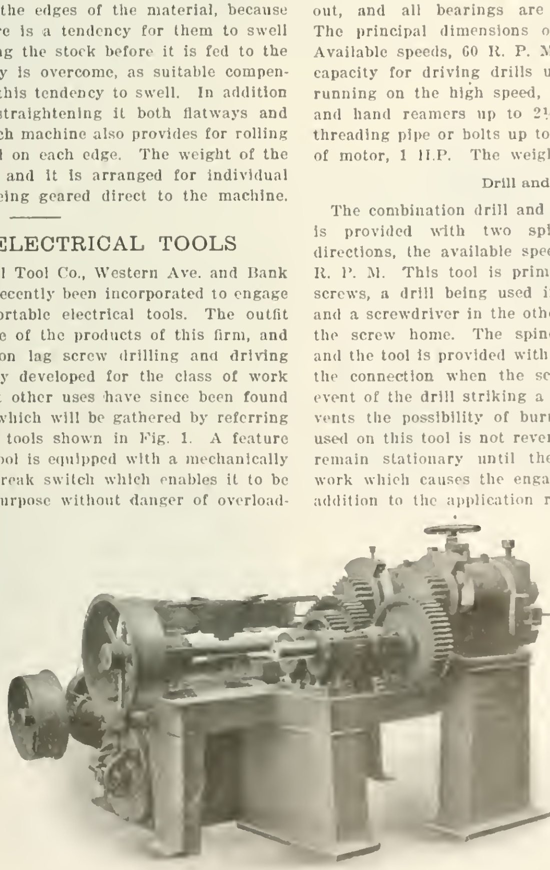


Fig. 2. Opposite Side of Kane & Roach Machine shown in Fig. 1

It will be seen that the spindle is located off center, which enables the tool to reach into corners; this design also eliminates the tendency for the tool to twist, and as a result it is easily held. The drill chuck is secured to the side handle and is advanced for drilling the required depth of hole; when the tool is used for driving lag screws the drill is drawn back to expose the square socket which receives the head of the screw or bolt. Hess-Bright or S. K. F. ball bearings are used throughout, and all bearings are enclosed in grease-tight cups. The principal dimensions of the machine are as follows: Available speeds, 60 R. P. M. and 400 R. P. M. under load; capacity for driving drills up to 3/4 inch in diameter when running on the high speed, taps up to 1 1/4 inch in diameter and hand reamers up to 2 1/2 inches diameter; capacity for threading pipe or bolts up to 3/4 inch in diameter; and power of motor, 1 H.P. The weight of the machine is 30 pounds.

Drill and Screwdriver

The combination drill and screwdriver illustrated in Fig. 2 is provided with two spindles which run in opposite directions, the available speeds being 125, 250, 375, and 500 R. P. M. This tool is primarily intended for driving wood screws, a drill being used in one spindle to make the hole and a screwdriver in the other spindle which is used to drive the screw home. The spindles run in opposite directions and the tool is provided with an automatic switch that breaks the connection when the screw is driven home—or in the event of the drill striking a hard spot in the work—and prevents the possibility of burning out the motor. The motor used on this tool is not reversible. Both spindles on the tool remain stationary until they are pressed down upon the work which causes the engagement of a positive clutch. In addition to the application referred to, this tool can also be provided with suitable sized sockets for use in tightening nuts on wood. It can also be used as a hand tool, and this allows the power of the motor to be augmented by manual power. Ball bearings are used throughout. The maximum capacity of the tool is for driving 1-inch No. 16 screws in pine without first drilling a hole for the screw. This is about what a manually operated brace can do. The weight is 5 pounds.

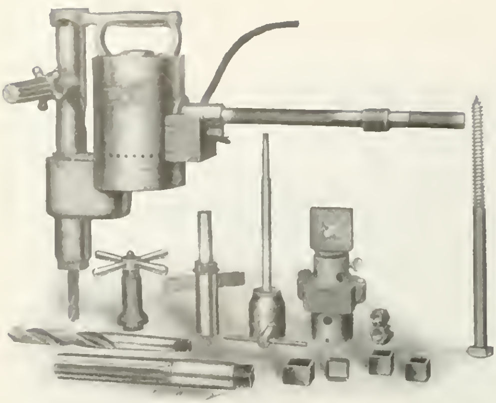


Fig. 1. Combination Lag Screw Drilling and Driving Machine made by the Automatic Electrical Tool Co.

Automatic ¼-inch Drill

The Automatic Electrical Tool Co. is also manufacturing a tool known as a ¼-inch drill which is essentially the same tool as the combination drill and screwdriver illustrated in Fig. 2, except that it has only one spindle and chuck. The feature of the tool is its extremely light weight, which enables it to be held with one hand while the work is steadied with the other hand, thus saving the time which would otherwise be required for clamping the work. The available speeds are 1000 R. P. M. and 1500 R. P. M. which are suitable for driving ¼- and 3/16-inch drills, respectively. The drive from the armature spindle to the drill is through a train of spur and spiral gears, and the spindle is supported in long bronze bearings to give permanent alignment, while the end thrust

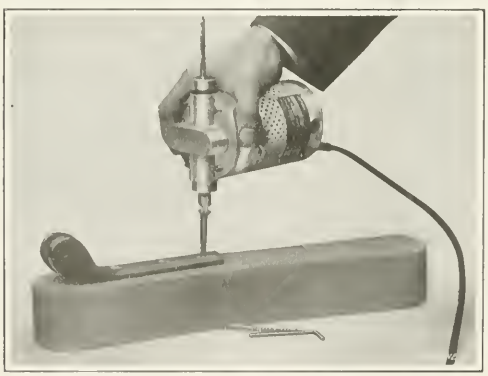
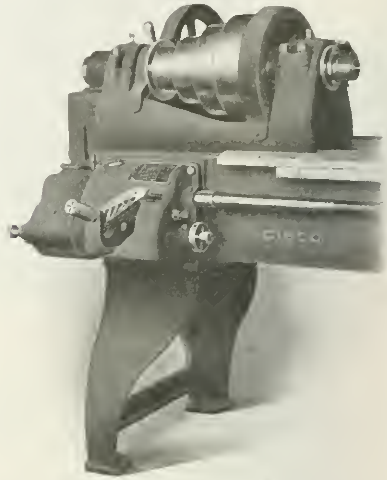


Fig. 2. Automatic Electrical Tool Co.'s Combination Drill and Screwdriver

is taken by a ball bearing located inside the gear case. These drills are fitted with a plug to enable them to be mounted in the spindle of a radial drill, thus making the equivalent of a drill speeder. The terminal block is located on the out-this type in 14-, 16, and 18-inch s'zes are equipped for cutting quickly made.

"CISCO" METRIC QUICK-CHANGE GEAR-BOX

The head end of a "Cisco" lathe manufactured by the Cincinnati Iron & Steel Co., Cincinnati, Ohio, is shown in the illustration which accompanies this description. Lathes of this type in 14-, 16-, and 18-inch sizes are equipped for cutting metric pitches, the range being as follows: 12, 11, 10, 9, 8, 7, 6, 5.5, 5, 4.5, 4, 3.5, 3, 2.75, 2.5, 2.25, 2, 1.75, 1.5, 1.375, 1.25, 1.125, 1, and 0.875. These are obtained through a quick-change gear-box, all changes being obtainable without the necessity of transposing gears. Instead of having the reverse mechanism in the headstock, it is incorporated in the gear-box where it is within easy reach of the operator. In all other details the

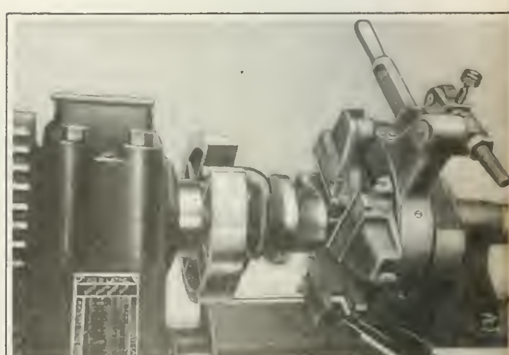


"Cisco" Lathe equipped with a Metric Gear-box

construction and operation of the metric lathe is the same as that of the standard lathes manufactured by the Cincinnati Iron & Steel Co.

LANDIS SHRAPNEL-THREADING DIE-HEAD

The accompanying illustration shows a stationary type of die-head recently developed by the Landis Machine Co., Inc., Waynesboro, Pa., for use in threading the base and fuse plugs for shrapnel shells. This die-head is manually operated by means of a bellcrank lever and is locked in the closed position. The parts of the tool are made of steel and it is of compact and durable design. The use of Landis long-life chasers insures accuracy of the work, together with economical operation and a high rate of production. The chasers may be furnished with short throats or without throats so that it is possible to cut a full thread right up to the head of the plug. The accompanying illustration shows the die-head attached to an engine lathe, the connection being made by bolting the die head to a bracket, which, in turn, is supported on the cross-slide guides. The die-head may also be equipped with a shank to provide for using it on turret lathes.



Landis Shrapnel Threading Die-head set up on Engine Lathe

DOUBLE-ACTING SPEED CONTROLLER

The double-acting speed controller which forms the subject of this description is a precision governor that has been designed and placed on the market by the Speed Controller Co., Inc., 257 William St., New York City, for the purpose of regulating the speed and power consumption within very narrow limits. It is adapted for use in connection with either electrical or other power systems, although the operation of the instrument itself is purely mechanical. It is equipped with two shafts, one of which is a high-speed governor shaft which runs continuously at the desired speed and is driven by the power which it is required to control; the other is a secondary shaft which is stationary when the governor shaft is revolving at the proper speed, but which rotates in either the forward or reverse direction when the speed of the governor shaft rises or falls from the desired point. The secondary shaft is geared to a valve, rheostat or other power regulating device, and continues its motion in the proper direction until the speed of the governor shaft has been restored to normal condition. When this result has been obtained, the secondary shaft comes to rest.

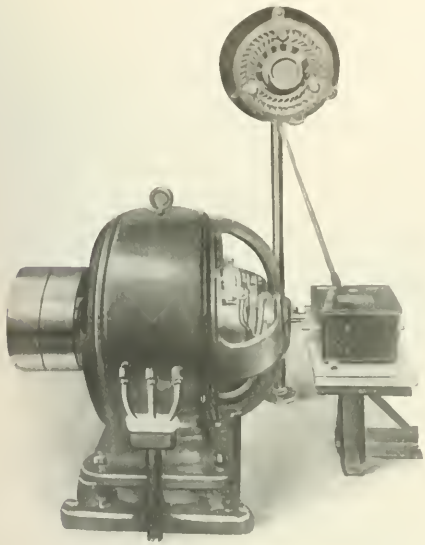


Fig. 1. Application of Speed Controller in Connection with Electric Motor

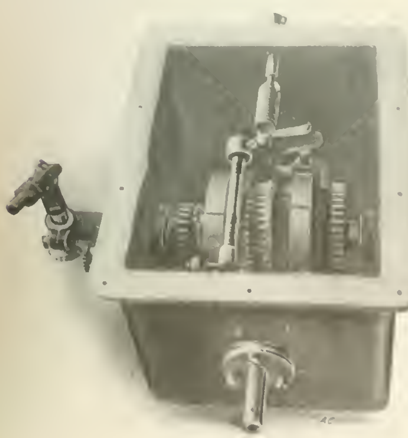


Fig. 2. Mechanism of Speed Controller

RESULTS OF TESTS TO DETERMINE SENSITIVENESS OF CONTROLLER*

Motor Speed	Variation in R. P. M. each Side of a Given Setting	Total Variation in R. P. M.	Per Cent of Variation Either Way	Total Per Cent of Variation
2230	10.00	20.00	0.45	0.90
2100	8.75	17.50	0.42	0.83
1560	7.50	15.00	0.48	0.96

Machinery

*Note. No load and full load results are the same

When the speed controller is connected to the field rheostat of a motor, the speed of the motor will be kept within a maximum limit of variation of about 0.83 per cent or about 0.42 per cent either way from the normal speed which is desired. If this variation of 0.42 per cent from the normal speed is too small, a wider variation or "neutral zone" is provided for by a suitable adjustment. The speed is controlled to exactly the same point whether the motor is under full load or under no load, and whether the field windings are either cold or warm. The controller may be used either direct or as a relay according to the conditions. While emphasis has been laid upon the application of the instrument to electrical installations, it is equally serviceable on steam engines, hydraulic machines and similar units. The table presented in this connection shows the results of a test of the instrument in which speed readings were taken with a Horn tachometer.

G. E. COMPENSATOR TYPE RELAY

A new type of circuit-opening inverse-time-limit oil-dashpot relay has recently been developed by the General Electric Co., Schenectady, N. Y., for use in conjunction with a low-voltage release for automatic, overload and low-voltage protection of alternating-current motors up to 2500 volts and 300 amperes. The relay is connected in series with the line, the low-voltage release across one phase in the usual manner with the low-voltage coil in series with the relay contacts. On overload greater than the current setting the relay, the relay contacts open-circuit the low-voltage release coil and the motor is cut out of the circuit. If the voltage drops to a predetermined per cent of normal, the motor is also disconnected from the power supply.

Series Inverse Time-limit Overload Type of Relay made by the General Electric Co.

This relay is mostly employed with motors using self-contained compensator control, but sometimes for switchboard service when both low-voltage and time-delay overload protection are required. Here series relays replace the secondary relays, current transformers and oil switch tripping coils otherwise required. Current calibration is from normal to twice normal, and the time adjustment from 10 seconds to 5 minutes on 25 per cent overload. The delay recommended, however, is about 15 seconds at the starting current of the motor. This affords ample protection to the

motor against damage from overload or single-phase operation, but prevents the circuit from being opened while the motor is starting. The new relay is a vast improvement over the one previously manufactured. The contact, dash-pot and calibrating tube are enclosed by dust-proof stamped steel covers. Current and time adjustment are accomplished outside of the dashpot simply with the aid of a screw-driver. The settings are constant, for an adjusting nut is locked in place after each setting is made.

LOWE "LAST WORD" INDICATOR

In the March, 1914, number of MACHINERY the "Last Word" dial test indicator manufactured by Henry A. Lowe, 1374 E. 88 St., Cleveland, Ohio, was illustrated and described. Those who read the description referred to will recall that this indicator is a simple and relatively low-priced instrument with a capacity for readings from zero to 0.025 inch. Fig. 1 shows an improved instrument of similar design which has recently been placed on the market by the same manufacturer. It will be seen that the present tool has a greater range, the capacity being from zero to 0.040 inch.

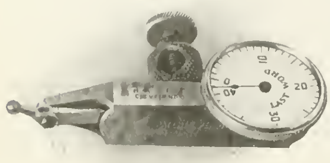


Fig. 1. H. A. Lowe Model B Dial Test Indicator

Another noteworthy improvement is that a friction joint is provided at the pivot of the contact point so that this point may be set in any position through an angle of 210 degrees, allowing the instrument to be used with equal facility on both inside and outside work, and in many positions which were not attainable with the original form of indicator in which the position of the point is fixed. The arrangement of the lever system in the indicator is such that the ratio is approximately 60 to 1. Fig. 2 illustrates the Model C indicator which is

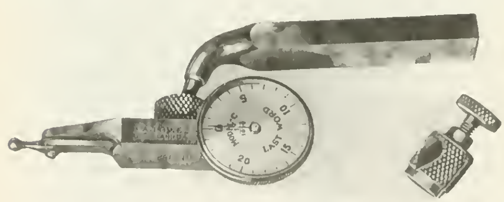


Fig. 2. Model C Dial Test Indicator made by H. A. Lowe

the only one of the Lowe "Last Word" indicators that is provided with an adjustable dial. The Model C instrument also has the friction joint adjustment for the contact point.

JOHNSON & CRUMP SURFACE FILE AND SCRAPERS

The Johnson & Crump Co., 413 W. Crawford St., Elkhart, Ind., is now manufacturing the surface file handle and the scrapers for internal and flat work, which are shown in the accompanying illustrations. Fig. 1 shows the handle for holding a file while working on flat surfaces, angles and under-cuts. It will be evident that this handle is provided with a clamp which grips the shank of the file without touching the surface of the work. As a result, the handle does not interfere with the work and the whole file surface is available, thus enabling the work to be done rapidly.

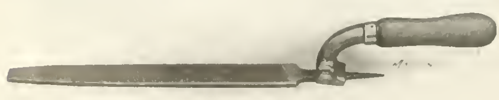


Fig. 1. Johnson & Crump Handle for a Surfacing File

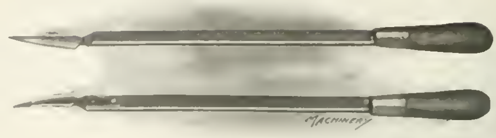


Fig. 2. Opposite Sides of Internal Scraper made by the Johnson & Crump Co.

Fig. 2 shows opposite sides of a scraping tool for use on internal work. It will be seen that the scraper shank is held in a slot cut in the end of the holder, and that the scraper is further supported by a dovetail which is fitted to the end of the holder. The scraper is held in place by two countersunk screws. The scraper blades are made of a special grade of tool steel which will hold its edge satisfactorily,

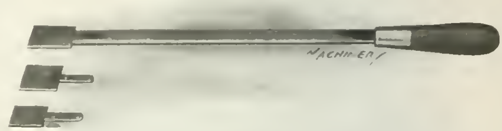
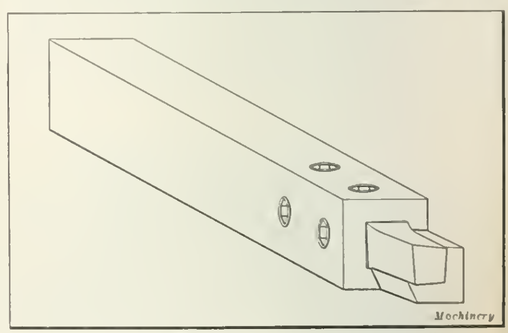


Fig. 3. Scrapers for Flat Surfaces fitted into Handle shown in Fig. 2

while the holder is made with sufficient spring to give the blades a shearing cut. Fig 3 shows the same type of holder provided with blades for scraping flat surfaces.

READY TOOL-HOLDER FOR STELLITE CUTTERS

The tool-holder for stellite cutters which forms the subject of the following description is the latest product of the Ready Tool Co., 654 Main St., Bridgeport, Conn. This holder is adapted for use in a boring mill or vertical turret lathe and is capable of holding a square stellite cutter 6 inches in length, which can be used up with not more than 1 inch of waste. The cutter is perfectly supported on the bottom and at the back, the construction being such that the required degree of rigidity is obtained and all danger of the cutter being broken is eliminated. Another desirable feature of this tool-holder is that by turning it through one quarter revolution, the tool can be adapted for operation in either a right-hand or left-hand position, with the proper clearance and



Ready Tool-holder especially adapted for using Stellite Cutters

side slope in either direction. The stellite cutter is held in place by hollow set-screws which offer no obstruction to the mounting of the holder in the toolpost.

HISEY-KING GUARD FOR VISE JAWS

To protect vise jaws from damage while working on a piece held in them, the Hisey-King Mfg. Co., Osgood, Ind., has recently developed a set of auxiliary jaws made of hard wood, which not only protect the jaws of the vise from injury but also prevent marring the surface of the work itself. It

Application of Hisey-King Vise Jaw Guard

is stated that the first experience which a mechanic has with the use of these jaws affords a surprise both in regard to the secure grip which is provided on the work and the length of time which the jaws last. Another claim made is that the vises will last longer because the tenacious grip of the wooden jaws on the work makes it unnecessary to tighten them to the degree which would otherwise be necessary. The general construction will be readily understood from the accompanying illustration; the jaws are made in two sizes which are 3 and 4 inches in width, respectively, and they have a capacity for opening from zero to 1¼ inch.

FRITZ "IDEAL" DRAWING TABLE

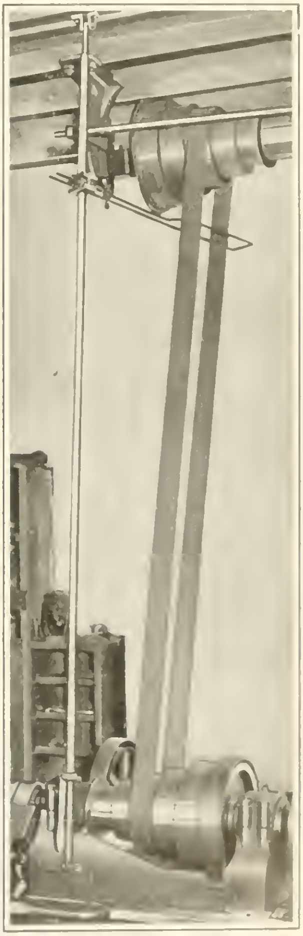
The style E "Ideal" drawing table which forms the subject of the following description is a recent addition to the line of drafting-room furniture made by the Fritz Mfg. Co., 60 Alabama St., Grand Rapids, Mich. A careful study of the illustration will make it evident that the features of strength and rigidity are provided without making the table excessively heavy, this result being obtained by a carefully worked out design in which all of the members are made to carry their full share of the load. This table has been particularly developed to meet the requirements of the drafting-rooms in manual training and technical schools, but it is also used in the drafting-rooms of many manufacturing plants.

Style E "Ideal" Drawing Table made by the Fritz Mfg. Co.

The frame is made of hard wood. The standards are slotted and the cross-bar has a tenant on each end which runs in the slots cut in the standards. The cross-bar also has a hole running through it which carries a rod that holds on the legs at each side. When the nut is tightened on this rod, the table is firmly supported without any vibration. These tables are made in four sizes with working areas of 22 by 30 inches, 24 by 32 inches, 32 by 42 inches, and 37 by 48 inches. On the two smaller sizes the table can be adjusted to any position between 30 and 40 inches from the floor, while the two larger sizes of tables can be set in any position ranging from 32 to 42 inches from the floor. The table top can be set at any angle from vertical to horizontal, this adjustment being accomplished by means of metal slides at each side, which can be clamped to secure the table top in the desired position. Both of the slides are clamped by tightening the thumb-nut at the right-hand side of the table. These tables are regularly furnished with soft wood tops, but the smallest size can be furnished with a hard wood top if so desired.

ALEXANDER & COX BELT SHIFTER

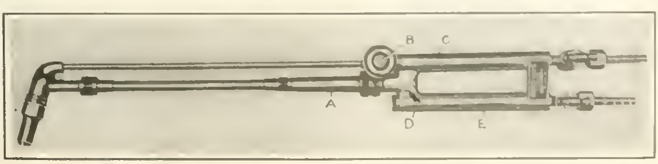
The loss of time and possibility of accident incident to the use of a pole for shifting belts from one step of a cone pulley to another, is too well known to require discussion. Various forms of mechanical belt shifters have been developed for the purpose of overcoming the objectionable features of the belt pole, and the accompanying illustration shows the device which has recently been perfected by the Alexander & Cox Co., 2358 Ogden Ave., Chicago, Ill. It is known as the "Acme" belt shifter and should commend itself to practical mechanics owing to the fact that only four screws are required to attach it in place ready for use. The method of operation will be obvious from the illustration, the shifting of the belt being effected by turning the hand-lever which is located in a convenient position at the head of the lathe; this results in swinging the shifter fork in the proper direction to move the belt onto the desired step of the cone. This belt shifter is equally applicable for use on various other types of machines.



Alexander & Cox Belt Shifter

MODERN CUTTING AND WELDING TORCH

In designing the "Meco" cutting and welding torch, the Modern Engineering Co., 14th and St Charles Sts., St. Louis, Mo., has paid particular attention to safeguarding the operator from possible injury through the gas burning



"Meco" Welding and Cutting Torch made by the Modern Engineering Co.

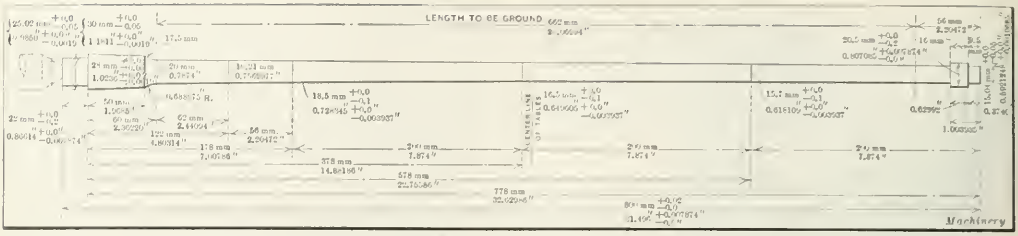


Fig. 1. Outside Dimensions of French Military Rifle Barrel showing Tapered Sections to be ground

back into the hose. This safety feature is afforded by a patented check valve system in both gas conduits which absolutely prevents either the oxygen or acetylene from flowing into the passage through which the other gas is being delivered to the tip of the torch. Another feature is that the handle is cast in a single piece and made of a special alloy which is said to be stronger than brass and lighter in weight than aluminum. All tips used on the "Meco" torch are equipped with a patented protected seal between the tip and the head of the torch which insures a perfect union and prevents leakage or damage to the torch if it is roughly handled.

The mixing chamber is made of bronze and is so designed that the gases are combined to produce an absolutely neutral flame with a temperature exceeding 6300 degrees F. It is also claimed that the consumption of gas by the torch is unusually low. The tips are furnished in various sizes suitable for handling all classes of work which come within the range of the oxy-acetylene process. A cutting attachment is provided for use with the welding torch, which may be easily and quickly applied. The work of securing the cutting attachment in place consists of two simple operations; the nut on the oxygen valve and the union nut on the gas conduit are removed, which makes the torch ready to receive the cutting attachment. The accompanying illustration shows the torch equipped with the cutting attachment. The universal mixing chamber is shown at *A*, the thumb controlled needle valve for the cutting jet at *B*, the automatic check valve system at *C* and *D*, and the one-piece handle at *E*.

CINCINNATI RIFLE BARREL GRINDING MACHINE

The barrel of the French military rifle is finished on the outside with five tapered sections, the dimensions of which—together with the other outside dimensions of the barrel—are shown in Fig. 1. These dimensions are given in millimeters in accordance with French shop practice, but the metric values have been converted into inches for the convenience of MACHINERY'S readers. For finishing the outside of rifle barrels, the Cincinnati Grinder Co., Cincinnati, Ohio, has recently built grinding machines for use in one of the French arsenals, which have given very satisfactory results. These machines are essentially the same as the universal Cincinnati grinding machine which was illustrated and described in the October, 1910, number of MACHINERY. Provision for grinding rifle barrels was made by the application of a fixture to the universal grinding machine, the fixture being fitted with five templets which are tapered to match the corresponding tapers which it is required to grind on the work.

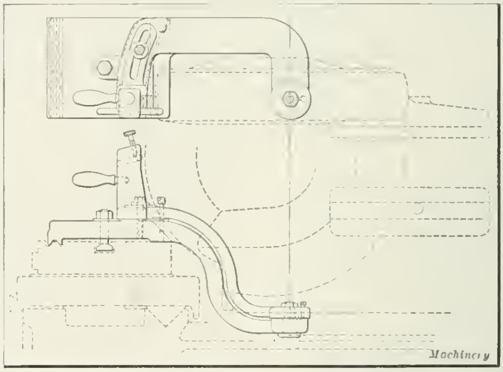


Fig. 2. Wheel Truing Device used in connection with Rifle Barrel Grinding Attachment

A partial plan view of the rifle barrel grinding fixture is shown in Fig. 3. The essential parts of the fixture consist of a bracket *A* which is bolted to the frame of the grinding machine, and a second bracket *B* which is secured to the table. The bracket *A* carries the five templets *C*, *D*, *E*, *F* and *G*, which have tapers corresponding to the tapers required to be ground on the work. These tapered templets are engaged by the rollers carried by the bracket *B*, positive engagement between the rollers and templets being insured by a spring (not shown) which is carried in the socket *H*. It will be evident that as the wheel moves over the rifle barrel which is to be ground, the engagement of the rollers with the tapered templets on the fixture results in so moving the grinder table that the required tapers are obtained on the work.

In order to provide for continuous traverse of the work over the wheel, it is necessary to have the face of the wheel trued to a circular arc. The reason for this is

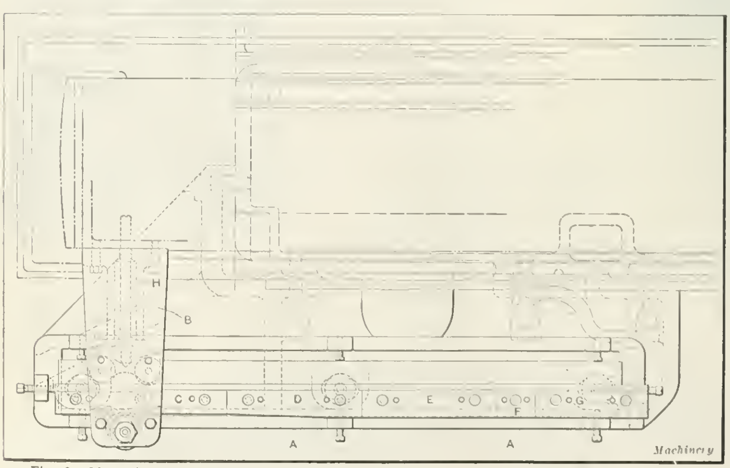
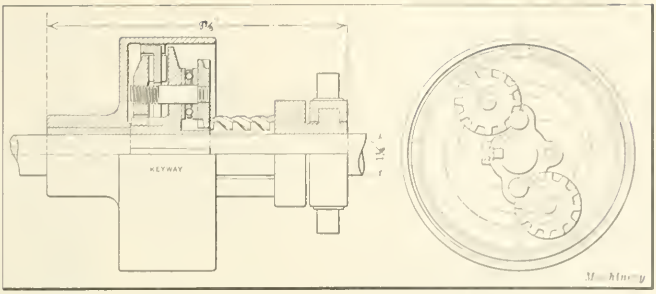


Fig. 3. Plan View of Cincinnati Universal Grinder equipped with Rifle Barrel Grinding Attachment

that if the face of the wheel were straight, the corner would dig into the work at each point of intersection between adjoining tapers, and this would destroy the finish. But difficulty from this source is completely overcome by the use of the wheel truing device shown in Fig. 2, which is mounted on the table of the machine and provides for truing the wheel to a curve so that, theoretically, there is only a single line of contact between the wheel and work. As a result, the wheel comes up to the intersection of adjoining tapers and passes on to grind the surface of the next taper without damaging the surface. In grinding rifle barrels on this machine, a table traverse of from 26 to 30 inches per minute is employed with a work speed of 100 feet per minute.

IMPROVED WILMARTH & MORMAN DRILL GRINDER

All experienced mechanics are familiar with the general features of the "New Yankee" drill grinder manufactured by the Wilmarth & Morman Co., 1180 Monroe Ave., N. W., Grand Rapids, Mich., so that it will only be necessary to refer to the improved features of the machine which is illustrated and described herewith. Two noteworthy changes have been made in the design. One of these consists of the provision of a larger sized pan which prevents water from being thrown onto the floor. After the pump has delivered the water to the work, that portion which formerly flowed down the drill-holder and was carried away by a flexible vent pipe now runs from the short outlet into the pan, from which it finds its way back to the reservoir. Inside the reservoir there is a separator plate extending almost to the surface of the water. The water returning to the reservoir finds its way in at one side of this plate while the pump takes its supply from the opposite side. As a result, abrasive dust, grindings or other foreign materials are prevented from finding their way into the pump. The other improved feature of the machine referred to consists of the substitution of bronze-bushed spindle bearings in place of the babbitt bearings formerly employed.



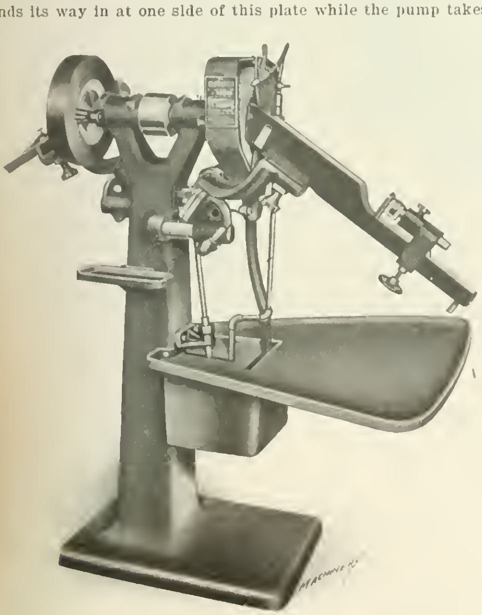
Hilliard 6-inch Machinery Clutch with Woven-wire and Asbestos Friction Rings

HILLIARD 6-INCH MACHINERY CLUTCH

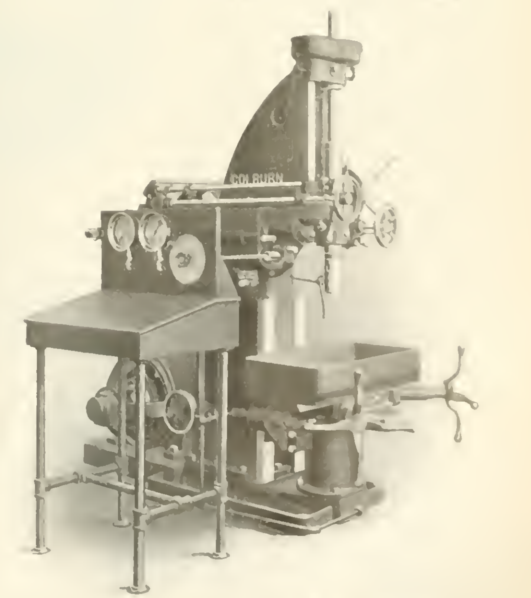
In the February, 1915, number of MACHINERY, the friction clutch manufactured by the Hilliard Clutch & Machinery Co., Elmira, N. Y., was illustrated and described. Recently the same firm has developed a clutch of similar design with the exception of the fact that two solid woven-wire asbestos rings are used for the friction material in place of the hard wood friction inserts employed in the type of clutch previously described. The use of the woven-wire asbestos rings was adopted to utilize waste material cut from the Hilliard automobile clutch linings. The result is very satisfactory, as the new frictional contact is superior to that obtained with hard wood, and its use enables a profitable outlet to be found for material which would otherwise go to waste. In their general characteristics the present clutch and the clutch described in the February, 1915, number of MACHINERY are the same, so that further description would be out of place. The chief point of difference is that the use of the woven-wire asbestos rings has made it necessary for the friction plate to which they are riveted to float on four driving keys which are integral with the outer sleeve member.

COLBURN TWIST DRILL TESTING MACHINE

The testing of twist drills on a special drill testing machine is an important factor in the process of manufacture, as it enables the drill maker to determine the various stresses to



Wilmarth & Morman Improved "New Yankee" Twist Drill Grinder, with Large Raised Pan and Bronze Bushed Spindle Bearings



Special Drilling Machine built by the Colburn Machine Tool Co. for Use in testing Twist Drills

which his product will be subjected when drilling different kinds of metals under various conditions of speed and feed. The results obtained from such tests also make it possible for the drill manufacturer to recommend the best speed and feed for different sizes of drills when working under various conditions.

The illustration on the preceding page shows a heavy-duty drill press built by the Colburn Machine Tool Co., Franklin, Pa., for the National Twist Drill Co. of Detroit, for testing twist drills. The machine is one of the Colburn standard motor-driven heavy-duty drill presses equipped with a specially designed compound table which registers the torque and pressure on the drill while it is in operation. The speed of the drill in revolutions per minute, and the feed per revolution, are also indicated. The table has both longitudinal and cross travel, and is carried on a large spindle having both annular and thrust ball bearings which allow it to revolve freely. The spindle rests on a plunger that fits into a cylinder filled with glycerine, the connection being made from this cylinder to the hydraulic pressure gage located at the left-hand side of the instrument board. Any pressure on the drill is thus indicated on the gage.

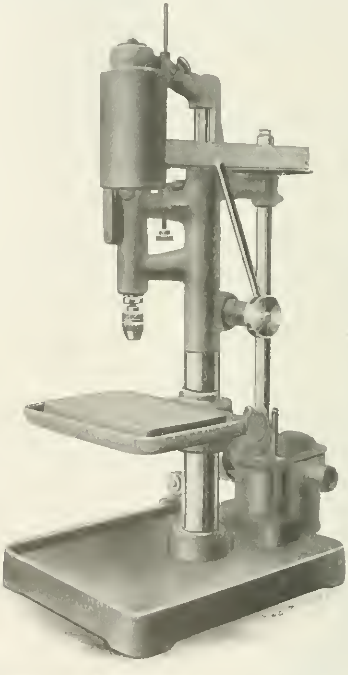
An arm projecting from the left-hand side of the spindle engages another plunger that fits into a cylinder filled with glycerine, which is connected to the hydraulic pressure gage at the right-hand side of the instrument board. Any torque exerted on the drill tends to revolve the table; this causes the arm to press against the plunger, and thus sets up a pressure which registers the amount of torque on the second gage. The plunger is 14 inches from the center of the spindle, and in order to find the actual torque on the drill it is necessary to multiply the pressure indicated by the gage by 28, and divide this result by the diameter of the drill. For example, if the gage registers 500 pounds when drilling with a 2-inch drill, then the actual torque on the drill would be $\frac{500 \times 28}{2} = 7000$ pounds.

A tachometer mounted at the extreme left of the instrument board and connected to the machine by a spring belt, shows the revolutions per minute of the drill at all times. The feed per revolution of the drill is shown on the feed plate at the right-hand side of the instrument board; thus a man standing at the desk in front of the instrument board can read the speed in revolutions per minute, the feed per revolution, torque, and pressure in pounds on the drill. The use of this machine has enabled a lot of interesting data to be collected, such classes of information being obtained as the manner in which the stress in the drill varies for different depths of holes and different lengths of time between grinding.

LANGELIER HIGH-SPEED SENSITIVE DRILL

The machine illustrated and described herewith is a recent product of the Langelier Mfg. Co., Providence, R. I., and has a capacity for drilling holes up to 1/8 inch in diameter at the center of a 6-inch circle, with a spindle speed of 9000 revolutions per minute. This is a ball bearing drill of the single-speed type. A substantial guard is provided at the front of the spindle which protects the operator and prevents oil being thrown from the machine. It will be seen that the spindle is driven direct by an open belt from a pulley at the upper end of a vertical shaft at the rear of the machine which, in turn, is positively driven by spiral gears which make connection with a horizontal shaft on which the tight and loose pulleys are mounted. The machine has a capacity for work or jigs up to 6½ inches in height and the table has a working surface of 4¼ inches deep by 7 inches wide. The maximum spindle travel is 2 inches. A threaded depth gage with a hardened and knurled screw head and side locking screw provides for adjusting the main depth gage very accurately.

The spindle is made of hardened steel and ground to size; it is double splined to provide perfect balance under the high speed at which the machine is used. The lower end of the spindle is tapered to fit the socket of a No. 0 Beach chuck made by the Morse Twist Drill Co., which has a capacity for holding all sizes of drills from the finest up to 1/8 inch in diameter. The lower portion of the spindle runs in hard phosphor-bronze bearings which are made adjustable to compensate for all normal wear likely to occur; and the thrust of the drill is taken at the upper end of the spindle by means of a combination thrust and radial bearing. A coiled spring keeps the spindle raised from the work when the machine is idle, this spring being located inside the column of the machine. The strength of the spring is just sufficient to raise the spindle and bring it to a gradual stop so that no jar or vibration is introduced.

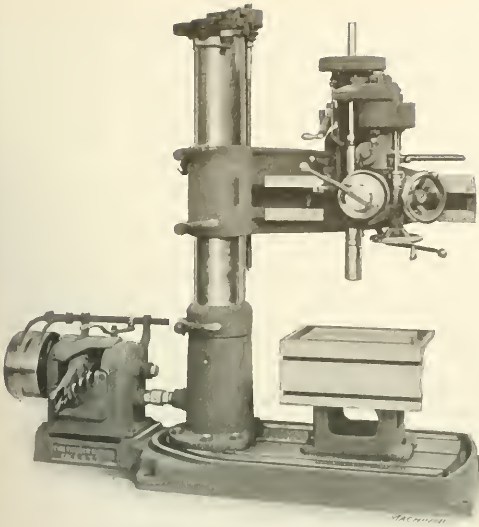


High-speed Ball Bearing Sensitive Drill made by the Langelier Mfg. Co.

The operation of the feed is made extremely sensitive by eliminating all direct pull from the spindle and by the arrangement of the feed mechanism. The spindle pulley is recessed and in this recess there are mounted two radial ball bearings. The outer races of these bearings are a creeping fit in the pulley and revolve with it while the inner races are mounted on a fixed hard phosphor-bronze sleeve which is clamped securely in the drill frame spindle bearing. As a result all belt pull is carried by this sleeve while the spindle which passes through it is entirely free from pull at all times. A hardened steel cap closes the open end of the spindle pulley and encases the ball bearings to exclude dust and grit. The driving belt is an endless woven canvas belt 1 inch in width. The sensitiveness of the feed is obtained by having the pinion which is operated by a hand lever mesh into a rack cut on the back of the drill spindle frame, but not directly into a rack mounted on a feed sleeve around the spindle. In this way the slightest resistance offered to the progress of the drill is instantly communicated to the operator's hand and the feed can be eased off to avoid breaking the drill.

FOSDICK MANUFACTURING RADIAL DRILLS

The Fosdick Machine Tool Co., Cincinnati, Ohio, has recently developed a line of radial drilling and tapping machines which are known as the Fosdick high-speed manufacturing radial drills. The first two sizes to be placed on the market are provided with 2- and 2½-foot arms, respectively, and are intended to meet the demand for high-speed durable machines which are capable of handling a great variety of work—especially in shops where unskilled labor is employed. It will be apparent from the illustration that the design of these machines follows closely along the lines of the Fosdick heavy-duty radials which have been illustrated and described



Fosdick High-speed Manufacturing Radial Drill

in MACHINERY, the oil channel base and table, the double tubular column, and the speed-box being identical on both types.

Provision is made for forty-eight rates of drilling which cover a range suitable for drilling with from 3/16 inch carbon-steel up to 2½ inch high-speed steel when working in iron and steel; and for boring holes up to 5 inches in diameter. All these rates of drilling are obtained with but one speed at the pulley. Particular care has been taken in the selection of materials used in the construction of these machines. The bushings are of a special grade of phosphor-bronze, and all gears subjected to severe duty are cut from steel forgings and hardened where necessary. In cases where the speed is high or the duty light, the gears are made of cast iron or bronze. The spindle and principal driving shafts are made of hammered steel; and the thrusts of the column, spindle and arm-elevating screw are carried on ball bearings. The column and shafting are finished by grinding.

Fig. 1. Cleveland Crane & Engineering Co.'s Press equipped for pressing Band on Shell

Thorough tests of these machines have been made at the works of the Fosdick Machine Tool Co., using high-speed steel drills up to 2½ inches in diameter working in both machine steel and cast iron. In one case a 1-inch high-speed steel drill was driven through a cast-iron slab 2 inches in thickness in 7 4/5 seconds, *i. e.*, at the rate of 15.4 inches per minute; the speed was 550 R.P.M. and the feed 0.028 inch per revolution. In another case a 2½-inch drill was driven through 1½ inch of machine steel at various rates ranging from a speed of 137 R.P.M. and a feed of 0.007 inch per revolution, to a speed of 49 R. P. M. and a feed of 0.028 inch per revolution. The 2-foot machine will drill to the center of a 48-inch circle at the base, which has a working surface of 26 by 31 inches. The 2½-foot machine will drill to the center of a 60-inch circle at the base, which has a working surface of 28 by 36 inches.

The following dimensions apply to both machines: distance from base to spindle, 51 inches; spindle traverse, 12 inches; minimum diameter of spindle; 1 9/16 inch; bore of spindle, No. 4 Morse taper; and net weight of machines, 2900 and 3200 pounds, respectively. As in the case of the Fosdick heavy-duty radial drills, the interchangeable drive has been adopted, *i. e.*, a cone-driven machine may be changed over to speed-box drive, or *vice versa;* or a constant or variable speed motor may be employed to drive the machine at any time after it has been placed in service, without the necessity of providing a special base, speed-box, shafts or gearing. Tilting, swinging or round tables of the standard types supplied with other Fosdick radial drills may be furnished on this machine as desired.

CLEVELAND SHELL BANDING AND NOSING PRESS

For use in nosing shrapnel and high-explosive shells in sizes up to the 18 pound and for pressing the copper bands on shells up to the 60-pound size, the Cleveland Crane & Engineering Co., Wickliffe, Ohio, is now making an air-operated press, the design of which is shown in the accompanying illustrations. The press is of simple design and rigidly constructed to enable it to stand up under severe service. The method of operation is as follows: Air at a pressure of 100 pounds per square inch is admitted to the cylinder *A*; the piston in this cylinder is 27 63/64 inches in diameter and has a lift of 2¼ inches. Six lugs *B* are cast to the top of the piston and these lugs carry the links which operate the toggles *C*.

The outer ends of the toggles are held by a fixed ring while their inner ends actuate the plungers which compress the copper band onto the shells. It will, of course, be evident that when air is admitted to the cylinder at *E*, the piston rises and the toggles force the plungers in against the work. Referring to the plan view, it will be seen that the shell on which the band is to be compressed occupies a vertical position in the space *G* between the six plungers. Two settings of the work are necessary, the shell being turned through an angle of 90 degrees after the first pressing operation has been performed. The rate of production on 18-pound shells can be maintained at 200 per hour.

The same press provides for performing the nosing operation. For this purpose a housing *H* is bolted to the top of the frame and an auxiliary plunger *J* is placed on top of the main piston. The top of the plunger *J* is recessed to fit the particular size of shell which is to be nosed, and when the piston rises, the shell is forced up into the die *K* which gives it the required form. It will be seen that the nosing die is bolted

Fig. 2. Auxiliary Housing and Plunger in Place ready for Nosing Operation

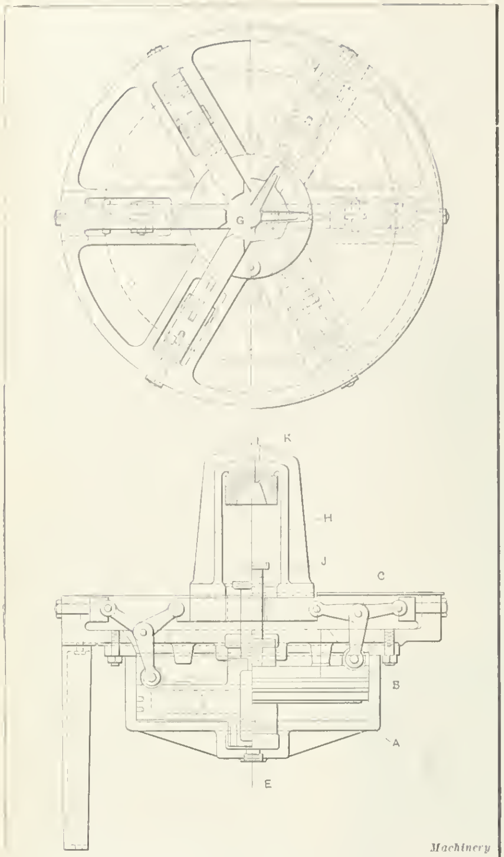
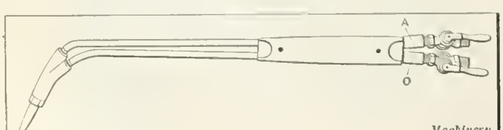


Fig. 3. Mechanism of Cleveland Crane & Engineering Co.'s Banding and Nosing Press

to the top of the housing; otherwise the operation of the press is the same as for the banding operation. The machine has a capacity for nosing shells up to the 18-pound size and the rate of production is 150 per hour. The same press can be used for marking shells by substituting a marking die in place of the nosing die.

FEDERAL WELDING TORCH

The "Federal" oxy-acetylene welding torch which is a recent product of the Federal Brass Works, 31st St. and Kedzie Ave., Chicago, Ill., is illustrated and described herewith. This is an equal pressure torch which is used in connection with regulators and gages to maintain a constant flow of the acetylene and oxygen. The claims made for this method of operation are a saving of 20 per cent in the amount of gases consumed, and the ability to handle a wider range of delicate work operating the torch with the gases at lower pressures than those which are normally employed. In this connection it is important to bear in mind that while the manufacturers of this torch recommend the use of an even mixture of gases, it can still be operated with a variety of other mixtures of oxygen and acetylene.



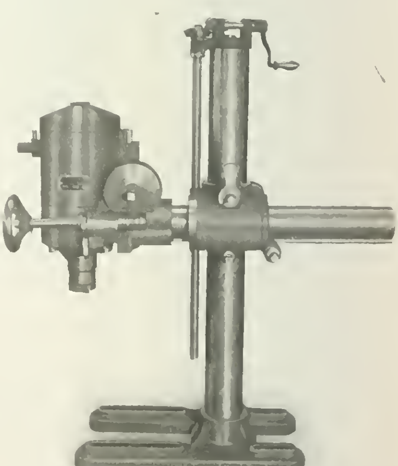
Oxy-acetylene Welding Torch made by the Federal Brass Works

The Federal welding torch has a nickel-plated mixing head of patented construction, and a light weight polished aluminum handle which is designed in such a way that it will not become uncomfortably hot. The torch is equipped with two straight-handled shut-off cocks, as shown in the illustration, where the acetylene cock is marked *A* and the oxygen cock *O*. These straight-handle cocks are so arranged that they can be closed almost instantly. The over-all length of the torch is 20 inches, and it is said to be exceptionally light and well balanced.

IMPROVED CINCINNATI PORTABLE RADIAL DRILL

The Cincinnati Electrical Tool Co., Cincinnati, Ohio, has recently made noteworthy improvements in the design of its portable radial drill, and the accompanying illustration shows the form in which tools of this type are now being built for the market. In general respects the design follows that of the portable radial drill of this company's manufacture which was illustrated and described in the April, 1910, number of MACHINERY; but probably the best way of explaining the improvements which have been made will be to give a general description, calling attention to the points where changes in design have been made.

It will be seen that the arm and knuckle have a vertical adjustment on the column by means of bevel gears and a lead-screw 34 inches in length. The crank handle which makes this adjustment is located in a horizontal position instead of being vertical, as on the original machine. This change was made to take advantage of the greater convenience of a horizontal handle. The revolving bearing in the knuckle which supports the cross-arm has a graduated collar to facilitate the making of accurate angular settings. The setting is made by means of a worm and worm-wheel in the knuckle, which enables the drill head to be set to any angle and held in that position until clamped. Formerly a simple



Portable Radial Drill made by the Cincinnati Electrical Tool Co.

clamp was used which made it necessary for the head to be held in place until clamped. The head can be set at any angle and has a circle radius of 24 inches; a maximum feed of 10 inches is provided through a handwheel, and quick return is also provided. An improvement has been made in this mechanism by allowing the handwheel to be used in either a horizontal or vertical position, the latter setting being convenient when it is required to get into close corners.

All gears are made of heat-treated steel and are mounted on ball bearings in an independent gear-case located at the end of the motor housing. The gears run in grease. Annular ball bearings are used at both ends of the armature shaft

and the spindle thrust is taken by a ball thrust bearing. The grease in the gear-case also serves as a lubricant for the annular and thrust bearings which carry the spindle, and also for the ball bearing at the lower end of the armature shaft. This is accomplished by the provision of suitable ducts through which the gears force the lubricant to the required positions. A threaded brass plug at the top of the case makes it an easy matter to renew the lubricant when necessary. The switch employed on these tools is of a special design developed by the Cincinnati Electrical Tool Co.; it is of the quick make-and-break type, and insures immediate and positive contact. The drills are equipped with a special type of Morse-taper slip-socket and the use of a drift key in the spindle is done away with. The motor is air-cooled.

NEW MACHINERY AND TOOLS NOTES

Combination Scale and Truck: National Scale Co., Chicopee Falls, Mass. A combination elevating transfer truck and scale which enables material to be weighed while it is on the truck. The truck is of the usual elevating type used in connection with loading platforms. The truck is made in four different sizes.

Portable Shop Crane: La Salle Machine & Tool Co., La Salle, Ill. This crane is mounted on an electrically-driven truck and is provided with a compensating quadrant. The capacity is for lifting pieces up to 1000 pounds in weight. The compensating mechanism on the crane allows the suspended load to be moved out or in on a line parallel to the floor.

Vertical Milling Machine: Rockford Milling Machine Co., Rockford, Ill. This concern is now equipping its No. 1½ plain back-geared cone miller with a vertical head and circular table. The table used is 12 inches in diameter and is graduated in degrees. The vertical head is attached to the column, and the spindle is bored to take a No. 10 B & S taper shank.

Pipe Machine with Centralized Control: Crane Co., Chicago, Ill. In the design of this machine particular attention has been paid to the location of all control wheels and handles at a point where they are easily reached by the operator. This arrangement naturally gives increased production by making it unnecessary for the workman to leave the operating position.

Profile Grinding Machine: Fischer Machine Co., Philadelphia, Pa. A universal profile grinding machine for use in grinding irregular shaped cutters for metal work. The machine is equipped with a narrow edged formed wheel which is shaped by an eccentric truing device, and two parallel motion tables, one of which carries the cutter to be ground and the other the guiding templet.

Detachable Turret Head: Newman Mfg. Co., 717 Sycamore St., Cincinnati, Ohio. An auxiliary turret head attachment for use in the tailstock of engine lathes up to 24 inches swing. The use of this attachment converts an ordinary engine lathe into the equivalent of a turret lathe and materially increases the rate of production on classes of work where a series of tools is required. The turret has holes to accommodate four tools.

Circular Saw Guard: Crescent Machine Co., 56 Main St., Leetonia, Ohio. An adjustable saw guard which can be locked out of the way by means of a simple latch and pin device. The guard is made with lattice castings on each side so that the saw is visible at all times, and the adjustment makes it possible to vary the relation of the guard to its point of support in order to make it adaptable for use on all types of saw tables.

Ratchet Die-stock: Oster Mfg. Co., 2111 E. 61st St., Cleveland, Ohio. A die-stock with a capacity for piping ranging from 2½ to 4 inches in diameter. In operation, the tool is placed on the pipe and a small rod or piece of pipe is used to revolve the universal scroll chuck until the gripping jaws engage the pipe. The lead-screw is in position to thread when the slanting post which causes the dies to recede is flush with the face of the die-stock.

Single-purpose Turret Lathe: Cleveland Crane & Engineering Co., Wickliffe, Ohio. A single-purpose chucking turret lathe especially adapted for use in machining shrapnel and high-explosive shells in sizes ranging from 3 to 5 inches. The machine provides for performing the turning, drilling, boring and end-forming operations. It is of simple design and rigidly constructed to stand up under the severe service conditions which obtain in the manufacture of shells.

Shell Marking Machines: Brown-Boggs Co., Hamilton, Ontario, Canada. One of these is a machine for marking the base of a shell which is so arranged that the entire pressure of the machine is exerted on each individual letter and figure successively, so that a deep impression is obtained. The second machine referred to is a body marking machine in which the shell is rolled between a large disk and the die-holder. Each letter and figure may be adjusted to give a light or heavy impression as required.

Multiple Shell Turning Lathe: Jenckes Knitting Machine Co., Pawtucket, R. I. A multiple lathe designed for rough-turning five 3-inch shells at the same time. For this purpose the machine is equipped with five sets of centers located along the lathe bed, and the tailstocks are adjustable for shells of different lengths. Where exceptionally long work is handled, the number of pieces which can be turned simultaneously will necessarily be reduced. The machine has a range for work up to 6 inches in diameter.

Shell Banding Machine: Lourie Mfg. Co., Springfield, Ill. A hydraulic machine provided with six rams which are carried by a heavy steel ring. Each of these rams has a capacity for 100 tons pressure. The hydraulic pump has two differential pump barrels with large upper pistons for rapid movement of the rams and small lower pistons to provide the heavy pressure. The distance between opposing rams is 17 inches, and suitable dies can be furnished with the machine for working on shells from 3 to 12 inches in diameter.

Milling Machine: Ingersoll Milling Machine Co., Rockford, Ill. A combination horizontal and vertical machine which differs considerably from former models of this type of machine which have been built by the Ingersoll Milling Machine Co. The machine can be used as a horizontal or vertical machine, or both horizontal and vertical spindles may be used at the same time. The machine is known as the Ingersoll No. 3 combined high-power miller, and is arranged for constant speed from either a belt or motor.

Hand Screw Machine: Charles Stecher, Chicago, Ill. This machine is designed with a plain head, automatic chuck, wire feed, hand longitudinal feed to cut off, and independent stops. The automatic turret stops are easily thrown out at any time when it is desired to use either of the turret tools separately. In designing the machine particular attention has been paid to the development of a rigid construction. The regular equipment provided with the machine includes one front and back toolpost, a geared oil pump, a double friction countershaft and the necessary wrenches.

Lincoln Miller: American Machine Tool Co., Hackettstown, N. J. A milling machine particularly adapted for use in the manufacture of gun parts and similar work. It is a No. 1 size and has a 2½-inch spindle with a ¾ inch hole bored for a No. 10 B & S taper. The greatest distance from the spindle to the support in the tailstock is 18½ inches, the extreme distance from the headstock to the tailstock is 22½ inches, and the available spindle speeds are 16, 27 and 38 revolutions per minute. Eight changes of feed are available, ranging from 0.018 to 0.200 inch per revolution.

Single-purpose Lathes: Cincinnati Iron & Steel Co., Cincinnati, Ohio. Two single-purpose lathes which are adapted for shell work, the manufacture of automobile parts and various other classes of service where single-purpose machines are employed. The machines are built in two sizes, one for shells up to 6 inches in diameter and the other for shells ranging from 8 to 12 inches in diameter. They are of the geared-head single-pulley type, and are provided with four speed changes. The gear-box on the smaller machine gives five changes of feed ranging from 0.020 to 0.100 inch per revolution; on the larger machine there are six changes of feed ranging from 0.03125 to 0.375 inch per revolution. Various attachments are provided with the lathes which facilitate the performance of certain operations for which they are adapted.

Hand Milling Machine: Adams Co., 1904 Bridge St., Dubuque, Iowa. An improved form of the hand milling machine formerly built by this company, in which the same box form of table is retained but on which the vertical and spindle feed levers have been replaced by handwheels. The machine is particularly adapted for work on which it is required to make short quick cuts instead of profiling the work. If necessary, several strokes may be taken to complete the milling operation and the construction is sufficiently rigid to enable heavy cuts to be taken without chatter. The head has a vertical adjustment of 12 inches; the table is 8 by 18 inches in size and has a traverse of 18 inches; the spindle quill may be given a longitudinal movement of 2¾ inches; the spindle is bored for a No. 9 B & S taper; the floor space occupied is 3 by 4 feet; and the weight of the machine and countershaft is 980 pounds.

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Garnet is an abrasive which varies widely in chemical composition and color, and which, applied to paper and cloth, is extensively used in the wood-working industries instead of sand paper. Garnet is found both in the massive state and in crystalline form, but it is only the crystalline garnet that is used as an abrasive.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

War as Affecting Contracts

(Federal) By the law of nations, all ordinary commercial intercourse between citizens of belligerents, being incompatible with a state of war between their countries, is absolutely interdicted. Where the law of both belligerent countries forbids a payment by a subject to a subject of the enemy country during the continuance of a war, such payment will not be enforced by a court of a neutral country, which has acquired jurisdiction of property of the debtor.

The United States District Court came to the foregoing conclusion in Watts, Watts & Co., Ltd., v. Unione Austriaca Di Navigazione. The Watts company is an English corporation, the Unione Austriaca, an Austrian company. Supplies consisting of machinery, coal and numerous other articles had been sold by the Austrian concern to the English company. Drafts were issued to cover the value of the property. The English company refused payment on the ground that a state of war existing between England and Austria discharged the obligation. The Austrian company thereupon brought this suit in the courts of the United States knowing that the English company had property here subject to execution. The District Court, however, held that where the law of both belligerent countries forbids a payment by a subject to a subject of the enemy country during the continuance of a war, such payment will not be enforced by a court of a neutral country, which has acquired jurisdiction of property of the debtor. *(Watts, Watts & Co. Ltd. v. Unione Austriaca Di Navigazione, 224 Fed. 188.)*

Oiling Machinery While in Motion Held Negligent

(Pennsylvania) An experienced machinist was not entitled to recover from his employer for injuries received while he was oiling a machine in motion and using an oil-can with a short spout, thus increasing the danger, though the machine was not guarded. *(Barrientos v. Brennon, 94 A. 927.)*

Waiver of Notice by Seller

(Oklahoma) Where a party purchases a piece of machinery under a contract which provides for a specific notice to be given the seller in case the machine proves unsatisfactory, held, that such notice is for the sole benefit of the seller, and may be waived by him. And, if waived by him, he cannot complain because the contract notice was not given. *(Continental Gin Co. v. Sullivan 150 P. 209.)*

Reliance on Warranty

(Utah) A written contract of sale contained a warranty providing that if after a trial of five days the machinery should fail to fulfill the warranty, written notice should be given to the seller and also the agent from whom the machinery was received, and that failure to make such trial or give such notices should be conclusive evidence of due fulfillment of warranty. Notice of breach of warranty was given to the agent, but not to the seller until nearly a year after the sale. Held, that as notice was a condition precedent to the reliance on the warranty, action for the price could not be defeated on the ground of breach of warranty, the notice to the agent not being enough.

Where a contract of sale required machinery found defective to be returned, a failure to return defective machinery precludes reliance on the warranty. *(Consolidated Wagon & Machine Co. v. Barben, 150 Pac. 953.)*

Moving Pulley Causes Injury

(Missouri) An employe holding a belt away from a moving pulley while coemployes shortened it was injured by having his arm drawn into the pulley. It was not customary to stop the machinery, and the employe had done this work for years without stopping the machinery, and was familiar with the work. The pulley was coated with some adhesive substance, which was nothing out of the ordinary, and it had flanges at the sides fastened by screws, but there was nothing to show that it was negligence to operate such a pulley. The operation was attended by some danger unless precaution was taken, and safer methods might have been employed by the employe and his coemployes in doing the work, but the employe made no request of any one in authority to stop any part of the machinery. Held, that the employer was not guilty of actionable negligence either in permitting the pulley to remain in motion or in failing to furnish safe place to work or safe appliances. *(Chandler v. St. Joseph Lead Co., 178 S. W. 217.)*

Unfair Competition in Sale of Tools

(Federal) Complainant invented an automobile tool for which he applied for a patent. Pending action on his application, he commenced manufacturing and through extensive demonstrations and advertising quickly created a market. Defendant then commenced making and selling the same tool, practically identical in form and appearance and also using complainant's cuts and other advertising matter. Held that, while defendant was within his legal rights in making the tool, his further acts in attempting to take the business complainant had built up constituted unfair competition, and therefore would be enjoined. *(Stewart v. Hudson, 222 Fed. 585.)*

Master Not Liable for Injuries

(Missouri) Where plaintiff's husband, employed by defendant to operate electrical machinery, was killed on Sunday, while at defendant's plant on a pleasure visit to show a new motor and the method of its operation to two friends, defendant was not liable for the death, since a master is not liable for injuries to his servant unless the latter was at the time in performance of some duty for which he was employed. *(Biddlecom v. Nelson Grain Co., 178 S. W. 750.)*

Failure to Inspect Machinery

(Kansas) One who, after contracting to buy an engine, subject to inspection, examines all of it except the firebox and omits to examine that because he could not do so without soiling his clothes, is not as a matter of law precluded from relying upon statements fraudulently made to him by the seller regarding its condition, or from making such statements the basis of a rescission of the contract for fraud. Whether a sufficient reason existed for omitting a complete inspection is a question of fact to be determined upon by a consideration of all the circumstances of the case.

Where a written contract for sale of machinery is complete, and covers the matter of warranty, the buyer cannot rely upon prior or contemporaneous oral representations of the seller as to the condition of the property as constituting a warranty. *(Aultman & Taylor Machinery Co. v. Schierkolk, 149 Pac. 680.)*

Inventions of Employes

(New York) The right of an employe to use exclusively a patent obtained while under contract of employment is discussed in Doscher v. Phelps Guardant Time Lock Co. "The doctrine that when a person in the employ of another in a certain line of work devises an improved method or instrument for doing that work, and uses the property of his employer and services of other employes to develop and put in practicable form his invention, and explicitly assents to the use by the employer of such invention, a jury or court trying the facts is warranted in finding that he has so far recognized the obligations of service flowing from his employment and the benefits resulting from his use of the property as to have given to such employer an irrevocable license to use such invention, is not applicable to the facts of this case, where the acts of the parties preclude any such finding. The work on the new patent did not interfere with, and was no part of, the duties of Phelps as general manager of the company, having been done outside of business hours. He himself paid the corporation for services rendered by its employes on his device when they had nothing else to do; and while the corporation incurred the obligation to pay for material in the construction of the new device pending the granting of the patent, and was authorized to sell the device to its customers, this was done to further the interests of the corporation, and with the view that when the patent was procured the patentee

would give the corporation the first opportunity to purchase it. Neither does the fiduciary relation of Phelps to the company, under the established facts, entitle the plaintiff to the relief demanded." *(Doscher v. Phelps Guardant Time Lock Co., 153 N. Y. S. 740.)*

New York Conditional Sales Law Held Not to Affect Interstate Commerce

(Federal) Where a monotype machine was sold by a Pennsylvania concern to a company in New York under the conditional sale plan, the New York law with relation to conditional sales must be strictly complied with, though the sale is one which has some evidence of being a transaction in interstate commerce. The United States Circuit Court of Appeals, Southern District of New York so held in Lanston Monotype Machine Co. v. Curtis.

One Curtis, a resident of New York City, purchased a monotype machine from the Lanston company, a Pennsylvania corporation. The sale was consummated in New York City and was conditional. Title was not to vest until the full purchase price had been paid which was $3240. Part of the purchase price was to be paid in advertising space in a journal of which Curtis was the editor. Curtis paid $1330 in cash and advertising and then defaulted. The monotype company took possession of the machine and made a resale, forgetting the provisions of the New York sales law which require that the vendor of goods sold on conditional sale must, on retaking the goods, hold them for thirty days giving the vendee an opportunity to perform the contract, and if he fails to do so sell the goods at public auction. Curtis brought suit to recover the $1330 alleging that the failure of the Lanston company to comply with the New York Sales law entitled him to the money which he had paid on the contract. On appeal, the United States Circuit Court of Appeals affirmed the holding, the court saying:

"We do not think the section of the personal property law relied upon by the defendant was a regulation of interstate commerce. No doubt it does indirectly affect such commerce, but it is in no sense a regulation of it. The purpose of the legislation is to protect the public against onerous and unreasonable contracts of conditional sale very likely to be misunderstood."

The contract having been executed in New York, and the monotype company not having exercised its right to cancel, the same is in our opinion a New York contract, to be governed by the law of that state. The parties evidently contracted with reference to the law of New York. The machinery was to be used there, and paid for there, and in case of the purchaser's default the remedies of the vendor were to be availed of there. Hence, when the monotype company retook the chattels, it did so subject to the provisions of the New York law regulating conditional sales. *(Lanston Monotype Machine Co. v. Curtis, 224 Fed. 405.)*

Machinery Subject to Lien

(Federal) The Ohio Code gives every person who furnishes machinery for altering a manufactory by virtue of any contract with the owner or lessee of the premises upon which the manufactory is situated, a lien to secure payment for the labor and machinery furnished. The law also provides that where machinery is furnished on leased lands, the leasehold shall be subject to the lien. Under this law a petition was filed in the case of E. A. Kinsey Co. v. Heckerman, trustee in bankruptcy, to establish a lien on certain machinery sold to the bankrupt James L. Patton. The Kinsey Co. had sold two wire-feed screw machines to the bankrupt, and the trustee in bankruptcy had refused to allow a lien on the machines asserting that the machines were not furnished for the purpose of "altering a manufactory" as prescribed in the law. The trustee in his report claimed that the machines were merely an addition to the equipment of the manufactory. The matter was taken to the United States Circuit Court of Appeals where the court held the installation of the machines to constitute the "alteration of a manufactory." *(E. A. Kinsey Co. v. Heckerman, 224 Fed. 313.)*

Injured in Starting Engine

(Federal) Where plaintiff was injured in trying to start a well-pumping engine, after he had oiled it, because the throttle allowed steam to leak into the cylinder, so that when he moved the engine from dead center it started suddenly he was entitled to damages for the injury irrespective of the fact that the owner of the machine believed the machine to be safe and had taken precaution to insure its safe condition *(Gillespie v. Collier, 224 Fed. 299.)*

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PUNCTUALITY

BY J P BROPHY*

There is no word in the English language that receives as much abuse as the word punctuality, and what is the reason? Weakness of human nature. Punctuality is a beautiful thing to talk and think about because it means so much when lived up to, but instead of being punctual thousands of people are merely procrastinators.

Time is everything to the individual who works his brain intelligently, either from the standpoint of pleasure or business, but the man who promises to meet you promptly at ten o'clock and wilfully forgets to do so or fails to keep his word, but hurriedly meets you at 10:30, giving flimsy excuses, is not in a class claiming punctuality. Such a person forgets that he is wasting your valuable time.

The meaning of this word punctuality is not to be considered along the lines of ordinary promises. Its meaning is far-reaching and extends deeply into the business world. When negotiating on any kind of deal, there is always a time named for doing things. The punctual business man is exceptionally careful not to overestimate his ability in naming a time in which any line of goods may be delivered. Not being punctual in many cases leads to serious misunderstandings and loss of business.

It is a source of great satisfaction to deal with an individual who is punctual, but the man who is constantly making promises which you know positively are not going to be kept is in many instances avoided. All this means that punctuality in all walks of life is a considerable asset.

To class an individual as a prevaricator is putting it strong, but a man who is not punctual is getting pretty close to that class. There is nothing so exasperating in the world as a promise broken. It leads to many annoyances in all directions, and very often prevents the performance of duties that should be taken care of. To say that you are going to do a thing at a certain time, knowing that you are not going to do it, means that you are in a class that should be avoided.

In the business world a common expression is: "We will have such and such a thing shipped in about ten days". This seems to be the first thing that enters any number of people's minds. Ten days seems to be an easy expression. The one to whom you say it, if he is not sure whether you mean it or not, is relying on these ten days, whereas you may be absolutely sure that it will be about twenty. This is where the word punctuality is abused in the extreme.

A really punctual person is admirable. You know that he means just what he says and will live up to his word. The man who is not punctual is an abuser of time; he is indifferent through his genuine selfishness. He cares nothing for the inconvenience of the one he is to meet or do business with in any form. He is thinking only of himself.

No doubt many promises that are made are intended to be kept, but something occurs that makes it impossible to keep them; however, the number of times that this happens is insignificant compared with the number of times the word punctuality is a misnomer. From a business standpoint, the false promiser is to be abhorred. He is dangerous in every way and will be shunned because of being an inveterate truth dodger, which creates disorder in business and otherwise.

The man who never discovers his own weakness as a promiser, who never sincerely means to qualify as dependable in either a social or business way is a menace, and this applies to both men and women.

* Vice-president and general manager, Cleveland Automatic Machine Co., Cleveland, Ohio.

METALS USED IN THE MANUFACTURE OF WAR MUNITIONS*

RESOURCES OF THE TWO SIDES IN THE WAR

In this article H. C. H. Carpenter attempts to compare briefly the resources of the Allies and of the Teutonic combination in respect to the metals which are essential for war purposes.

The most important metal is iron, the basis of the steel which is used in a multitude of ways. Both sides can show abundant resources of iron ore and of the plants necessary to produce the metal. The Teutonic deposits, however, would appear to be of lower grade from the fact that Germany makes 96 per cent of her steel in basic-lined furnaces and England only 36 per cent.

For shrapnel and high-explosive shell casings, open-hearth steel is used, and to make this from pig iron requires the addition of manganese. Thus manganese is very important; it is used in the form of spiegeleisen or of ferro-manganese to deoxidize the steel and to leave a small percentage in the finished product. Manganese producers in the order of their importance are Russia, India and the United States. In 1913 Germany imported about 670,000 tons of high-grade ore, chiefly from Russia, six or seven times her domestic production including Austria-Hungary. It is unlikely, however, that the shutting off of outside supplies will hamper her. Manganese is wide-spread in nature and while many deposits remain unworked because more valuable ones are available, in times of stress these could furnish large quantities of lower-grade ores. Germany could thus supply herself, and her metallurgists could easily solve the problem of handling the poorer material; it seems probable also that she had accumulated stores previous to the outbreak of the war, and she may be able to discover substitutes.

Nickel is an indispensable constituent of gun and armor-plate steel, as well as of the modern bullet and armor-piercing projectile. It is doubtful whether any satisfactory substitute could be found. The Canadian mines produce about 85 per cent of the world's supply, most of it refined in the United States, some in South Wales; New Caledonia supplies the balance except a little from Norway. Fully 98.5 per cent was produced in the allied countries before the war.

Nickel ores occur in the Teutonic countries and could furnish some metal, but they would be inadequate for the needs of Germany even if she gets the 400 tons produced by Norway. For in the first half of 1913 she imported almost 7000 tons of ore and 3500 tons of metal, while her exports were only 2409 tons of metal for the entire year.

Chromium is almost as important as nickel, being an essential constituent of armor plate and armor-piercing projectiles. Most of it has come from Rhodesia and New Caledonia, some from Russia and some from Greece and Asia Minor, the production of the last two countries having declined lately. It is likely, however, that Germany could obtain all she needed from Asia Minor even if Greece should join the Allies.

Copper is of prime importance in the manufacture of munitions of war. All shells are fitted with a copper band to expand into the rifling, thus stopping the passage of the gases, effecting the rotation of the shell and keeping the shell itself from contact with the gun barrel. Before the war, some zinc was used with the copper to lower the cost, but with zinc selling higher than copper this is no longer necessary. Copper is also used in cartridge cases, in shell fuse-heads and in Admiralty gun-metal and high-tension hydraulic bronze.

Of the world's output, about a million tons, the United States produces over half, Germany and Austria-Hungary about 3 per cent. All the belligerent countries except Japan imported from the United States. The Allies have obtained copper at will since the war began, while their enemies have been in straits. The latter have probably received a good deal through neutral countries, but their own production being only about 10 per cent of their peace consumption, it is certain that the use of copper is being restricted to purposes for which it is essential. Reserves must be greatly depleted and all producing plants worked to their utmost capacity, while strong efforts are being made to develop substitutes.

The use of aluminum has received a great impetus from its suitability for the construction of air craft. It is also valuable as an explosive. "Ammonal" consists of ammonium nitrate and finely divided aluminum. It is a disruptive explosive not suitable for propulsion but excellent for filling explosive shells. The United States and Canada have produced about half of the world's supply, the rest coming from France, England and Switzerland. The latter is available for Germany and Germany herself has become a producer, but the Allies, especially in view of the bauxite deposits of France, are in a far stronger position.

The five-fold advance in the price of zinc has been one of the most spectacular events of the war. Germany has heretofore smelted large quantities, drawn largely from Australia, but there are available supplies within the Teutonic boundaries. Great Britain is experiencing a shortage, due to inadequate smelting works, and has to draw upon the United States for most of her supply. Zinc as a constituent of brass is used in cartridge cases, and also for galvanizing barbed wire.

As for lead, Germany is a large producer, while the Allies draw most of their supplies from the United States, Mexico and Spain. Lead is used for bullets, the shrapnel bullet being a lead-antimony alloy. Antimony has advanced in price as has zinc; most of it comes from China.

Tin is used in bearing metals, various solders, tin plate and gun-metal. The ores come from the Straits Settlements and Bolivia chiefly. England has smelted a good deal. The Teutonic countries have heretofore relied upon imported ores for their supply and their domestic resources are inadequate.

It appears then that of the ten leading munition metals, Germany and her allies can produce five without recourse to imports, namely, iron, manganese, chromium, zinc and lead. It is questionable whether they could supply themselves with nickel, copper, aluminum, tin and antimony from their domestic deposits. It is reasonably certain, however, that before the war, they had laid in large stocks of these metals or their ores and that a very long war indeed would be required to exhaust them, while in that event it is a safe conclusion that their metallurgists will have been employed in the discovery of substitutes for the metals likely to run low. The Allies need have no fear of a shortage in any direction except that zinc may be scarce for a while.

* Abstract of article that appeared in "Nature."

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MONTHLY MEETING OF THE A. S. M. E.

The October monthly meeting of the American Society of Mechanical Engineers was held Tuesday evening, October 12, in the Engineering Societies Bldg., New York City. A paper had been prepared by Frank B. Gilbreth on "Motion Study for Crippled Soldiers," but Mr. Gilbreth was unable to present it owing to illness, and the paper was read by Robert T. Kent, a member of the society. In his paper, which was illustrated with lantern slides, Mr. Gilbreth stated that there are already two million men in Europe who have suffered the loss of limbs, faculties, or both as a result of injury in the war. The study of adapting these crippled men to machines for manufacturing operations or of redesigning machines to fit the men is a problem which will have to be solved in the near future. The lantern slides showed the use of the chronocyclegraph, micromotion and simultaneous cycle chart. The motions of the worker are photographed in such a way that they can be followed in a time sequence. By a study of these various motions in every sort of occupation, Mr. Gilbreth believes that the cripples may be utilized in many occupations in which, without the advantage of these special studies, they would be useless. In order to make headway with the crippled soldiers' problem, there must be general cooperation, and Mr. Gilbreth pointed to the need of photographs, records and histories of cases where cripples have been trained to do work that is usually performed successfully only by men in full possession of their limbs and faculties.

WAGES AND HOURS OF LABOR

U. S. Department of Labor, Bureau of Labor Statistics, reports that the highest wage scale per hour paid in May, 1914, in a few of the principal trades were as follows: bricklayers 87.5 cents, in Dallas and San Francisco; carpenters 65 cents, in Chicago; hod carriers 50 cents, in Portland, St. Louis, Salt Lake City and San Francisco; painters 70 cents, in Chicago; plasterers 87.5 cents, in Dallas and San Francisco; plumbers and gas fitters 75 cents, in Chicago, Dallas, Portland, St. Louis, Salt Lake City, San Francisco and Seattle; sheet-metal workers 68.8 cents, in Chicago and San Francisco; stonecutters 70 cents, in Portland and San Francisco; structural iron workers 70 cents, in Cleveland; freight handlers 60.6 cents, in New Orleans; granite cutters 68.8 cents, in New York; iron molders 50 cents, in San Francisco; linotype operators (Hebrew book and job) 83.3 cents, in New York; compositors (English newspaper) day work 75 cents, in Seattle. The building trades in the majority have an eight-hour day and most building trades also have a Saturday half holiday either for the whole year or part of the year. Inside wiremen, lathers, marble setters, fresco painters, sign painters, structural ironworkers and the granite and stone trades all have an eight-hour day in the cities reported and nearly all have a Saturday half holiday the year round. The hours of labor range from forty-four to sixty per week, fifty-four being the predominant number of hours. The printing trade and job offices in nearly all the cities covered and in the newspaper offices have an eight-hour day or less.

* * *

CALCIUM CARBONATE—NOT CALCIUM CARBIDE

Allow me to make a correction in the article on oxy-acetylene welding and cutting in the October number. It was stated on page 90 that in purifying air for the manufacture of oxygen by the liquid air method the air is drawn through a pit containing lime which absorbs the carbon dioxide by chemical reaction, resulting in the formation of calcium carbide. This is an error; calcium carbonate is the result, as shown by the following: Common quick-lime is CaH_2O_2 and carbon dioxide is CO_2; hence $CaH_2O_2 + CO_2 = CaCO_3 + H_2O$, and $CaCO_3$ is known as calcium carbonate and not as calcium carbide.

G. B. M.

* * *

THE NATIONAL MACHINE TOOL BUILDERS ASSOCIATION CONVENTION

The fourteenth annual convention of the National Machine Tool Builders' Association was held in New York City at the Hotel Astor, October 28-29. President W. A. Viall of the Brown & Sharpe Mfg. Co. presided. On account of the abnormal conditions produced by the huge war orders and widespread labor troubles the executive sessions took up the large part of the time. The usual meetings of the lathe, planer, drilling machine and other machine tool committees were held, in which the state of business in the individual lines represented, was discussed in detail. Charles Meigs Ripley addressed the members in open meeting on power and lighting plants.

* * *

U. S. Civil Service examinations will be held November 2 in Washington, D. C., Chattanooga, Tenn., Kansas City, Mo., and San Francisco, Cal., for the following positions: Senior electrical engineer, senior signal engineer, senior telegraph and telephone engineer, senior architect and senior structural engineer. The salaries of all these positions range from $1800 to $2700 a year.

* * *

QUOTATIONS OF WHOLESALE METAL PRICES

Week Ending October 22

Aluminum, pig, per pound, ton lots	$ 0.55
Antimony, Asiatic, per pound	0.29
Black sheets, No. 28, per 100 pounds, Pittsburgh	2.00
Copper, electrolytic, per pound	0.17¾
Copper, lake, per pound, New York	0.17¾
Galvanized sheets, No. 28, per 100 pounds, Pittsburgh	3.50
Iron bars, refined, per 100 pounds, Pittsburgh	1.40
Iron, pig, foundry No. 2, per ton, Philadelphia	16.25
Iron, pig, basic, valley furnace, per ton	15.00
Iron, pig, Bessemer, per ton, Pittsburgh	16.95
Iron, pig, gray forge, per ton, Pittsburgh	14.70
Lead, per 100 pounds, New York	4.50
Nails, cut, per 100 pounds, Pittsburgh	1.70
Nails, steel wire, per 100 pounds, Pittsburgh	1.80
Spelter, per pound, New York	0.13⅜
Steel angles, per 100 pounds, Pittsburgh	1.45
Steel bars, per 100 pounds, Pittsburgh	1.45
Steel beams, per 100 pounds, Pittsburgh	1.45
Steel billets, forging, per ton, Pittsburgh	34.50
Steel rails, per ton, at mill	28.00
Steel tank plates, per 100 pounds, Pittsburgh	1.45
Tin, per pound, New York	0.33⅜
Tin plate, per 100-pound box, New York	3.39
Wire, barbed, galvanized, per 100 pounds, Pittsburgh	2.70

The foregoing metal prices quoted are nominal, especially in the steel trade. The enormous demand for steel bars used in the manufacture of shrapnel and high-explosive shells has resulted in flooding the steel mills with orders, and while $1.45 per hundred pounds is the price fixed by the Carnegie Steel Co. for steel bars, large rounds are actually quoted at from $3 to $3.25 for quick delivery. The steel mills are months behind in deliveries, and at the present rate of order-taking their full capacity for 1916 will have been contracted for before the end of the present year. Brass is practically unobtainable in large quantities for early delivery. The railways, having postponed orders for equipment greatly needed a year or two ago when the mills were begging for business, now find themselves swamped with freight and unable to get quickly the rails and cars required to replace worn-out track and rolling stock. Heavy foreign demands for rails, bars and billets have forced prices up abnormally. Forging billets that ordinarily sell for $26 a ton have sold as high as $56 a ton.

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PERSONALS

L. A. Perris, importer and exporter, New York City, has removed his office from 80 Wall St. to 24 State St., where he has associated himself with the Warehouse Mercantile Co.

Robert Allan has been appointed district branch manager for northern California by the Burd High Compression Ring Co. His headquarters will be 847 Phelan Bldg., San Francisco.

E. Ashton has been transferred from the Canadian plant of the United Shoe Machinery Co. at Montreal, to the Beverly, Mass., plant, and is succeeded by C. W. Miess, as chief tool designer.

W. L. Wright has resigned the position of vice-president of the Keystone Watch Case Co. to take the position of vice-president of Driggs-Seabury Ordnance Co., Sharon, Pa., with offices at 50 Church St., New York City.

C. A. Bennett, foreign representative of the Fellows Gear Shaper Co., Springfield, Vt., has returned to England to take up the work there. Mr. Bennett made his headquarters in Paris, France, before the outbreak of the war.

Frank O. Hoagland, works manager of the Union Metallic Cartridge Co., Bridgeport, Conn., has resigned the position to become assistant to B. M. W. Hanson, vice-president and works manager of the Pratt & Whitney Co., Hartford, Conn.

E. P. Tuinhout, representative of Van Rietschoten & Houwens, Rotterdam, Holland, importers of American machinery, is in the United States on a six weeks' business trip for the purpose of securing agencies for American machine tools, woodworking machinery, box machinery, etc. His headquarters while in the United States will be MACHINERY's office, to which mail may be addressed.

* * *

OBITUARIES

Capt. John J. Knapp, commandant of the Philadelphia Navy Yard, died at the Naval Hospital in Philadelphia, September 28, of apoplexy, aged fifty-eight years.

Augustus J. Dubois for years professor of civil engineering in the Sheffield Scientific School, Yale University, died of heart failure, October 19, at his home in New Haven, Conn., aged sixty-six years. Prof. Dubois was widely known as a writer on engineering subjects.

Frederick J. Chisholm died in New York September 25, following a long illness, aged forty-one. Mr. Chisholm was an electrical engineer, and for a number of years represented the Allis-Chalmers Co. in the West and later the General Electric Co. in New York City.

Thomas Pattison, for more than fifty years a well-known railroad man in Western Massachusetts, died at his home in West Springfield, September 27, aged eighty-three years. He retired from the Boston & Albany R. R. shops in 1896 after a continuous service of forty-two years, during which time he assisted in building 137 locomotives.

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COMING EVENTS

December 7-10.—Annual meeting of the American Society of Mechanical Engineers, New York City; Engineering Societies Bldg., headquarters. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

Lowell Textile School, Lowell, Mass. Bulletin outlining the evening courses of the school for 1915-1916.

American Society of Mechanical Engineers, 29 W. 39th St., New York City. "Condensed Catalogues of Mechanical Equipment" containing a collection of catalogue data concerning the product of manufacturers of mechanical equipment, and a mechanical equipment directory classified. It also contains thirty-four pages of mechanical engineering data compiled from the transactions of the society, Vol. 36, and the "Journal" for the year 1914.

Society to Promote the Science of Management held a memorial meeting to Frederick W. Taylor in Houston Hall, University of Pennsylvania, Philadelphia, October 22 and 23. The speakers were Rudolph Blankenburg, mayor of Philadelphia, Carl G. Barth, Louis D. Brandeis, James M. Dodge, Edgar F. Smith, Henry L. Gantt, Harlow S. Person and Sanford E. Thompson. Appreciations from Prof. A. Wallichs, Royal Polytechnic School, Aix-le-Chapelle; M. Henri Le Chatelier, Paris; M. Charpy, director St. Jacques Steel Works; and Prof. J. J. Sederholm, University of Helsingfors, Finland, were read. A paper was presented by Richard A. Feiss of Joseph & Feiss, Cleveland, Ohio, entitled "The Relationship between Management and Employes as Developed at the Clothcraft Shops" The secretary of this society is Prof. Henry W. Shelton, 35 College St., Hanover, N. H.

NEW BOOKS AND PAMPHLETS

The Manufacture of Coke in 1914. By C. A. Lesher. 58 pages, 6 by 9 inches. Published by the U. S. Geological Survey, Department of the Interior, Washington, D. C. as Part II of the Mineral Resources of the U. S., Calendar Year 1914.

Influence of Temperature on the Strength of Concrete. By A. B. McDaniel. 24 pages, 6 by 9 inches. 13 diagrams. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 81. Price, 15 cents.

This bulletin presents a study of the data obtained from three series of tests of concrete cubes and cylinders, hardened under temperature conditions varying from 25 to 90 degrees F. and tested at various ages up to twenty-eight days.

Location of Ignition System Troubles Made Easy. By Victor W. Page. Chart 24 by 38 inches. Published by the Norman W. Henley Publishing Co., New York City. Price, $0.25.

The chart shows the ignition system of the internal combustion motor on a large scale and analyzes the causes of trouble under the following heads: Motor Will Not Start or Starts Hard, Motor Stops Without Warning, Motor Runs Irregularly or Misfires. Defects in components such as spark plugs, storage batteries, dry cell batteries, magneto, induction coil and wiring are noted in detail.

The Boy Mechanic. 480 pages, 6¾ by 9¾ inches. 995 illustrations. Published by the Popular Mechanics Co., 6 N. Michigan Ave., Chicago, Ill. Price, $1.50.

This book is the second volume of an interesting and comprehensive work for boys. It tells, as stated in its sub-title, about "1000 things for boys to do." This volume describes how to construct devices for winter sports, motion-picture camera, indoor games, reed furniture, electrical novelties, boats, fishing rods, camps and camp appliances, kites and gliders, pushmobiles, roller coaster, ferris wheel, art craft work and many other things. The many illustrations make the construction clear. This book should be of considerable educational value in teaching a boy the use of his hands, and there is no doubt but that every boy would find it a source of amusement and delight.

Empirical Design. By Leslie D. Hayes. 105 pages, 6 by 9 inches. 66 illustrations. Published by Carpenter & Co., Ithaca, N. Y. Price, $1 net.

This work was prepared to meet the needs of second year students in the department of machine design in Sibley College, Cornell University. The practical importance of empirical design was recognized and the need of giving students instruction made a book on the subject desirable. The author defines empirical design, stating that when a machine part has been proportioned from experience obtained in making other similar machine parts and without any direct application of the theory and principles of rational machine design it is said to have been designed empirically. The work deals with screw fastenings, keys and taper pins, shafting and shaft fittings, shaft fixtures, transmission members, pipe and pipe fittings; concluding with tables on decimal equivalents and trigonometric functions.

Forging of Iron and Steel. By William A. Richards. 219 pages, 5½ by 8 inches. 272 illustrations. Published by D. Van Nostrand Co., New York City. Price, $1.50 net.

This book on the hot working of iron and steel is a text-book for the use of students in colleges, secondary schools and shops. It treats of the various forms of iron; methods of manufacture of pig iron, cast iron, wrought iron, and steel; equipment required in the blacksmith shops; fuel and fires; drawing down and upsetting; bending and twisting; splitting, punching and riveting; uses of blacksmiths' tools; welding; electric, autogenous and thermit welding, brazing; tool steel; high-speed tool steel; art iron work; steam and power hammers; and miscellaneous matters. The illustrations are generally half-tone reproductions of crayon drawings in perspective. The work is elementary but comprehensive and should be an acceptable text-book for students generally.

Examples in Alternating Currents. By F. E. Austin. Published by F. E. Austin, 11 S. Park St., Hanover, N. H. Price, $2.40.

This work for students, teachers and engineers contains a large number of examples chosen to illustrate the principles of alternating currents, the application of fundamental principles being shown by completely worked out problems. The methods of the calculus are used freely without apology, as they produce results as nearly in accord with practice as are necessary in most cases, and insure a great saving of time in many solutions. The work is one that should be appreciated by students, teachers, electrical engineers and non-electrical engineers engaged in electrical work. It is valuable as a reference work for all classes desiring concise and exact information on electrical matters involving the principles of electrical currents. The illustrations are carefully made and include diagrams of electrical circuits with corresponding vector diagrams of pressure and current components. Diagrams showing the combination of sine-curve alternating quantities, simple applications of calculus and derivation of fundamental equations are inserted.

Saving Fuel in Heating a House. By L. P. Breckenridge and S. B. Flagg. 35 pages, 6 by 8 inches. 3 illustrations. Published by the Department of the Interior, Bureau of Mines, as Technical Paper 97.

This practical pamphlet may be studied with profit generally by those having to heat their own homes in winter. Much fuel is wasted by careless and irregular furnace firing. The pamphlet points out wasteful practices and shows how fuel can be conserved and uniform heating secured by proper furnace attendance. It deals with the characteristics of fuels used for heating residences including wood, anthracite, bituminous coals, sub-bituminous coal, lignite, peat, coke, fuel oil and gas. Heating with electricity is also touched on. The methods of heating residences are discussed under the headings of fireplaces, stoves, hot air, steam, hot water. The factors governing the consumption of fuel and convenience of operation next receive attention, these being climate, size and type of dwelling, location of dwelling, heating and ventilating systems used, size of boiler and furnace, kind of fuel used, care of furnace, including regulation of draft, firing and cleaning furnace, ash in different coals, etc. The pamphlet may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for five cents a copy.

Hendricks' Commercial Register of the U. S. for Buyers and Sellers. 1500 pages, 7½ by 10 inches. Bound in "Fabrikoid" imitation leather. Published by S. E. Hendricks Co., Inc., New York City. Price, $10.

The twenty-fourth annual edition of this well-known trade directory appears in a new dress, the matter having been reset throughout. The new edition has been thoroughly revised, name for name, and dead wood and useless matter have been eliminated. Many new names and headings have been added, the number of headings now being 17,143. The scope of the directory though broad is especially the architectural, contracting, electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries. It is indispensable to purchasing agents, and invaluable to sellers who wish to circularize any given trade or class of manufacturers. Those wishing to circularize architects, engineers, contractors, etc. will find these classes segregated, thus making readily available up-to-date mailing lists. The result of the revision has been the addition of many new names and lines of manufactures, but the elimination of useless names and headings has resulted in keeping the work about the same convenient size as heretofore. The contents are thoroughly indexed, 147 pages being taken for the index alone. The work is recommended to all having need for a comprehensive trade directory.

Rubber Machinery. By Henry C. Pearson. 419 pages, 6 by 9 inches. 428 illustrations. Published by the "India Rubber World," New York City. Price, $6.

This work by the editor of the "India Rubber World" is a cyclopedia of the machines used in rubber manufacture, including crude rubber washing, drying, preparing of ingredients, mixing, preparing of fabrics, calendering, vulcanizing, etc. Many new and improved machines have been developed in late years for working rubber and to supplant hand labor. Rubber manufacture is divided into some thirteen well defined classes, but in all these industries certain basic processes are employed, such as washing and mixing. The work treats of the washing of crude rubber; crude rubber drying; dry-sifting and batching of compound ingredients; mixing or compounding of rubber; preparing fabrics for calendering and spreading; calenders; clutches, drives and safety stops for mills and calenders; metal and rubber molds; general types of vulcanizers; screw and hydraulic vulcanizing presses; tube-making machinery; spreaders, doublers and surface finishers; cement and solution machinery; extraction of rubber and gutta percha from shrubs, vines, roots and leaves; extraction of resin from rubber and gutta percha; reclaiming; temperature recording and controlling devices; and rubber laboratory equipment. The work is one that should be generally appreciated by rubber mill superintendents and others concerned with the manufacture of rubber into its many varied forms.

Book of Progress. Compiled and edited by Albert A. Hopkins. Vol. I, 342 pages, 6½ by 9½ inches, Man the Creator; Vol. II, 337 pages, 6½ by 9½ inches, Man the Destroyer; Vol. III, 342 pages, 6½ by 9½ inches, Man and Nature. Published by the Cricks Publishing Corporation, New York City. Price, $9.

These interesting volumes, compiled chiefly from the volumes of the "Scientific American" within the last five years, cover a great variety of subjects of interest to the average man. Vol. I contains twenty-three chapters as follows: Moving Pictures, Tallest Buildings, Going Through the Shops, Some Curiosities of Motor Vehicles, Mobilizing the News, Some Recent Developments of Electricity, Crime and Its Detection, How Manufacturing Problems are Solved, Labor-Saving Duplicating Machines for the Office, Labor-Saving Appliances of the Modern Great Hotel, The Art of Making Statues, Concrete and Its Uses, Buying and Selling Gold and Silver, Things Postal, How Railroad Men are Made, Uncle Sam's Appraisers, Across the Continent by Telephone, Utilization of Animal Matters, Manufacture of Celluloid, The Rubber Industry, How Trees are Converted into Paper, The Manufacture of Twine, Woven Wire Netting. Vol. II, devoted to the mechanism and technique of warfare, contains twenty-five chapters as follows: An Army on the March, Protection for the Fighting Line of an Army, The Mechanism of a Battle, Field Gun and Aerial Projectiles, War Experiences of an Air Scout, The Art of Deception in War, Blowing Up Barbed Wire Entanglements, The Turret Fort, Siege Artillery, Mining and Countermining of Fortifications, Building Bridges Under Fire, Protecting a Retreating Army, The Motor Truck in Modern Military Service, Armored Automobiles, War Use of the Motorcycle, A Modern Military Camp, Trench Warfare, Getting the Range, A Fort that Travels on Wheels, Rapid Fire Machine Guns, The European Infantryman's Rifle, How Rifle Bullets Fly, The Bullets of the Nations, Dum-Dum Bullets, Grenades in Modern Warfare. Vol. III is divided into nine general sections as follows: Man and His Environment, Man and the Soil, Man and His Home, Education, Man the Athlete, Dangerous Avocations, Some Curiosities of Sound, Light and Heat, Psychology in Business, Some Miscellaneous Chapters. The three volumes contain 1614 illustrations and are cyclopedic in their range. The volume of the war is of extraordinary general interest. The submarine and means for protecting shipping from its depredations are treated at length.

NEW CATALOGUES AND CIRCULARS

Scranton Pump Co., Scranton, Pa. Bulletin 103, descriptive of Scranton jet condensers and vacuum pumps.

Conway & Co., Cincinnati, Ohio. Circular of "C. M. T." friction clutch expressly designed for machine tools.

Gardner Governor Co., Quincy, Ill. Pamphlets AC-9 descriptive of Gardner vertical air-cooled compressors and vacuum pumps.

E. G. Smith, 315 W. Park Ave., Tampa, Fla. Circular advertising "Which way" pocket level and Columbia open-face caliper.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Bulletin 213 describing "Simplate" flat disk valves for use in air compressors.

American Blower Co., Detroit, Mich. Circular illustrating installations of "Sirocco" heating and ventilating outfits. Applications of the "Sirocco" brick dryer are also shown.

Gardner Governor Co., Quincy, Ill. Pamphlets containing descriptive data of the Gardner-Rix vertical air compressor, Gardner governors, steam separators, and garage pumps.

American Steel Dredge Co., Fort Wayne, Ind. Bulletin No. 10 on "single-line" revolving steam shovels, type S, full-circle swing, for the use of excavators, builders, contractors, etc.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins 1040 and 1041, describing the Youngstown safety limit stop for direct-current motors, and type S crane switchboards for direct-current motors.

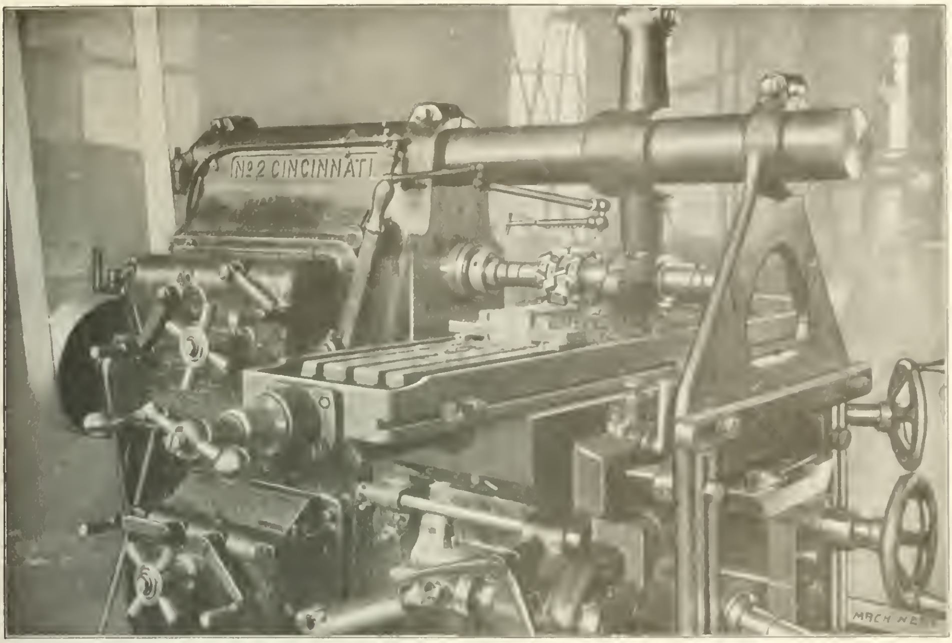
A. R. Williams Machinery Co., Ltd., 64-66 Front St., W., Toronto, Ont., Canada. Circular of the "Boyd" heavy-duty horizontal drilling machine for drilling billets for 18-pound high-explosive shells.

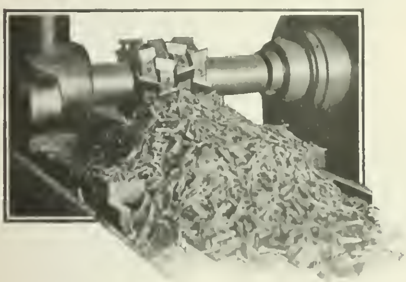
Cleveland Crane & Engineering Co., Wickliffe, Ohio. Circular of the Cleveland chucking lathe, a single-purpose turret lathe designed for turning three-inch to five-inch shrapnel and high-explosive shells.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Bulletin 216, covering the "Hummer" self rotating type of hammer drills, which are made in three sizes suitable for drilling 6-, 8-, and 12-foot holes, respectively.

Manufacturing Equipment & Engineering Co., 209 Washington St., Boston, Mass. Leaflets on sanitary bubbling fountains, sanitary washbowls, metal lockers, and miscellaneous metal sanitary and fireproof equipment.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio. Folder entitled, "Maintaining a Precedence in Exposition Awards" which illustrates and briefly touches on the company's exhibit at the Panama-Pacific Exposition.





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Edward R. Ladew Co., Inc. 137 Centre St., New York City. Booklet on leather belting, giving price-lists of single and double belts, round belting and twisted belting. Belt cements and leather preservatives are also kept in stock.

Hisey-King Mfg. Co., Osgood, Ind. Circular of supplementary vise jaws made of hard wood for use in machinists' vises, when gripping work that must not be bruised or marred. The hard wood jaws grip the work firmly without crushing or marring it.

Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn. Catalogue 14, illustrating and giving price-lists of adjustable stocks, gage blocks, pipe dies, machines for cutting-off and threading pipe, vises, pipe cutters, pipe wrenches, hand and machine taps, etc.

National Tracing Cloth Co., Saylesville, R. I. Sample of National tracing cloth, an American product woven in the mills of the National Tracing Cloth Co., and which has superior erasing and ink-taking characteristics. The cloth is highly transparent and free from pin-holes.

Conway & Co., Cincinnati, Ohio. Catalogue 1915-A of Conway solid compression clutches, clamp compression clutches, compression clutch pulleys, compression sleeve clutches and clutch parts, expansion clutches, expansion sleeve clutches and couplings, and expansion clutch parts.

National Machinery Co., Tiffin, Ohio. Circular of the "National" semi-automatic continuous hammer bolt header made in 3/4-inch, 1-inch and 1 1/2-inch sizes. The machine may be set to deliver a determined number of blows in making the bolt, from three to eight, depending on the quality of bolts wanted.

Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Circular illustrating the use of the Beaudry "Champion" power hammer for nosing shrapnel and high-explosive shells up to 155 millimeters diameter. These hammers are also being used in the manufacture of rifles, swords, bayonets, trench-digging tools, etc.

Yawman & Erbe Mfg. Co., Rochester, N. Y. Booklet descriptive of the "Mammoth" vertical file for blueprints and drawings, a cabinet which is so constructed that the drawings are filed flat in a series of manila pockets which are numbered to enable the blueprints or drawings to be indexed and readily located.

New Departure Mfg. Co., Bristol, Conn. Loose-leaf sheets 47 FE to 50 FE, descriptive of ball bearings in a special shaving machine, change speed gearing for machine tools, horizontal disk grinding for small work, ball bearings for cone pulley and change speed gearing, and ball bearings in vertical armature electric motor.

Simonds Mfg. Co., Fitchburg, Mass. Booklet on metal cutting saws, listing Simonds saws for Higley machines, for Q & C Bryant machines, and for other makes of metal sawing machines. The booklet also lists bandsaws, hack-saws, files, and contains a treatise on metal saws that is of general interest and value to all saw users.

Tate, Jones & Co., Inc., Pittsburg, Pa. Circular 148 entitled "Shells and Shell Furnaces," giving details on heating equipment for the forging, annealing, nosing, heat-treating, banding and baking of shells and annealing of cartridge cases for shrapnel and high-explosive shells, as called for by specifications of various European governments.

P. F. McDonald & Co., 178 High St., Boston, Mass. Circular of oxy-acetylene welding supplies, comprising Swedish welding wire, special welding steel, aluminum rods, cast-iron rods, tobin bronze, soft brass wire, manganese tobin bronze; fluxes for cast iron, aluminum, brass, copper, soft steel, vanadium, manganese steel, malleable iron, etc.

Henry A. Lowe, 1374 E. 88th St., Cleveland, Ohio. Circular of the "Last Word" universal test indicator with friction joint composite lever, adjustable through an arc of 210 degrees, adapted to inside or outside work. The range of the indicator is 0.040 inch, the ratio of movement of the indicator needle to the feeler is 60 to 1 and weight 1 1/4 ounce.

Lincoln Electric Co., E. 38th St. and Kelley Ave., Cleveland, Ohio. Pamphlet entitled "Welding with the Electric Arc" treating of the underlying principles of arc welding practice and illustrating many examples of repair work done. Data on time and costs are included. The Lincoln apparatus for electric arc welding is illustrated and described.

National Machinery Co., Tiffin, Ohio. Circular on outputs and tap speeds of the National automatic (bent tap) nut tapper, containing a table of speeds recommended for the National automatic nut tappers with various sizes of taps, ranging from 1/4 to 3/4 inch. The speeds given in this circular permit the best possible output to be secured with these machines.

Celburn Machine Tool Co., Franklin, Pa. Catalogue of heavy-duty drill presses of 24-inch and 36-inch swing. This book, in addition to describing the machines in detail, gives the drilling records made with these machines and illustrates the attachments supplied, which include tapping attachment, boring-bar and steady support, tapping hood and universal chuck.

Greenlee Machine Tool Co., Rockford, Ill. Circular "Series I." on Greenlee flat turret lathes. These lathes are built in two sizes, 2 1/4 by 26 inches and 3 1/4 by 40 inches. Both these sizes are arranged in either of two forms, one with the turret mounted on a cross-slide and suited for both bar and chucking work and the other with the rigid type of turret, revolving on the carriage without cross movement.

Union Chain & Mfg. Co., Seville, Ohio. Catalogue 3, illustrating and describing various types of chains ranging in pitch from [illegible] to 12 inches, for transmitting power, and for use in connection with the elevating and conveying of materials. This catalogue contains complete engineering data relating to the proper methods of laying out chain drives, designing and cutting sprockets, and the care of chain transmissions.

Morse Chain Co., Ithaca, N. Y. Catalogue 14 illustrating the application of the Morse silent chain drives in a large number of plants. Details of the installations are given, including size of chain and sprockets, and horsepower transmitted. One of the illustrations shows the largest chain drive in the world, used for transmitting 5000 horsepower from water wheels to a generator of a hydro-electric plant in Copperfield, Ore.

Greenfield Tap & Die Corporation, Greenfield, Mass. Circular of the "Lightning" garage repair set for Ford motor cars, consisting of an assortment of taps, dies and reamers, which have been found by experience to meet the demands of repair men working on Ford cars. Price of the set is $14.50. The circular also illustrates an emergency repair kit for Ford cars in a goatskin leather, canvas lined case. Price of this set is $18.50.

Carter & Hakes Co., Sterling Place, Winsted, Conn. Catalogue 3 covering the entire line of this company's manufacture, which includes Lincoln milling machines, with automatic quick return, hand milling machines, bench milling machines, plain index centers, half universal centers, screw and lever vises. Since the last catalogue was issued, the No. 2 hand miller and a wide-opening quick-operating lever vise have been added to the line.

S. K. F. Ball Bearing Co., 50 Church St., New York City. Catalogue illustrating the application of S. K. F. ball bearings in generators for car lighting. It is necessary in car lighting, of course, that continuous service be maintained, and this means that the generators must be so constructed as to withstand the severe conditions of railway service. One of the chief requisites is the provision of proper ball bearings. The book outlines the qualifications of S. K. F. ball bearings for this purpose.

Searchlight Co., 1016 Karpen Bldg., Chicago, Ill. Booklets entitled "The Searchlight Treatise on Acetylene" and "The Searchlight on Welding and Cutting." The first mentioned briefly describes the development of the uses of acetylene, the commercialization of oxygen and acetylene, purifying acetylene and points on the economy of purchasing acetylene in cylinders as compared with generating it as used. The second booklet gives some specific information on the welding and cutting of metals by the oxy-acetylene process and lists the specialized equipment used for welding and cutting.

Gisholt Machine Co., Madison, Wis. New catalogue J-7, illustrating and describing the standard Gisholt turret lathe. The book contains a general description of this machine, and illustrates the standard lathe and motor driven lathes. Tables of dimensions and shipping weights covering all sizes are given on page 9. A new design of standard boring and turning tools is shown, as well as bar-tools, facing heads and accessories, and full-swing wing rest. There are a number of illustrations showing operations performed on Gisholt lathes and parts that have been finished on these machines. Several interesting views show the Gisholt lathe at work in various shops.

Union Twist Drill Co., Athol, Mass., has just issued catalogue G on twist drills, reamers, gear and milling cutters, and machine tools. The catalogue contains 381 pages, 4 1/2 by 7 1/4 inches, and is full of valuable information for those interested in this line of tools. The cutter section comprises tables of dimensions and prices of various types of milling cutters, standard keyways for cutters, comparative curves of involute tooth shapes, formulas for determining the dimensions of gears by diametral pitch, sizing and cutting of gears, formulas for calculating diameters of sprocket wheels for roller chains, tables of dimensions and prices of hobs, formed cutters, end mills, metal slitting saws, screw-slotting cutters, etc. High power milling cutters comprise another section. The machine tool section gives information on sharpening cutters and shows universal cutter and reamer grinder, face and side mill grinding fixtures, cold-saw cutting-off machine, formed cutter grinders, circular grinding machines, hob grinding machine, spur gear testing machine, etc. The drill section gives suggestions for ordering special drills, points on grinding drills, dimensions and prices of twist drills, bit stock drills, drills for blacksmiths' drill presses, straight fluted drills, machine bits, bonding drills, combined drills and countersinks, left-hand drills, steel sockets and sleeves, collets, jewelers' sets of drills, drill cases. The section on reamers covers hand reamers, jobbers' reamers, shell reamers, chucking reamers, taper reamers, center reamers, reamer sets. The last section takes up arbors and contains miscellaneous information including tables of cutting speeds, decimal equivalents, tap drills, drill list for machine screw taps, screw threads, different standards for wire gage, thickness and weight of sheet steel and iron, horsepower of leather belting, and much other valuable information.

TRADE NOTES

Standard Spinning & Stamping Co., 170 Smead Ave., Toledo, Ohio, has changed its name to Toledo Screw & Stamping Co.

J. Morton Poole Co., Wilmington, Del., has sold its entire plant and equipment to E. I. du Pont de Nemours & Co., and has discontinued business.

Baker Bros., Toledo, Ohio, manufacturers of drilling machinery, have completed an addition to their machine shop that will increase its capacity about 50 per cent.

Post Van Der Burg & Co., 44 Whitehall St., New York City, has opened an office for the purpose of buying machinery, machine tools, metal goods, etc., for export trade.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., received the highest award for their drop forgings and drop forged tools at the Panama-Pacific International Exposition.

Earle Gear & Machine Co., Philadelphia, Pa., is erecting a one-story and basement brick and stone office building, 51 by 65 feet, on its property at Stenton and Wyoming Aves., Wayne Junction, Philadelphia, Pa.

Aberthaw Construction Co., Boston, Mass., specialists in reinforced concrete, industrial buildings, dams and water powers, has moved its main offices from 8 Beacon St. to the new Niles Bldg. at 27 School St.

Pope Mfg. Co., Westfield, Mass., maker of the "Columbia," "Cleveland," "Rambler," "Tribune" and "Crescent" bicycles and motorcycles, has sold its plant in Westfield to the Westfield Mfg. Co., which will continue the business.

Burd High Compression Ring Co., Rockford, Ill., announces the appointment of Robert Allan, as district branch manager for Northern California, with headquarters at 847 Phelan Bldg., San Francisco, where a complete stock of Burd compression rings will be carried.

Cincinnati Screw Co., Twightwee, Ohio, has purchased the plant and equipment of the Cincinnati Screw & Tap Co., consisting of over one hundred automatic screw machines of 3/4 inch to 2 inches capacity. The plant will be put into full operation immediately.

Joseph T. Ryerson & Son, Chicago, Ill., offered a prize early in the year for the best names suggested for their tool steel. The prize of $100 was awarded to Robert H. N. McNeilly, Nashville, Tenn., and P. R. Kohlsdorf, Milwaukee, Wis., for the name "Ryolite."

Pratt & Whitney Co., Hartford, Conn., has moved its stock of machine tools, machinists' small tools and gages from the Chicago store formerly occupied, to the new Sharples building, corner of Washington Boulevard and Jefferson St. The move was necessitated by the increased volume of business.

Metals Welding Co., 4400 Perkins Ave., Cleveland, Ohio, has established a department for the welding of steam boilers in charge of an expert boilermaker. The company is also prepared to send men with oxy-acetylene welding equipments to all parts of the United States to do boiler repair work.

Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., maker of engine lathes has increased its capital from $60,000 to $300,000. The increase of capital stock means no new activity or added capital for carrying on the business. It was added to absorb the surplus accumulated since the company was incorporated in 1891.

Maher & Byrne Co., 10 S. La Salle St., Chicago, Ill., representative of the Palm Vacuum Cleaner Co., maker of stationary vacuum cleaners, the Blaisdell Machinery Co., maker of air compressors and vacuum pumps, and the Kingsford Foundry & Machine Works, maker of centrifugal pumping machinery, has changed its corporate name to Anson-Byrne Co.

Acme Die-Casting Corporation, Bush Terminal No. 5, 35th St. and 3rd Ave., Brooklyn, N. Y., has found it necessary to increase its capital from $125,000 to $200,000 after eight months of business. Up to the present it has been working to full capacity and has been obliged to turn away orders. More space has been contracted for, which will double the capacity of the plant.

Waterbury Tool Co., New Britain, Conn., has purchased a ten-acre plot in Waterbury, Conn., on which a one-story machine shop, 212 by 120 feet, will be erected. The new plant will be ready for occupancy about June 1, 1916. The company has been manufacturing hydraulic variable speed gears for turret turning and gun elevating on battleships and upon the completion of the new plant in Waterbury, the business will be moved to that city.

Westinghouse Machine Co., East Pittsburg, Pa., has received a report from the chief engineer of the Quincy Market Cold Storage & Warehouse Co., Boston, Mass., on a 500 K.W. Westinghouse-Parsons turbine which has been in operation continuously for two years and eight months without the steam being turned off at the throttle. A short time ago, the turbine was shut down for an inspection which showed it to be in perfect condition.

T. A. Willson & Co., Inc., 3rd and Washington Sts., Reading, Pa., made a display of safety glasses at the Panama-Pacific International Exposition in the Collective Insurance and Universal Safety Exhibit that attracted much attention. Twelve different styles of safety glasses were on view, including glasses adapted for the use of grinders, machinists and others whose eyes require protection from flying particles. Seven different kinds of these glasses were shown, some with metal shields, some with leather shields and with other variations suiting them for different branches of work; also with glasses colored dark blue to protect the workmen from the glare of furnaces.

New Departure Mfg. Co., Bristol, Conn., at an annual meeting of the board of directors held October 19, elected DeWitt Page president; Frank P. Furlong, vice-president; C. T. Treadway, treasurer; and A. C. Hitchcock, secretary. The following directors were also elected: DeWitt Page, C. T. Treadway, F. P. Furlong, Charles F. Pope, E. R. Burwell, A. C. Hitchcock, Townsend G.

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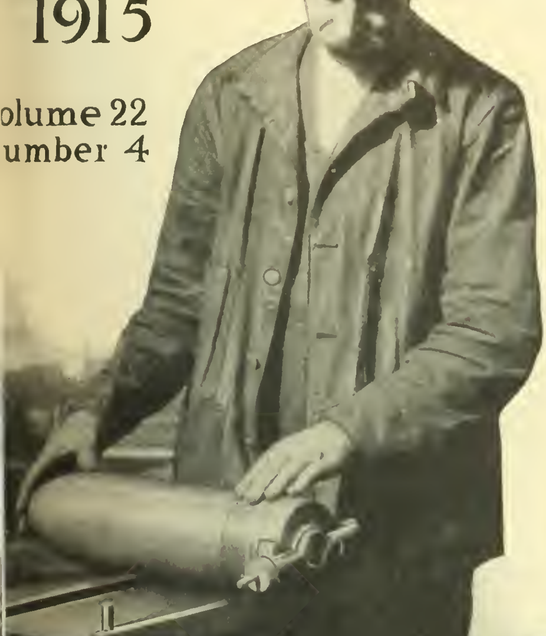

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Machine Tools Achieve Fame

Through the fearful instrumentality of a terrible war, the world has discovered that the machine tool industry, although relatively small in size and numbers employed, is an industry of such vital importance to a nation that government, civil and military, will hereafter need to have a definite knowledge of its character, extent and possibilities in order to realize the absolutely essential resources of a nation at war.

Behind guns and ammunition the world sees now, as never before, the men, machines and tools which must produce these implements and materials of modern warfare. They see the machinery manufacturer, the mechanical engineer, the machine designer and mechanic, not as mere commonplace figures in industry, but as factors of the utmost importance, to be mobilized like soldiers and war vessels, in military and naval plans and campaigns.

It is now realized by the people of every land, that great fortresses are of less importance to a nation than the capacity to produce guns and ammunition and to keep on producing them as rapidly as needed in the tremendous operations of modern warfare. The prosaic lathe, planer, drilling machine and other metal-working tools have taken on an importance rivaling the battleship and the submarine. The magnificent dreadnought, throbbing with life and terrible in its power of destruction, becomes a useless hulk, a helpless target, without the guns and ammunition produced in the machine shop.

It is well for the machine-tool industry that its importance in relation to warfare has been discovered, but of far greater significance is the fact that it will lead to a more general appreciation of the fundamental relation of this industry to the arts and industries of peace. And simultaneous with the discovery of what machine tools mean in war and in peace, will come the knowledge that in this country the industry has been brought to the highest point of development. In no country can be found in a single industry an aggregation of individuals manifesting so much mechanical ingenuity, manufacturing skill, technical knowledge and business enterprise. The High Explosive treatise in this number of MACHINERY is a convincing demonstration of high efficiency in American machine tools and machine-shop practice.

Production of Shells of the Common and Armor-piercing Types, Detonating Fuses, Cartridge Cases, Primers, Etc.

THE common high-explosive shell which is used chiefly for the destruction of fortifications did not come into general use until the latter part of the sixteenth century. About that time hollow balls of cast iron were filled partly with black gunpowder and partly with a slow-burning composition that was ignited by several different types of fuses. These shells did not give very satisfactory results. An improvement was later made that consisted in fitting into the shell a hollow forged iron or copper plug filled with slow-burning powder. The early shells were spherical in shape and were fired from smooth-bored guns (not rifled). They were used in this manner up to about 1871.

Development of High-explosive Shells

Upon the advent of the rifled gun, sabots, as shown in Fig. 1, were fastened to the base of the spherical shell and took the rifling grooves in the gun. These were usually made of wood and the rim was covered with sheet iron, steel or copper. When the first types of high-explosive shells burst, they broke into comparatively large pieces, and did not have a very destructive effect. Later developments consisted in making the shells from cast or forged steel and filling them with high-explosives such as lyddite, melenite, shimose, etc., instead of common black gunpowder. These shells were sometimes cast in sand molds head downward from steel of the proper composition to give the required strength. They were then annealed by leaving them in a furnace for a sufficient length of time to bring them to a red heat, after which they were removed and allowed to cool gradually in the air. The interior of the cast shell was seldom machined, except at the base end for the insertion of the base fuse, and the exterior was either ground or finished in a lathe and grooved at the base end to form a seat for the driving band.

Types of High-explosive Shells

There are four types of shells in use at the present time that may be said to be high-explosive. The first, but not the most common, is known as the high-explosive shrapnel shell. This type of projectile, shown at A in Fig. 2, combines the principles of both the high-explosive shell and the common shrapnel shell, and has been used by some governments within the past four or five years. In this shell the head or fuse carries a high-explosive charge and the matrix surrounding the bullets is a high-explosive material capable of being detonated by the detonation of the fuse. This projectile carries a combination time and percussion fuse and a base charge of black powder similar to the common shrapnel described in the April number of MACHINERY. For use as a common shrapnel, the fuse and bullets are expelled without any detonation,

the matrix serving to produce smoke as in the common shrapnel. The head or fuse continues in flight and detonates upon impact, causing considerable damage, and is capable of destroying the shield used in protecting a field gun. In the event that the fuse is set to explode upon impact, the high-explosive material in the head and the matrix in the shell detonate together, thus giving the effect of a high-explosive shell. The explosive commonly used in the head and as a matrix in this class of ammunition, is trinitrotoluol which is used in connection with fulminate of mercury, or other similar materials necessary to start the detonation. Fig. 4 shows the condition of one of these shells after being detonated upon impact, this shell not having filled the function of a common shrapnel shell. The projectile shown here is an American 3-inch caliber, high-explosive shrapnel weighing 15 pounds.

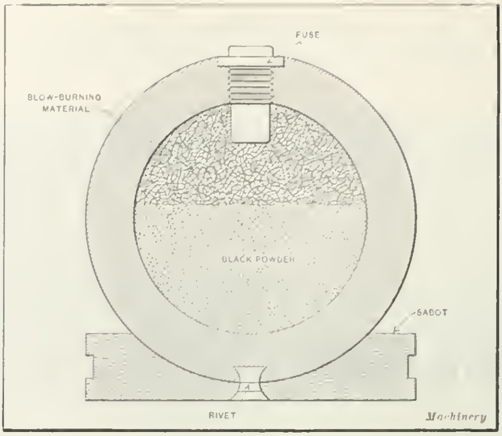


Fig. 1. Original Cast-iron Spherical High-explosive Shell

The shell shown at *B* in Fig. 2 is known as a common high-explosive shell, and is the type used in medium-caliber field guns by the Russian government. It will be noticed that the fuse or exploder is inserted in the nose end of the shell, and surrounding this there is usually a high-explosive, picric acid, lyddite or melenite, trinitrotoluol, etc. This shell is used principally against fortifications, although it can be used to some extent for field operations. It explodes upon impact and possesses enormous destructive power. Some idea of the great damage wrought by a modern high-explosive shell will be obtained by referring to Fig. 5, which shows the condition of an American 3-inch high-explosive shell after bursting. The fragments were obtained by exploding the shell in an enclosed sand pit.

The shell shown at *C* is used in coast defense and field guns and carries a fuse located in the base. When used by the American government in field guns, it is equipped with a delay-action fuse and carries from 3 per cent to 30 per cent of its weight of high-explosive. The lighter charged shells are used for repelling infantry attacks, whereas the heavier charged shells are used for destroying fortifications. One of these types is used as an armor-piercing shell; this contains a very large bursting charge and is furnished with a quick-acting fuse. It is used principally to repel attacks of light armored vessels or for attacking the upper works of heavily armored ships. It accomplishes its purpose by exploding upon impact, driving in the thin plates and destroying those parts not protected by heavy armor.

The type of shell shown at *D* in Fig. 2 is also known as an armor-piercing shell. This carries a much lighter explosive charge than the shell shown at *C*, and is made with much thicker walls. This shell carries a delay-action fuse, which permits the projectile to pass through the armor plate and into the interior of the vessel before exploding.

Construction of Modern High-explosive Shells

High-explosive shells are made at present in a variety of shapes and sizes, ranging all the way from 1.4 inch to 16 inches in diameter and from 1 to 2400 pounds in weight. The high-explosive shells used by various governments also differ considerably in construction. For instance, the American government uses a solid-point nose shell shown at *A* in Fig. 3. This shell is almost the same in construction as the armor-piercing shell, and can be used, of course, against light armored cruisers or the upper works of heavily armored ships. The shell is provided with a rifling band near the base and also with an inserted bronze plug in which the base type of fuse is held. The type of fuse used varies in accordance with the use to be made of the shell. For instance, in mountain guns, howitzers, and mortars, a centrifugal type of fuse as shown in the illustration is generally used, whereas for high-velocity field guns a ring-resistance fuse as will be described later is generally employed. The cartridge case and primer held in the base are similar in construction to those used on shrapnel shells. This type of high-explosive shell explodes upon impact only and the cavity is filled with an explosive

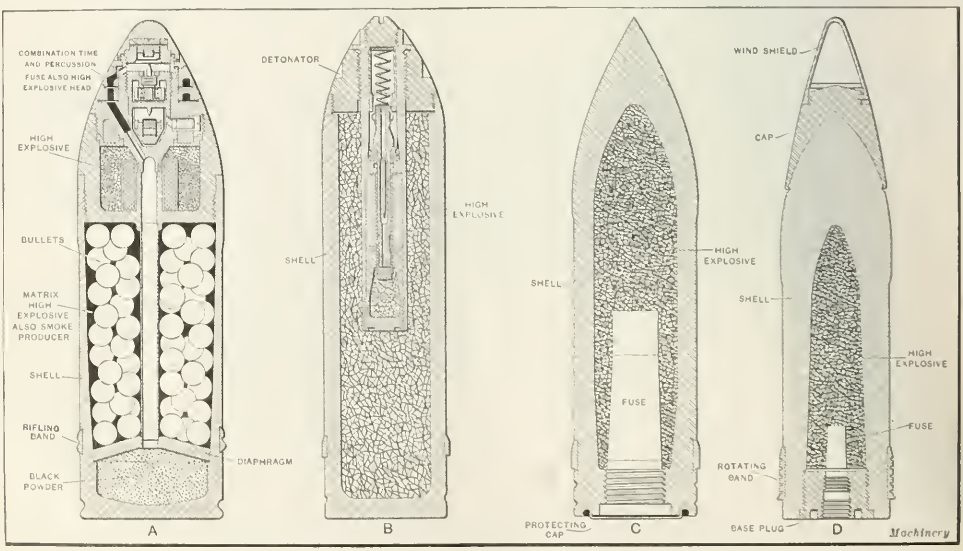


Fig. 2. Diagrammatical Views of Different Types of High-explosive and Armor-piercing Shells

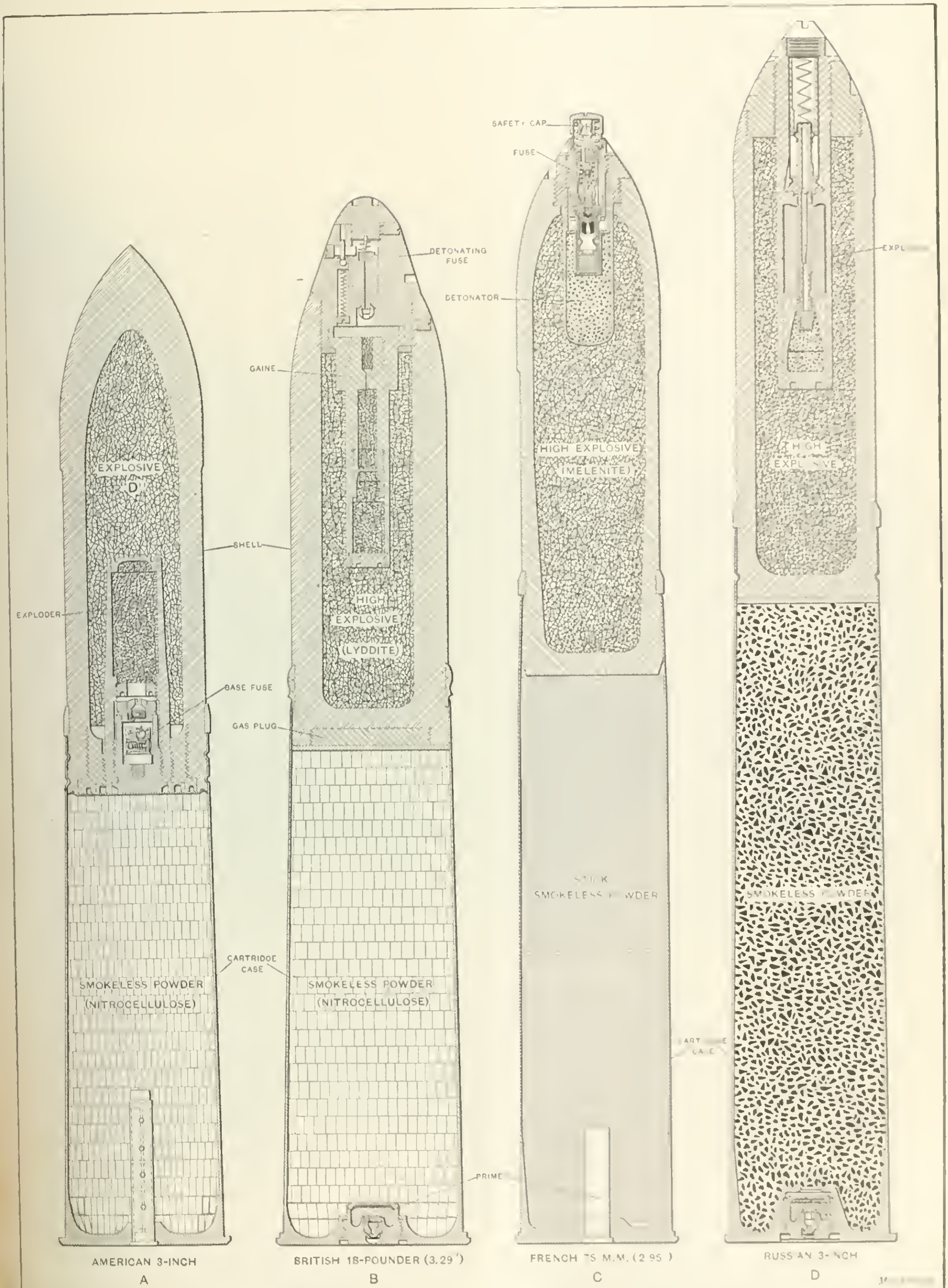


Fig. 3. Types of High-explosive Shells used by American, British, French and Russian Governments (About One-third Actual Size

called explosive "D" from its inventor Lieut.-Col. B. W. Dunn. This is also sometimes known as "dunnite." Dunnite is not a sensitive explosive and consequently it requires considerable shattering effect to detonate it. In order to accomplish this, quite a heavy detonating charge is used. The detonating composition is made of picric acid in various portions or T. N. T. (trinitrotoluol).

The British 18-pound high-explosive shell is shown at *B* in Fig. 3. This shell, it will be noticed, is provided with very thick walls and carries a charge of high-explosive, gen-

erally lyddite. A nose fuse instead of a base fuse is used and the fuse operates on percussion only as will be described later. In order that the lyddite be satisfactorily detonated, the fuse has an extension known as a gaine which continues down into the cavity of the shell for quite a distance. This gaine is filled with three different detonating materials, each successive one being more powerful than the last. In other words, this shell is set off by what is known as the delay-action fuse. This allows the shell to penetrate fortifications or earthworks before it is detonated, and consequently enables the explosion to have a much more destructive effect than if it took place instantaneously upon impact. This particular size of high-explosive shell is generally made from bar stock and in order to avoid chances of piping, a gas plug is inserted in the base of the shell as shown. The cartridge case and primer held in the base are the same as those used on the shrapnel shell.

The now famous French 75-millimeter high-explosive shell is shown at *C* in Fig. 3. This shell is made from a forging having comparatively thin walls, and it is hardened and heat-treated to increase its elastic limit and tensile strength. It also carries a delay-action fuse in the nose that is of interesting construction, as will be described later. The cavity in the shell is generally filled with a high-explosive known as melenite, the base of which is picric acid. The melenite which is used in the cavity of the shell itself is poured in while in a liquid form and solidifies upon cooling. The exploder, shown extending from the end of the fuse into the explosive, is filled with melenite in powder form. The characteristics of the detonator and bursting charge have to be similar in order that the greatest possible shattering effect may be produced. The fuse used in this shell is also of the delay-action type and enables the projectile to penetrate earthworks or fortifications before detonation takes place. The cartridge case is similar to that used on the shrapnel shell and is filled with smokeless powder (nitrocellulose) in stick form.

The Russian 3-inch high-explosive shell is shown at *D* in Fig. 3. The shell proper is made from a forging that is heat-treated before or after machining, depending on the practice followed. This must have an elastic limit of not less than 62,000 pounds per square inch and a tensile strength of 118,000 pounds per square inch. This shell also carries a detonating fuse in its nose, and upon reference to the illustration it will be noted that it differs considerably from any of the fuses previously illustrated. This fuse is not of the delay type, but is practically instantaneous and detonates the high-explosive material in the shell upon impact. The cartridge case carries a heavy charge of smokeless powder—generally nitro-cellulose—and also a primer in the base end somewhat similar in construction to that used in the British shell. This projectile has a muzzle velocity of over 1900 feet per second, and as the shell proper is heat-treated it has considerable destructive effect when the high-explosive contained within it is detonated.

Armor-piercing Projectiles

Following the introduction of iron sheathing for ships, it was found that the ordinary cast-iron high-explosive projectile did not readily pierce the plate, so that it became necessary to produce a projectile which would pierce the armor. This was accomplished by Sir W. Palliser, who invented a method of hardening the head of the pointed cast-iron shell. This was done by casting the projectile point downward and forming the head in an iron mold; the metal at the point being suddenly chilled became intensely hard, while the rest of the casting remained comparatively soft. The casting when partially cold was taken out of the mold and thrown down in the sand, where it was allowed to cool off gradually. These shells proved very effective against wrought-iron armor, but had little effect against steel armor plates. An improved shell was then devised which was made from forged steel with a point hardened so as to pierce the armor. This projectile is generally formed from steel containing both nickel and chromium, and sometimes tungsten. Armor-piercing shells are generally cast from a special mixture of chrome-nickel steel, melted in a crucible and afterward forged into shape. The shell is then thoroughly annealed, bored internally and turned on the exterior in a lathe. The heat-treatment consists in hardening the head of the projectile and tempering it in such a manner that the rear portion is reduced in hardness so as to render it extremely tough, whereas the point is extremely hard. There are two types of armor-piercing shells; one is known as a shot and is used for piercing armor, carrying a light bursting charge. The other is known as a shell; it carries a much heavier bursting charge, is longer, has thinner walls, and is much more destructive.

As shown at *D* in Fig. 2, the armor-piercing shell is similar in shape to the common high-explosive shell shown at *C*, with the one exception that the walls are much thicker and the point of a still greater thickness. In order to greatly reduce the air resistance encountered in flight, armor-piercing shells are provided with a long pointed outer covering

Fig. 4. Condition of an American 3-inch High-explosive Shrapnel after being exploded upon Impact (Annual Report, Smithsonian Institution, 1914)

for the head. It was also found that if an armor-piercing shell having a hardened nose struck an armor plate with great force, the force of the blow shattered the head and made it ineffective. A soft steel cap was then placed on the shell; this gave the point support and greatly improved the chances of the projectile getting through a hard armor plate unbroken. One of the plausible theories advanced as to the ineffectiveness of an uncapped head is as follows: When an uncapped projectile strikes the extremely hard face of a modern armor plate, the whole energy of the projectile is applied at the point, and the high resistance of the face of the plate puts the very small arc at the point of the projectile to a stress greater than the metal can resist. The point is therefore broken or crushed and the head of the projectile is flattened. This greatly reduces the penetrating power and results in the point of the projectile being practically welded to the armor plate. When a capped projectile strikes a hard plate, the resistance of the plate is distributed over a greater area, and, in addition, the point is supported by the soft metal cap. Consequently, the point is not deformed and passes through the plate.

The specifications for the test governing the manufacture of armor-piercing projectiles are very stringent and require that the shell perforate a hard-face armor plate as thick as the caliber of the projectile without breaking the point. In other words, a 6-inch projectile is required to completely perforate a 6-inch armor plate and pass through it in an unbroken condition.

General Methods of Manufacturing High-explosive Shells

At present there are two general methods of manufacturing high-explosive shells. One is to make the shell from bar stock, removing the excess material to form the cavity by means of high-power drilling machines, whereas the other is to forge the shell to approximately the correct shape. Until within the last few years, cast-iron shells were used quite extensively; these were cast in sand molds using a core to form the cavity. Great difficulty, however, was experienced in obtaining a casting free from flaws and other imperfections, and this method has generally been superseded by either the forged or bar stock shell. When the shell is made from bar stock, it is usually found necessary to fit a gas plug in the base end to eliminate any chances of piping. At present, cast-iron shells are still used for target practice.

High-explosive shells are made in three distinct types as has been already mentioned. They are those with a solid base carrying a nose fuse, those with a solid nose carrying a base fuse, and those with an open nose and base carrying a nose fuse. If the shell is intended to carry a nose fuse, the base end is shaped in forging by the press and the nose subsequently formed to shape by a nosing-in die. In small shells of about 2 inches diameter, the nose when red-hot can be spun over in the lathe by properly formed tools. However, it is usually closed in by a press. For base fuse shells, the nose is produced by the forging machine and the base is subsequently formed by pressing the metal to the required shape.

Generally speaking, the operations on a British high-explosive shell when made from forgings are as follows: Bar stock of the required diameter is first cut off into billet lengths, then these billets are heated to about 1900 degrees F., and by subsequent piercing and drawing operations are drawn out to the correct length and diameter. Following this, the mouth end and base end are trimmed and faced off. Then several operations are performed on the external diameter of the shell, such as turning, grooving, etc. The shell is then held in a chuck and several operations are performed on the cavity, after which it is nosed-in, the final operations consisting in machining the nose, pressing on the band, machining it, testing, etc. After the shell has been completely machined, it is filled with lyddite. In filling the shell, great precautions are taken to prevent the melted lyddite (which contains picric acid) from coming in contact with certain materials, such as combinations of lead and soda, which produce sensitive picrates. The shells are consequently painted externally with a special non-lead paint and lacquered internally with a special lacquer. The picric acid is then melted in a pot, the temperature being carefully controlled. Then certain ingredients are added to reduce the melting temperature of the picric acid. The melted material is then poured into the shell through a bronze funnel, the latter forming a space for the exploder. In cooling, the material solidifies into a dense hard mass.

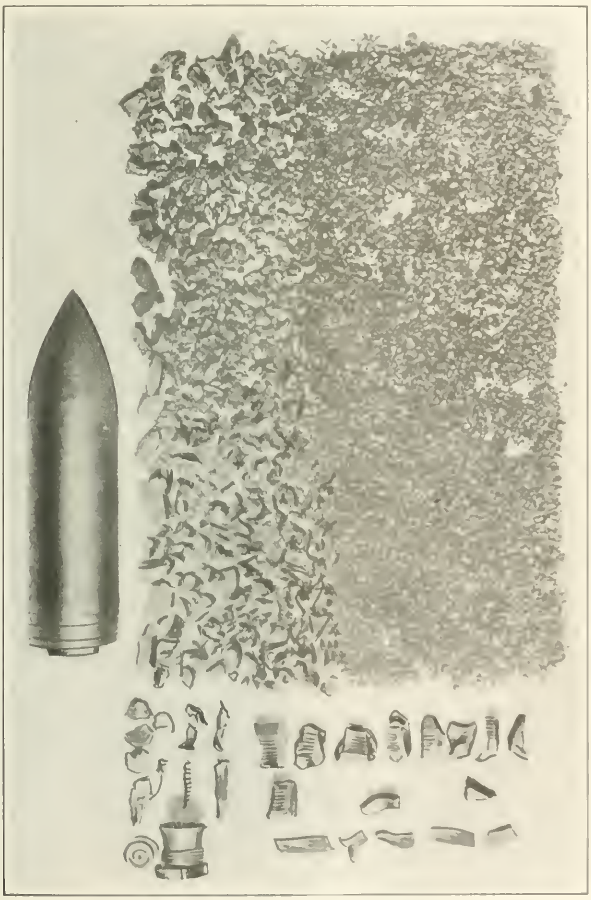


Fig. 5. Condition of a 3-inch American Common High-explosive Shell after passing through a Steel Plate and into a Bank of Sand, and after bursting (Annual Report Smithsonian Institution, 1914)

The French high-explosive shell was adopted in 1886. The high-explosive used in this shell was melenite and it was originally put into an ordinary cast iron common shell having thick walls. Afterward a forged steel thin-walled shell was introduced, as shown at C in Fig. 3. The general manufacturing methods on this shell are first cutting off a billet of the required length, heating and forging. The French shell is made with thin walls and consequently is hardened and heat-treated in order to give it the correct tensile strength. The operations on the French shell differ from those on the British shell in that no machining is done on the inside of

the shell or the cavity. Usually after forging, the forgings are pickled. Then the base end is faced and centered, the external diameter is turned, after which the shell is nosed-in. Following the nosing-in operation, the shell is hardened and tempered, after which it is faced off on the nose end, bored, reamed, threaded and finally ground or turned on the external diameter; after this the rifling groove is cut, the rifling band pressed in and turned to shape. In order to avoid the formation of picrates, the interior of the shell is lacquered, and the external surface painted with a non-acid paint. The melenite is then melted and poured in.

HIGH-EXPLOSIVE SHELL FUSES

Various types and forms of fuses or detonators are used in high-explosive shells, some governments using a plain type of concussion fuse held in the base end of the shell, and to which no gaine is attached. This fuse, of course, is set off upon the impact of the shell against fortifications or other obstructions. Others use percussion fuses of extremely complicated design which are provided with exploders that extend down into the cavity in the shell. These carry a detonating primer and exploding material for detonating the high-explosive contained in the cavity of the shell. Where ordinary black powder is used to burst the shell a high-power detonator is not necessary. The direct-action or impact fuses, of course, are more simple in construction than the combination time and percussion fuses, and they are usually made of material that will withstand considerable pressure without crushing.

High-explosive shell fuses may be divided into two distinct groups: First those that explode instantaneously upon impact, and second, those that explode shortly after impact, or in other words, those in which the detonating action is slightly delayed. From the standpoint of design and operation these groups are subject to a still further division. For example, some fuses are started or "unloaded" by the gas pressure in the gun, others upon rotation, and some a combination of both. Then there are the types employing split rings, centrifugal bolts, springs, etc., or a combination of two or more different actions.

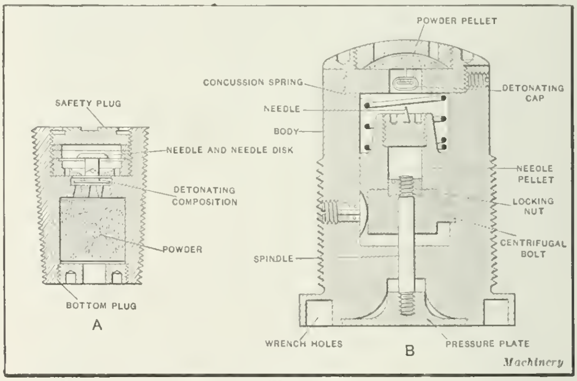


Fig. 6. Common Types of Concussion Fuses used in Nose and Base of High-explosive Shells

Common Type of Concussion Fuse

A common type of concussion or direct-action fuse which fits in the nose of the shell and is set off upon impact is shown at *A* in Fig. 6. The fuse body and other important members are made from steel of sufficient strength to be discharged from the gun without rupture, but upon striking, the needle disk is crushed in and the needle explodes the detonator which, in turn, explodes the powder in the base of the fuse. At *B* in Fig. 6 is shown the common type of concussion fuse used in the base of high-explosive shells. In this fuse, before firing, the needle pellet is held back by a central spindle which has a pressure plate attached to its rear end. A centrifugal bolt is also inserted for additional safety, which is released by the rotation of the shell. In action, this fuse works as follows: Upon the discharge of the projectile from the gun, the gas pressure pushes in the pressure plate so that the central spindle is carried forward, unlocking the centrifugal bolt. The needle pellet is then free to move forward and explode the detonating cap when the shell strikes. These two types of fuses are not very extensively used at the present time, and have been superseded in general by more complicated but effective fuses.

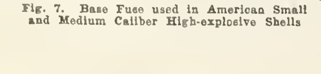


Fig. 7. Base Fuse used in American Small and Medium Caliber High-explosive Shells

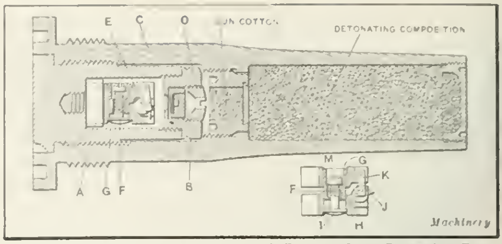


Fig. 8. Frankford Arsenal Centrifugal Type of Base Percussion Fuse

American Base Percussion Fuse

In American high-explosive shells fired from one- and two-pounders, as well as from six-pounders and 2.38-inch field guns, the type of fuse shown in Fig. 7 is used. This fuse is of simple construction and depends for its action upon the expanding of a split ring *A*. As the primer end of the fuse is toward the interior of the shell the flame passes from the priming charge *B* directly to the bursting charge in the shell without passing through the body of the fuse itself. The primer cup contains the percussion composition and priming charge, and is enclosed at its outer end by means of a brass disk *C* secured in place by crimping over the outer end of the primer holder, or brass closing screw *D*. The act of arming this fuse is simple, and as previously explained, depends upon the expanding of the split ring, which is accomplished when the shell strikes a solid body.

Centrifugal Type of Base Percussion Fuse

In the case of ring-resistance fuses, or in fact, in any fuse the action of which depends upon the longitudinal stresses developed by the pressure in the gun, the conditions of safety in handling and certainty of action are not all that could be desired. A fuse which is armed by the centrifugal force developed by the rotation of the projectile, and which is safe until the maximum velocity of rotation is nearly obtained, is secured in the Frankford arsenal fuse shown in Fig. 8, where a separate view of the expanding centrifugal plunger is also shown, presenting the firing pin in the armed position.

This fuse is used in shells fired from mountain guns, howitzers and mortars. It is made up of two principal parts, the body *A* and the closing screw *B*, which are held in the steel stock *C*; this also carries the detonating charge. The primer or detonating agent is also held in the nose of the fuse, and to reach the exploder the flame passes through a small vent in the primer closing screw *D* to the guncotton, which facilitates and increases the igniting effect. The centrifugal plunger, shown in the armed position at *H*, is made in two parts, which when the fuse is at rest are held together by the pressure of a spiral spring *F* contained in the cylindrical bushing *G* secured to each end of the plunger halves. The spring exerts its pressure on half of the plunger through the bolt *I*. Pivoted in a recess in one half of the plunger is the firing pin *J*, which, when the fuse is at rest is held with its point below the front surface of the plunger by the lever action of the link *K* that is pivoted to the other half. When subjected to the action of centrifugal force developed by the

rapid rotation of the projectile in passing from the bore of the gun, the two halves of the plunger separate. This separating movement causes the rotation of the firing pin J, the point of which is now held in advance of the front surface of the plunger, to pierce the brass primer shield and ignite the detonating composition. When the fuse is armed the end of the link K rests on the pivot of the firing pin, thus affording support to the firing pin when it strikes the percussion primer. The amount of separation of the plunger parts is limited by the nut M coming to a bearing on a shoulder in the bushing G, and thus preventing the diameter of the expanding plunger from equalling the full diameter of the hole in the fuse body. A stud screwed into the head of the fuse stock engages a corresponding slot cut through the bottom of both plunger halves and insures the rotation of the plunger with the shell. The strength of the spring F is adjusted so that the fuse will not arm until its rapidity of rotation is a certain percentage of that exerted in the shell in which it is used, and so that it will surely arm whenever the rapidity of revolution approximates the speed of rotation of the shell when fired. In the case of the parts of the plunger being accidentally separated and the fuse armed by a sudden jolt or jar in transportation or handling, the reaction of this spring will immediately bring the plunger back to its unarmed position.

British High-explosive Fuse

The fuse shown in Fig. 9 is known as the British 100-graze high-explosive fuse, and it is used in British high-explosive shells that are fired from field and mountain guns. This fuse explodes upon impact only and screws into the nose of the shell. All of the parts of this fuse except the adapter and gaine are made from brass or bronze. It operates as follows: When the shell is fired, and before it commences its rotary motion imparted by the rifling in the gun bore, the impact of the explosive charge in the case causes the combined top and bottom detent A and B respectively, to drop back and compress the detent spring C. The detent assembly, as will be seen, is made in two pieces, and as the stem A is free to move out of alignment it drops to one side, by the action of gravity, when it is forced back; thus it is caught by the edge of the counterbored hole and prevented from taking its original position.

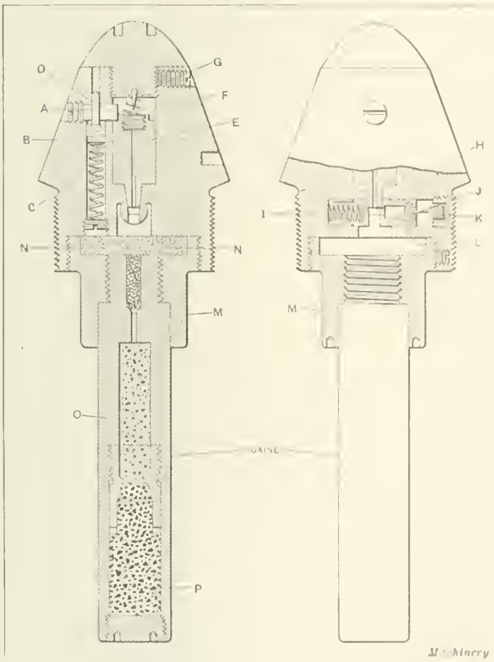


Fig. 9. British No. 100 Graze High-explosive Shell Fuse

By this time the centrifugal action of the shell throws centrifugal bolt D, whose path is now clear, out of the way of the graze pellet E. The only member that now prevents detonation is the hair spring F. The slightest impact causes the relatively heavy graze pellet to jump forward and explode the shell. The primer that is held in the counterbored end of the graze pellet is exploded upon impact with needle G, and from here the flame extends down into the other explosives in the gaine as will be described later. The primer in pellet E is loaded with a composition composed of 45 parts chlorate of potassium, 23 parts sulphide of antimony and 32 parts fulminate of mercury. The different constituents are measured by weight, and are loaded into the primer cup under a pressure of 600 pounds, after which the cup carrying the explosive charge is dried.

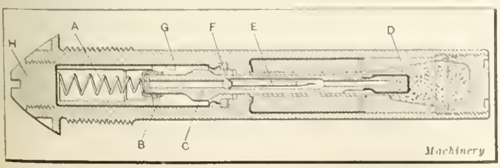


Fig. 10. Russian High-explosive Shell Detonating Head

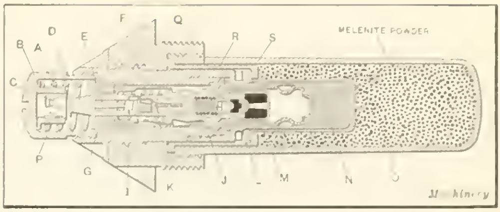


Fig. 11. French Detonating Fuse for Use in 75-millimeter High-explosive Shells

Should the primer in pellet E, for any reason, fail to explode, there is a second detonation that takes place simultaneously. As will be seen in the view to the right, the lower end of pellet E is tapered and is seated in a cross hole in the percussion pellet H. When the graze pellet moves forward, pellet H is released and the centrifugal action combined with spring I drives the pellet carrying needle J against primer K, exploding it. The flame passes through four small holes in the needle holder L, thence into the chamber and from there down into the gaine containing the detonating charges.

The gaine is held to the fuse body by adapter M. It is provided with three chambers N, O and P, which contain different high-explosives, each succeeding one being of greater power than the last. Chamber P is filled with lyddite in flake form. The flame from the detonating primers first explodes the material in chamber N, then that in chamber O and then that in chamber P, which causes such a terrific shattering effect that the lyddite in the shell is detonated and blows the shell to atoms—some parts to the fineness of sand. It is stated upon good authority that after a shell has been detonated it is impossible to find the gaine or its parts, so terrific is the effect of the explosion.

Russian High-explosive Fuse

The Russian high-explosive fuse or detonating head used in high-explosive shells is shown in Fig. 10. This detonating head explodes upon impact, and the gaine is a part of the head, extending down into the explosive material in the cavity of the shell. It operates in the following manner: The force of impact of the shell against a solid body overcomes the resistance of spring A and stirrup B, allowing striker rod C to move forward into the cavity occupied by spring A. Attached to the lower end of striker rod C is a detonator pellet D. This carries a charge of mercury fulminate and in coming in contact with the steel needle E is exploded. The flame passes from this detonator down into the detonating composition held in the base of the fuse and ignites it, thus exploding the high-explosive material held

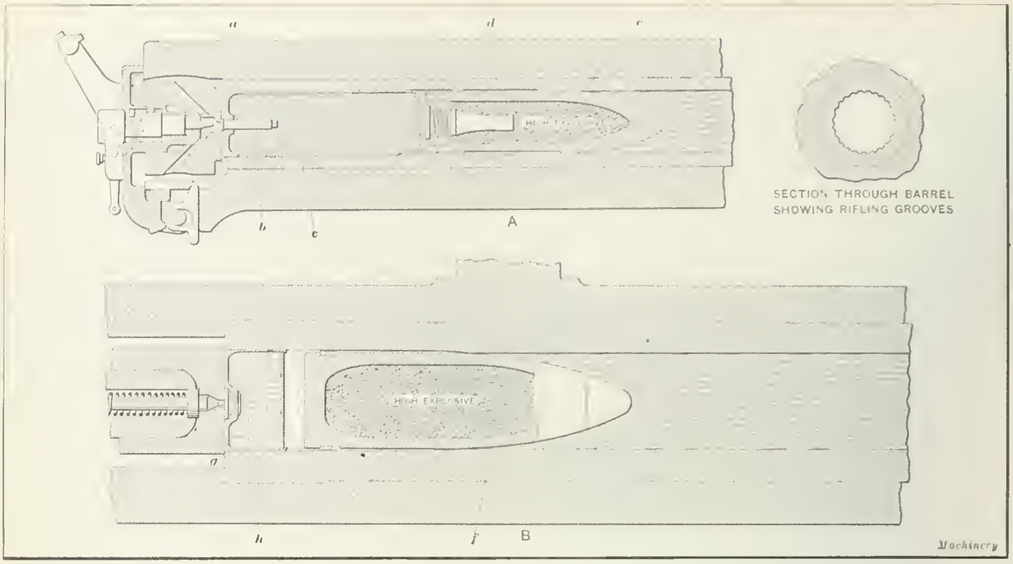


Fig. 12. Diagram illustrating Method of retaining Propelling Charge in Field Guns and Howitzers

in the cavity of the shell. Needle *E* is held in a steel plug *F* and the latter is kept from moving up with striker rod *C* by means of a striker casing *G* which is crimped around it as shown and extends up through the body of the fuse, coming in contact with the lower face of the head plug *H*. In order that the body of this detonator be capable of resisting considerable shock, it is made from high tensile strength steel, generally alloy steel, of about 110,000 pounds per square inch tensile strength.

French High-explosive Fuse

A high-explosive shell fuse of the delay-action type used in the French 75-millimeter high-explosive shell is shown in Fig. 11. This is provided with a safety head and is carried in the nose of the shell. In action, this fuse works as follows: Upon the discharge of the projectile from the bore of the gun the gas pressure overcomes the resistance of spring *A*. This causes bushing *B* to drop back, and stirrup *C*, which is held to it as shown, grips the head of plunger *D*. Plunger *D*, it will be noticed, completely envelopes firing pin *E* and prevents the detonator *F* from being accidentally discharged. When this plunger is withdrawn it exposes the firing pin *E*, which is riveted to the retainer *G*, and does not move with the plunger.

The fuse is now in the armed position, and as soon as it strikes a solid body the resistance of springs *I* and *J* is overcome and primer *F* is thus free to contact with firing pin *E*. The flame from primer *F* ignites guncotton *K*, and the powder surrounding it. This ignites the compressed gunpowder in cups *L* and *M*, which results in quite a powerful explosion and explodes the detonating composition in cup *N*. This, in turn, explodes the detonator *O* which is filled with melenite in flake form. It will be seen from this that the fuse does not detonate the high-explosive composition in the shell instantaneously, but causes a series of explosions, finally resulting in the detonation of the melenite in the shell by the exploder which extends into it. All the working parts of this fuse are made from brass or bronze with the exception of safety cap *P*, nose *Q*, cup *R* and exploder cup *S*; these are made from steel.

LOADING PROPELLING CHARGES IN GUNS AND HOWITZERS

In the early cannon the spherical shot and powder charges were rammed in from the muzzle of the gun the same as in loading small arms. It was not until early in the eighteenth century—in fact, 1845— that a successful breech loading gun was designed. In this case, the projectile, which bore a marked resemblance to the present-day type, was placed in the gun from the breech end with a propelling charge of black powder packed in behind it, the vent being closed by a hinged door. Following this, several different types of breech closing mechanism were developed, and in England in 1854 the Armstrong breech loading gun was designed. The projectile and propelling charge, however, were still made up in separate units, and it was not until the middle of the nineteenth century that fixed ammunition was used in field guns. In early cannon the barrels were made from either bronze or cast iron, bronze being used for field guns and cast iron for large coast artillery. These two metals were subsequently abandoned, and forged steel was used in their place.

Fixed Ammunition

Fixed ammunition is the name given to that class of shells in which the propelling charge for the projectile is held in a cartridge case attached to the rear end of the projectile. In other words, the projectile, propelling charge and firing member or primer form a complete unit. The diagram at *A* in Fig. 12 shows a sectional view of a 3-inch field gun with the complete round of ammunition inserted in the breech. Here it will be noticed that the gun is chambered to receive the projectile and cartridge case, and carries a breech-block containing the striker mechanism. Upon the operation of the striker mechanism, firing pin *a* hits primer *b*, igniting the percussion cap in its head which, in turn, ignites the black powder charge in the body of the primer itself. The propellant in cartridge case *c* is now ignited, and almost instantly converted into a gas. The gas thus formed occupies a much greater volume than the original material, with the result that the projectile *e* is started on its journey through the bore of the gun.

As soon as the projectile starts forward, the copper rifling band *d* is forced into the rifling grooves in the bore of the gun, which are located in a helical path. This results in the projectile being rotated at the same time that it advances. In addition to rotating, the rifling band also centers the projectile and at the same time prevents the propelling gas from escaping past it. Modern propellants, by virtue of their ingredients, are of the slow-burning variety, and consequently the gas pressure increases, with the result that the projectile increases in velocity from the time that it leaves the breech until it reaches the muzzle of the gun. To provide for this, the rifling grooves in some guns are not made of a uniform twist, but increase in pitch as they reach the muzzle of the gun. For example, in the 3-inch American quick-firing field gun, the rifling grooves start at the breech with a twist of one turn in 50 calibers, and increase to one turn in 25 calibers

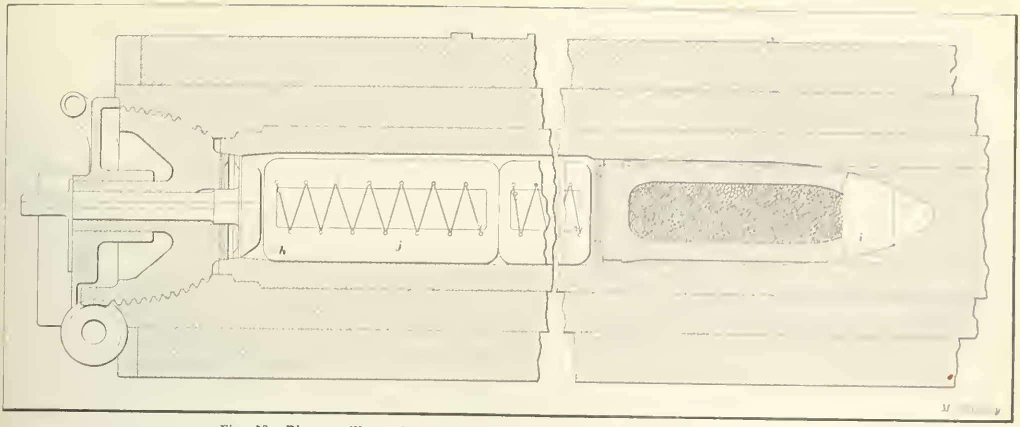


Fig. 13. Diagram illustrating Method of retaining Propelling Charge in 6-inch Gun

at a distance of 2½ calibers from the muzzle. It is therefore evident that as the velocity of the projectile is increased, the speed of rotation upon its axis is accelerated. This in part accounts for the comparatively flat trajectory of the modern high-power quick-firing gun in comparison with the older and less efficient guns.

Loading Howitzers and Mortars

A howitzer differs from a quick-firing field gun in several ways. First, the barrel is much shorter; second, no cartridge case is used (except for medium-caliber howitzers where a short case is sometimes used); third, the muzzle velocity is only about one-half that of a quick-firing gun of the same caliber; and fourth, it is used for high-angle firing, particularly against troops protected by entrenchments or other shelter. The diagram *B*, Fig. 12, shows a section through the barrel of a 4.5-inch howitzer. It will be noticed that the projectile *f* is not fixed to the cartridge case *g* but is separated from it. The difference between this cartridge case and the one shown at *A* is in length only. The howitzer cartridge case is of a length equal to about one-half the caliber, and carries a comparatively light propelling charge of smokeless powder *h*, that is held in the case by wads. Having the ammunition arranged in this manner makes possible the varying of the charge depending upon the results wanted. In larger-bore howitzers, 6-inch caliber, a charge of powder in the form of doughnuts or large disks is used. These are placed directly in the breech of the gun, and no cartridge case is used.

Another type of gun that bears a marked resemblance to the howitzer is the mortar. These are classified under two principal headings, field or trench, and coast-defense mortars. This gun differs from the howitzer only in the length of the barrel, the latter being still shorter than that of the howitzer. Fixed ammunition is never used in a mortar, and its chief application is for high-angle and vertical firing.

Loading Propelling Charges in Large-caliber Rapid-fire Guns

Fixed ammunition is used in rapid-fire guns from the 1-pounder (1.45 inch) up to and sometimes including 6-inch guns. In guns of a larger caliber than this the projectile and propelling charges are separated. Fig. 13 shows a section taken through the chamber and barrel of a 6-inch rapid-fire gun. Here it will be noticed that the projectile *i* is separate, and located between the projectile and the breech-block is a propelling charge of smokeless powder and detonating cap contained in silk bags *j*, the number of bags depending on the size of the gun and the weight of the charge put up in each. These bags are made from raw silk with the ends made double-ply, and between the two pieces at each end is placed a priming charge of black powder quilted in, in squares of about 2 inches, and uniformly spread over the surface. The charge used for propelling a projectile of this particular size of gun weighs about 24 pounds and consequently only two bags would be needed. The obturator *k* acts as a gas check and at its rear end carries the electric primer. In larger-bore guns several bags of smokeless powder are inserted. For instance, in the 16-inch American gun six bags containing a total of 666.5 pounds of smokeless powder are used. The method of igniting the powder charge is by means of either a friction or electric primer shown at *A*, *B* and *C* in Fig. 14. The primer, of course, is not a part of the propelling charge, but is held in the breech-block of the gun.

FRICTION, ELECTRIC AND PERCUSSION PRIMERS

Various types of primers are used in howitzers and field guns for igniting the propelling charges. For guns using fixed ammunition the primer is carried in the base of the cartridge case, whereas for guns firing "loose" projectiles the primer is held in the breech-block. Inasmuch as large and medium size caliber projectiles will receive attention in the following article, it would seem advisable to describe briefly two of the principal types of primers used in the breech-blocks of guns. Fig. 14 shows the common type of friction primer which may be fired either by friction or by electricity.

This primer comprises a brass case *a* held in the breech-block of the gun, and carrying an interior case *b* enclosing the firing or igniting elements. When used as a friction primer, an angular pellet *c* of friction composition is pressed into case *b* and rests on a vulcanite washer *d*. This washer supports the friction composition and prevents it from crumbling when rod *e* is pulled to ignite the primer. The inner end of firing rod *e* is loosely surrounded by serrated cylinder *g* the latter being embedded up to the serrations in the friction composition. The inner end of the firing rod is provided with a head that operates upon cylinder *g*, and these parts are securely held in place by forked lever *h* and nut *i*. (See enlarged section at *B*.)

In operation, when rod *e* is pulled, serrated cylinder *g* is drawn through the composition c and ignites it. The conical end of the cylinder is then drawn to its seat in the rear part of the primer and prevents the escape of gas at the rear. The flame from the friction composition passes through vents in closing nut i and ignites the priming charge of compressed and loose black powder in the body of the primer. The resulting explosion blows out the cemented brass cup [illegible] in the mouth of the primer and thus allows the flame to pass through the breech-block to the propelling charge in the breech of the gun.

In order to adapt this primer for electric firing, rod [illegible] is covered with an insulating cylinder *k* and enters the primer through vulcanite plug *l*. Rod *e* is in electric contact with the serrated cylinder *g*, but this is insulated from the primer body by washer *d* and the pellet of friction composition which is a non-conductor of electricity. The electric circuit is completed by platinum wire *m* that is soldered to fork *h* and nut *i*. An igniting charge of guncotton surrounds the wire.

In operation, when the primer is inserted in the gun, in-

sulated button n on rod e is grasped by an electric contact piece through which the electric current passes. The passage of the electric current heats the platinum wire, igniting the guncotton and the priming charge of powder. In this primer the frictional and electrical elements are independent and when it fails to fire by electricity it may still be fired by friction.

Percussion Primers

In fixed ammunition where the cartridge case forms a unit with the projectile, the firing is done by means of a primer held in the cartridge case. D in Fig. 14 shows the primer used in the head of American 3-inch cartridge cases. This

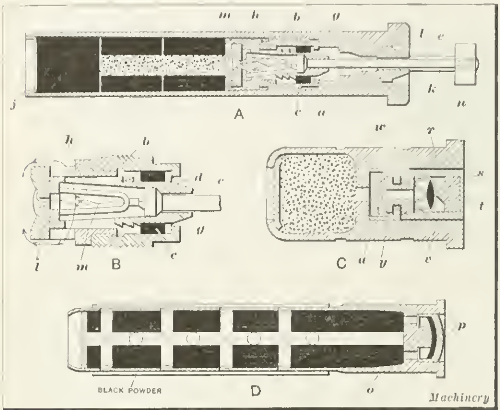


Fig. 14. Friction, Electric and Percussion Primers

is known as the 110-grain percussion primer, and consists of a brass case o resembling in shape a small-arms cartridge case, in which a percussion cap is held. The head or rear end of the primer case is countersunk to form a cup shaped recess in which the percussion primer proper p is located. The latter consists of a cup, anvil and percussion composition. The percussion composition is composed of the following ingredients:

Ingredients	Per Cent
Chlorate of Potash................	49.6
Sulphide of Antimony.............	21.5
Glass (ground)	16.6
Sulphur	8.7

Owing to the danger involved in the handling of mixtures containing fulminate of mercury, the Frankford Arsenal has abandoned this ingredient and substituted the ingredients given above for use in the service primers.

The percussion cap recess is connected with the interior of the primer case by two small vents. The body of the case contains 110 grains of black powder that constitutes the rear "priming" or igniting charge for the smokeless powder propellant. This black powder is inserted in the case under a pressure of 36,000 pounds per square inch, and is pressed into the primer body around a central wire which is then withdrawn leaving a longitudinal hole the full length of the powder charge. Eight radial holes are then drilled through the primer body and compressed powder, thus affording sixteen vents for the free exit of the black powder flames to the smokeless powder charge. After filling the case, the front end is closed by a cardboard wad covered with shellac and the radial perforations are covered by a tin foil wrapper so as to retain any loose black powder and exclude moisture.

In action, the firing pin hits the percussion cap and explodes it. This ignites the black powder charge, and the flames from the latter shoot out through the vents in the case and ignite the smokeless powder charge. In order to make the combustion of the smokeless powder complete, a second igniting or priming charge is generally used. In the 3-inch shell this additional charge consists of ¼ ounce of black powder which is contained in a disk shaped bag placed in the case directly in front of the smokeless powder charge.

Another percussion primer which differs considerably from that illustrated at D in Fig. 14 is shown in Fig. 15. This particular primer is used in British 18-pound cartridge cases. It comprises a brass cup A, threaded on the external diameter so as to screw into the pocket in the head of the case, and recessed and threaded to receive the anvil B. This, in turn, is counterbored to receive a brass ball C and is also provided with three fire holes. It is backed up by means of a plug D, the latter being sealed with a paper disk E secured with Pettman's cement. Seated on the head of anvil B is the percussion composition F which is pressed into the form of a cup and inside of which is located a tin foil washer. The percussion composition, known as the 1.2-grain composition consists of the following ingredients:

Ingredients	Per Cent
Sulphide of Antimony.............	54.5
Chlorate of Potash................	36.5
Glass (ground)	3
Powder (mealed)	3
Sulphur	3

In the front end of the primer enclosed by brass closing disk G is a charge of RFG² powder. Separating the closing disk and the powder is a paper disk H secured with Pettman's cement. The closing disk G is held in place by spinning over the front edge of cup A.

In action, the firing pin comes directly in contact with the percussion cap F, exploding it and causing the flames to pass through the vents in anvil B and plug D. Paper disk E is thus ignited together with the powder charge in the front end of the primer. The resulting pressure forces out the center of closing disk G which is weakened by six radial slots. The flame then passes to the secondary powder charge in the base of the cartridge case, thus effecting complete combustion of the propelling charge. In order to prevent the escape of gas back through the vents in the primer before complete combustion has taken place, soft brass ball C is inserted in the anvil. As soon as the powder in the front of the primer is ignited the resultant back pressure forces the ball into the circular seat in the anvil and effectively prevents the further escape of gas.

Combination Electric and Percussion Primer

The United States Navy uses a combination electric and percussion primer in rapid-fire guns of the type shown at C in Fig. 14. When fired by percussion the percussion cap r is not struck directly by the firing pin, but the point of the pin forces in the head of the cup t and this, in turn, advances plug s. The method of igniting this primer electrically is as follows: Ignition is effected through the brass cup t to which one end of the platinum wire u is soldered. A small quantity of guncotton surrounds this wire. Electric contact is made with cup t by the insulated firing pin of the gun. This cup is insulated from the body of the primer by the

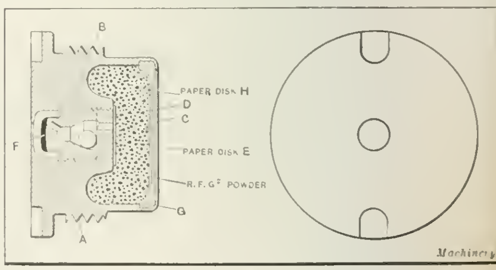


Fig. 15. Percussion Primer used in British Cartridge Cases

cylinder w and bushing v, both made of vulcanite. The brass contact bushing y to which the other end of the platinum wire is soldered completes the electrical connection.

EXPLOSIVES, DETONATORS AND FULMINATES

Reference to Fig. 3 will show that a high-explosive shell of the fixed-ammunition type comprises four principal parts, namely, the projectile itself, fuse (detonating) cartridge case and primer. The projectile carries the high-explosive which when detonated produces such a powerful shattering effect that the steel shell is blown into atoms. The high-explosive

in the shell is detonated by other very powerful explosives that are contained in the gaine of the detonating fuse. In the fuse proper as many as four different classes of explosives are used, namely, fulminate of mercury, black powder, picric acid and other compounds of a similar nature so combined as to make their explosive effect of different strengths.

The cartridge case carries a propellant, usually nitro-cellulose or nitro-glycerine, that is put up in the form of flakes, long tubes, perforated grains or flat strips. It also contains either one or two charges of common black powder. One charge is located between the smokeless powder and the projectile. The other is located next to the primer pocket, and assists the priming charge in effecting complete combustion of the propelling charge. The last or fourth member is the primer. This usually contains two explosive agents, namely, fulminates or chlorates, and black powder.

Classification of Explosives

The explosives used in high-explosive shells, cartridge cases, fuses and primers, may be divided into three general classes, namely, (1) progressing or propelling explosives—known as "low" explosives; (2) detonating or disruptive explosives—known as "high-explosives"; (3) detonators, known as "fulminates" or "chlorates." The first of these includes black gunpowder, smokeless powder, and black blasting powder; the second, dynamite, nitro-glycerine, guncotton, etc.; the third, fulminates and chlorates. In all classes of explosives, the effect of the explosion is dependent upon the quantity of gas and heat developed per unit of weight, the volume of the explosion, the rapidity of reaction and the character of

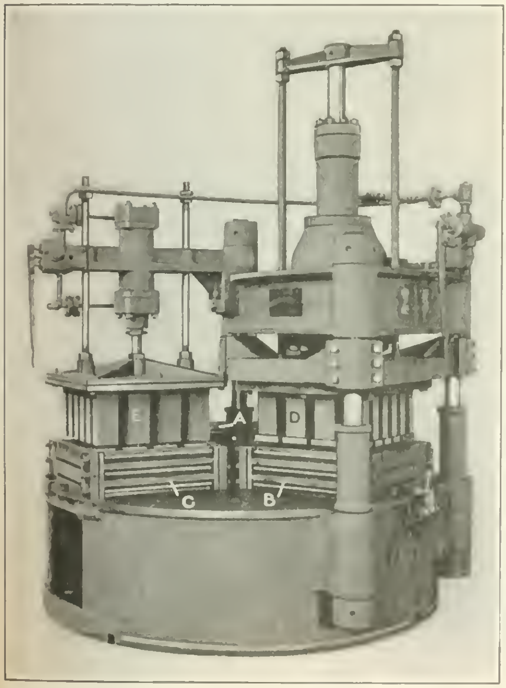


Fig. 16. Boomer & Boschert Guncotton Press

the confinement, if any, in which the explosive charge is placed.

Black Gunpowder

The most common of all explosives is black gunpowder. The earliest known use of gunpowder was in the sixteenth century and at that time it was used in the form of fine powder or dust. No marked improvement was made in gunpowder until 1860, when General Rodman of the Ordnance Department of the United States Army discovered the principle of progressive combustion. This consisted in using larger grains of greater density so that the rate of combustion could be more uniformly controlled. The increased density diminished the rate of combustion, so that black powder in this form developed less gas in the first instant of combustion, and the volume of gas increased as the projectile moved through the bore of the gun. Black gunpowder is usually made up of a mechanical mixture of niter, charcoal and sulphur in the proportions of 70 parts niter, 15 charcoal and 10 sulphur. The niter furnishes the oxygen to burn the charcoal and sulphur, and the charcoal furnishes the carbon, whereas

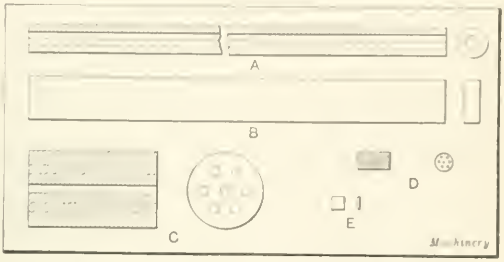


Fig. 17. Form and Size of Grain for Smokeless Powders

the sulphur gives density of grain to the powder and lowers its point of ignition.

The manufacture of black gunpowder is comparatively simple. The ingredients are first ground and pulverized, after which the correct proportions of each ingredient are intimately mixed in an incorporating mill consisting of two heavy iron wheels mounted to run in a circular bed. The product is called a "mill cake." The "mill cake" is then subjected to pressure in a hydraulic press and forms what is known as a "press-cake." The cake from the press is then broken up into grains by passing through rollers and the grains are graded by passing through sieves. The grains are either glazed by rotating in drums with or without graphite, which gives a uniform density to the surface. When special forms are to be given to the powder, dies are used to obtain the desired shape. This is done after the powder has been thoroughly mixed and formed into "press-cake."

Black powder or gunpowder is used in primers, fuses, and also in the cartridge case as an additional priming charge for completing the combustion of the propelling charge. In the early use of high-explosive shells, black gunpowder was also used as a bursting charge, but in recent years this has been supplemented by other and more powerful high-explosives.

Smokeless Powder

The modern smokeless powders are put up into many different forms, but all have the same base, namely guncotton. The invention of guncotton is credited to a German chemist Schoenbein who, in 1846, discovered a substance that he called "cotton powder." Further improvements were later made in the manufacture of guncotton by General Von Lenk and Sir Frederick Abel. Two of the principal smokeless powders are nitro-cellulose and nitro-glycerine. As has been previously stated, the base of these explosives is guncotton, but the final stages in their manufacture are handled in a somewhat different manner. For instance, in the manufacture of nitro-glycerine, a mineral jelly is added.

Manufacture of Guncotton

In the manufacture of guncotton, the short fiber of the cotton which is detached from the cotton seed rather late in the process of removal is used. After being bleached and purified, this is run through a picker which opens up the fiber and breaks up any lumps. It is then thoroughly dried and is ready for nitration. The most generally used method of nitration consists in putting the cotton into a large vessel nearly filled with a mixture of nitric and sulphuric acid. The sulphuric acid is used to absorb the water developed in the process of nitration which would otherwise dilute the nitric acid too much. After a few minutes immersion the pot is rapidly rotated by machinery and the acid permitted to es-

cape. The nitrated product is then washed in a preliminary way, removed from the nitrator and repeatedly washed and boiled to remove all traces of free acid. In the process of nitration, the cotton has not changed its appearance, but has become a little harsh to touch. The keeping qualities of smokeless powder are dependent upon the thoroughness with which it is purified. At this stage of the manufacture at least five boilings, with a change of water after each boiling, covering a total of forty hours, is necessary. Following this preliminary purification the cotton is cut up into still shorter lengths by being repeatedly run between cylinders carrying revolving knives. This operation is necessary, as the cotton fibers are hollow tubes, making it difficult to remove the traces of acid from the interior unless they are of very short lengths. After being pulped, the cotton is given six more boilings with a change of water after each, followed by ten cold water washings. The completed material is then known as guncotton or pyro-cellulose.

Before adding the solvent (acetone), the guncotton must be completely freed from water. This is partly accomplished in a centrifugal wringer, but is completed by compressing the guncotton into a solid block and forcing alcohol through the compressed mass. To convert the guncotton or pyro-cellulose into nitro-cellulose, ether is added to the pyro-cellulose thus impregnated with alcohol, the relative proportions being about two parts of ether to one part of alcohol, by volume. After the ether has been thoroughly incorporated in a kneading machine, the material is compressed into blocks. This is generally accomplished in a hydraulic press; a machine especially designed for this purpose is shown in Fig. 16. This press is built by the Canadian Boomer & Boschert Press Co., Ltd., and is capable of exerting a pressure of 150 tons on the material. Reference to this illustration will show that this press has three sets of dies *A*, *B* and *C*, which are held on a separate column on the press upon which they revolve; also two sets of punches or male dies, set *D* being used for pressing the cotton, and the other set *E* for ejecting it after pressing. The base of the machine is of cast iron, through which a number of small holes are drilled to allow drainage of the water from the cotton. The chief advantage of this press is that, being provided with three sets of dies, it is possible to load one set of dies while another is being pressed and the cotton ejected, thereby making the operation practically continuous. This press is operated by a pump giving a pressure of 1500 pounds per square inch.

The size of the compressed blocks varies; in some cases these blocks are made 10 inches in diameter by 15 inches long, or are made of square section. In this operation the pyro-cellulose loses the appearance of cotton and takes on a dense horny appearance, forming what is known as a colloid. The colloid is then transferred to a finishing press where it is again forced through dies and comes out in the form of long strips or rods, which are cut into grains of the required length. The grains are then subjected to a drying process, which removes nearly all the solvent (acetone) and leaves the powder in a suitable condition for use. The drying process is a lengthy one, taking as much as four or five months for the larger grain powders. Upon completion, the powder is blended and packed in air-tight boxes.

Cordite

Cordite is the form in which smokeless powder is used by the English government and it is composed of 58 per cent nitro-glycerine, 37 per cent guncotton, and 5 per cent vaseline. The vaseline serves to render the powder waterproof, and improves its keeping qualities. For use in cannon, cordite is made into long thick rods that are tubular in form or in the form of perforated cylinders. For heavy guns a powder called cordite M. D. has lately been introduced. This composition consists of 30 parts nitro-glycerine, 65 parts guncotton, and 5 parts vaseline. The reduction in the percentage of nitro-glycerine was made necessary because of the desire to lower the temperature of the explosive and the consequent erosion in the bore of the gun.

Forms of Smokeless Powder Grains

The form of grain in which smokeless powder is made differs in various countries. In foreign countries, especially in Germany, nitro-cellulose in the form of long tubes similar in shape to macaroni are used. Fig. 17 shows a few of the many forms in which smokeless powder is put up. *A* shows a tube which is sometimes as long as two feet. Usually, however, the nitro-cellulose when put up in this form is about the length of the chamber in the gun or long enough to about fill the cartridge case. Another way in which nitro-glycerine smokeless powder is put up is in slab form, as shown at *B*. In cartridges used by the French government, this slab is 0.0195 inch thick and ½ inch wide, and about 5 to 6 inches long. This form of smokeless powder is also used by the Italian government. In the United States Army service, the nitro-cellulose powder is put up in the form of cylindrical grains, as shown at *C* and *D*, which are provided with seven longitudinal perforations, one central and the other six equally distributed midway between the center of the grain and its circumference. A uniform thickness of web is thus obtained. The length and diameter of the grain vary in powders for different guns, the size increasing with the caliber of the gun. The length is unimportant, the web between the perforations being the factor that receives first attention. For the 3-inch rifle, the grain has a length of about ⅜ inch, and a diameter of 0.195 inch as shown at *D*. For the 12-inch rifle, the length is 1½ inch, and the diameter ⅞ inch as shown at *C*. For smaller guns, the grains are in the form of thin flat squares, as shown at *E*. When used in howitzers or mortars, smokeless powder is put up sometimes in the form of tubes, solid and tubular rods, flat disks, and rolled sheets.

High-explosives—Shell Fillers

High-explosives which are generally termed "shell fillers" are known by various tradenames, such as emmensite, lyddite, melenite, maximite, nitro-benzole, nitro-naphthaline, shimose, trintitrotoluol, etc. The base of such explosives as emmensite, maximite, lyddite, melenite and shimose is picric acid, which is secured from coal tar, subjected to fractional distillation. The liquid which comes off when this is raised to a temperature of 150 degrees C. is called "light" oil, and when these light oils have been again distilled, the next fraction or "middle" oil is phenol or carbolic acid. This substance when nitrated gives off picric acid, or as it is sometimes called trinitrophenol. As a shell filler, this explosive may be pressed into the explosive cavity or melted and poured in. It forms an unstable metallic salt when coming in contact with the body of the shell, and consequently in assembling or in pouring the melted acid in the shell it is necessary to first coat the cavity thoroughly with a non-metallic paint. Picric acid is the basis of many of the foreign shell fillers given above. The difference in composition of these various explosives usually consists in the addition of an ingredient (camphor, nitro-naphthaline, trinitrotoluene, etc.) which are introduced to reduce the melting point.

At present, the most popular or generally used shell filler is T. N. T. (trinitrotoluol). Although the explosive force of trinitrotoluol is somewhat less than that of picric acid, the pressure of the latter being about 135,820 pounds per square inch, as against 119,000 pounds for trinitrotoluol, its advantages more than compensate for the difference. Trinitrotoluol is obtained by the nitration of toluene obtained from crude benzol distilled from coal tar and washed out from coal gas. The crude benzol contains roughly:

Constituent	Per Cent
Benzine	50
Toluene	36
Xylene	11
Other Substances	3

Toluene, to be used for the manufacture of trinitrotoluol, should be a clear water-like liquid, free from suspended solid matter, and having a specific gravity not less than 0.868 nor more than 0.870, at 15.5 degrees C. Trinitrotoluol, when pure, has no odor, and is a yellowish crystalline powder which darkens slightly with age. It cannot be exploded by flame or strong percussion and a rifle bullet may be fired through it without any effect. When heated to 180 degrees C. it ignites and burns with a heavy black smoke; but when detonated by a fulminate of mercury detonator, it explodes with great force, giving off a black smoke. Shells containing this explosive first used on the Western battlefront

were given such names as "coal-boxes," "Jack Johnson," "Black Maria's," etc., by the Allies.

In the United States service, picric acid, explosive "D" and trinitrotoluol are used as shell fillers. High-explosive shells containing explosive "D" with a small charge of picric acid surrounding the detonator are used, and in high-explosive shrapnel, trinitrotoluol is used as a matrix. Trinitrotoluol may also be detonated with a fulminate of mercury detonator augmented by a small amount of trinitrotoluol in loose crystals.

The Russians and Austrians use a high-explosive known as ammonal, in which 12 to 15 per cent of trinitrotoluol is mixed with an oxidizing compound, ammonium nitrate, a small amount of aluminum powder and a trace of charcoal. This high-explosive gives somewhat better results than plain trinitrotoluol, but has the one disadvantage of easily collecting moisture, and consequently must be made up in air-tight cartridges. The British are now using an improved compound of this character, which is so prepared that trouble is not experienced with the collection of moisture.

Fulminates and Chlorates

The action of fulminates is more powerful than either the low- or high-explosives described. They can be readily detonated by slight shock or by the application of heat and are used in primers for setting off the propelling charge in the cartridge case, and in fuses, either of the plain percussion or combination time and percussion types. The most common fulminate is made by dissolving mercury in strong nitric acid and then pouring the solution into alcohol. After an apparently violent reaction, a mass of fine, gray crystals of fulminate of mercury is produced. The crystalline powder thus produced is washed with water to free it from acid, and is then mixed with glass ground to a fine powder. Because of its extreme sensitiveness to heat produced by the slightest friction, it is usually kept soaked in water or alcohol until needed.

A common mixture of fulminate of mercury for use in primers contains the following ingredients:

Ingredients	Per Cent
Fulminate of Mercury............	50
Chlorate of Potassium............	20
Glass (ground)	30

The ground glass must be sifted through a sieve having 100 meshes to the linear inch. To the mixture given is added 0.25 per cent of tragacanth gum and a trace of gum arabic. This composition is placed in the primer while moist; after compression the primer cap is dried for ten days at a temperature of 88 degrees F., and for twelve days at 111 degrees F. Then the exterior surface of the parchment covering the mixture is coated with a thick varnish composed of 0.891 gallon of 95 per cent alcohol, 2.75 pounds of shellac, and 0.5 pound resin. The varnished primers are dried at a room temperature for five or six days.

In primers used in British, American and some of the foreign cartridge cases, the fulminate of mercury detonator is not used, but is replaced by a composition generally called chlorate of potassium. A common mixture includes the following ingredients:

Ingredients	Per Cent
Chlorate of Potassium...........	49.6
Sulphide of Antimony............	25.1
Glass (ground)	16.6
Sulphur	8.7

This composition is less dangerous to handle than fulminate of mercury, and also has much less erosive effect on the bore of the gun.

FORGING HIGH-EXPLOSIVE SHELLS

THE preliminary stages in the forging of a high-explosive shell do not differ materially from those through which a shrapnel shell passes as described in the April number of MACHINERY. Since the article referred to has been published, however, many improvements have been effected, and a variety of new methods of accomplishing the work have been devised. At present, the preliminary stages in the manufacture of high-explosive shell forgings are carried on in one of two ways: The first is to use hot-drawn bar stock which is cut up into billets of the required length in cutting-off or shearing machines; and the second is to cast billets, varying in length and diameter depending on the size of shell. These billets are then cut up into blanks of the required lengths for forging.

In one of the prominent Canadian plants engaged in this work, billets for British 4.5 high-explosive shells are cast in ingot molds to 33 inches in length by 4 15/16 inches diameter. Following the casting, the billets are thrown down into the sand and allowed to cool off. The next operation is to cut the billets up into sections 9½ inches long. This is done in a lathe where the bar is partially severed at the required points and then taken out of the lathe and broken up. The teats are finally cut off on a planer, leaving the blanks in a suitable condition for forging. When the forgings are made from bar stock, cut off from hot-rolled bars, the high-power cutting-off machine is generally used, as will be described later.

Forging British 4.5 High-explosive Shell Blanks

Several different methods have been used in the Canadian plants in forging high-explosive shell blanks. One prominent concern, in the early stages of this work, adopted the method shown in Fig. 18 for forging 4.5 high-explosive shell blanks. To start with, a blank 4 13/16 inches in diameter by 9 inches long was used. This was heated in a furnace to 1950 degrees F. for about 45 minutes, and when it had acquired the correct forging temperature it was taken out and dropped into the die *a* shown at *A* in Fig. 18. One operator then quickly placed the guide *b* over the die and put in the punch *c*. The steam hammer was then operated and punch *c* started into the billet. When the punch had been driven in far enough to get a good start, it was removed, cooled off in water, guide *b* removed, the punch replaced, and three or four more blows delivered, finishing the billet as shown at *B*. The next operation was performed in a hydraulic press of 500 tons' capacity. The billet was again heated to the correct temperature, placed in the die as shown at *C* and drawn up to the shape shown at *D*. This was done in one stroke of the press. A final forging or drawing operation was then accomplished as shown at *E* and *F*. As will be noticed in this case, the forging is forced through two dies that are 5 1/16 and 4 15/16 inches in diameter, respectively. The forging as completed was 4⅞ inches diameter, by 12¾ inches long, with a base 1½ inch thick. After the forgings were removed from the die, they were allowed to cool, after which they were inspected.

The method just described has been improved upon somewhat by the concern using it. The new method is illustrated in Figs. 19 and 20. In Fig. 20, is shown the 350-ton hydraulic press used to complete the forging in one "shot." The billet, as will be seen from Fig. 19, is 4.8 inches diameter and 9½ inches long. This is cut off from a cast billet, as previously described, and is placed in a furnace heated by fuel oil, where it is left until it reaches a temperature of about 1900 to 1950 degrees F. It is then pulled out by a long bar with a bent end, dropped onto a sheet-iron slide, and carried over near the hydraulic press. Here it is quickly picked up by one of the operators and placed on a block, where all the excessive scale is removed by means of a scoop. It is then dropped into the die and the press operated. In this particular case, no bushing or guide is used to center the punch, and it is allowed to descend freely into the heated billet, extruding it around the punch. The punch and die are kept lubricated with a mixture of graphite and oil and are also cooled by a stream of water after each billet has been pierced. In this operation the forging is drawn out in one "shot" from 9½ to 13¾ inches in length, and sometimes it even exceeds 14 inches. The shape of the die and the size and shape of the finished forging are shown at *B* in Fig. 19. The production on this operation is 220 in eight hours, and four men are required, three to attend to the press and one to the furnace.

Forging Russian 3-inch High-explosive Shell Blanks

A very complete and interesting forging equipment is used by the Laconia Car Co., Laconia, N. H., for turning out 3-inch Russian shrapnel forgings at the rate of 3000 per day. In this plant the bulldozer is used for performing both the piercing and drawing operations on the forgings as will be described later. Russian high-explosive shell forgings are made from steel containing 50-point carbon and are also high in manganese. Great difficulty has been experienced in cutting these bars off with cold saws, and the Laconia Car Co. has

employed with success a Cleveland Punch & Shear Co.'s shear, shown in Fig. 22. This machine is provided with cutting-off blades made from special shear blade steel, which are formed to the shape of the bar. About 3000 pieces are cut off between grindings of the shear blade. The bars are about 20 feet long and 3¼ inches in diameter, and the billets are cut off to 6¾ inches in length. The machine makes about five strokes per minute.

After cutting off, the billets are placed in a furnace of the type shown in Fig. 21, which has been built especially for this work by this company. Here the blanks are heated to 2250 degrees F. These furnaces are of the open-hearth down-draft type, built to the dimensions given in the illustration. The heating space is 18 inches at the highest point of the arc, and 3 feet wide by 5 feet 6 inches long. Each furnace is

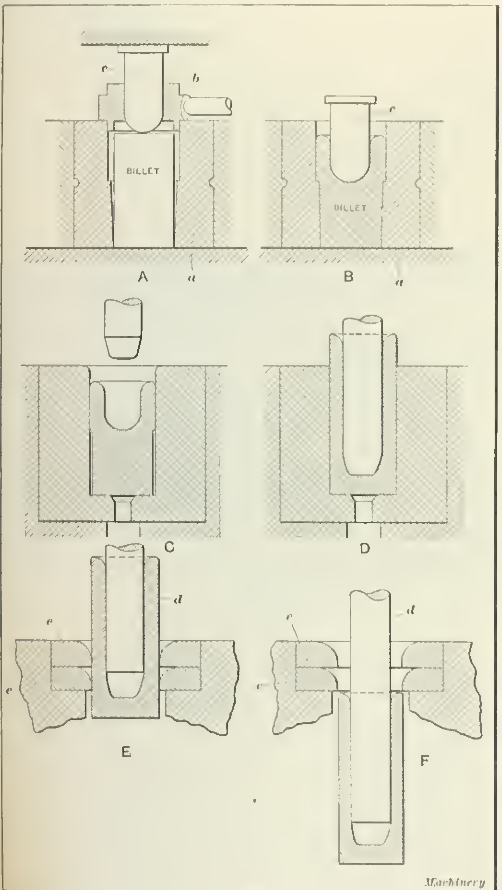


Fig. 18. Three-operation Method of making 4.5 British High-explosive Shell Forgings

provided with two double burners, and ½-pound air pressure from a Sturtevant fan is sufficient to operate them. In maintaining a temperature of 2250 degrees F. only 9 gallons of crude oil is consumed per hour by each furnace. With these furnaces, a temperature of 2850 degrees F. can be obtained without trouble, but the temperature required for this work seldom exceeds 2300 degrees.

The forging is done on a Williams & White size 9-U bulldozer, as shown in the initial illustration and the close-range view Fig. 23. This machine is capable of making six strokes per minute and a forging is completed in two strokes. The piercing punches and dies shape the piece, as shown at *B* in Fig. 25, whereas the drawing punches and dies complete the forging as shown at *C*. By referring to Fig. 23 it will be noticed that the piercing and drawing dies are held in a special holder fastened to the bed, whereas the punches are held on the cross-head. The two outer punches at each side, *A*, *B*, *C*, and *D* are the drawing punches, whereas the four inner ones *E*, *G*, *H*, and *I* are for piercing. There are seven men in the forging team for each machine; one attends to the furnace, one removes the forgings from the furnace, the third man starts and stops the bulldozer and looks after the machine. On each side of the machine there are two tool-men and two forgers. This machine will carry on a piercing and drawing operation at the same time.

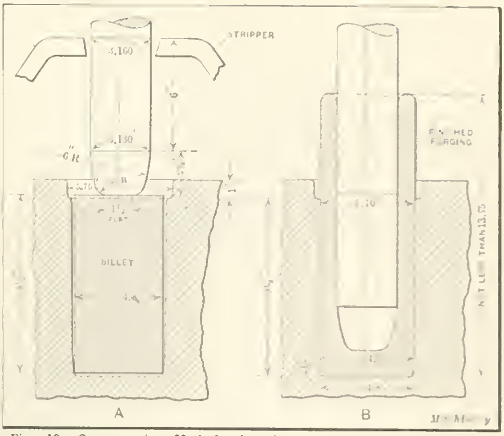


Fig. 19. One-operation Method of making 4.5 British High-explosive Shell Forgings

The method of operation is as follows: The forge-man gets the hot billet from the furnace-man and puts it in one of the two piercing dies on his side of the machine. One blow partly forms it, and he then passes it on to one of the two drawing punches at his side, the tool-man swinging the punch up to permit the forging to be removed and at the same time greasing the punch. The object of having two piercing and two drawing punches is to allow one to cool while the other is being used, the two sides of the machine being used alternately.

Fig. 20. Forging British 4.5 High-explosive Shells in One Operation

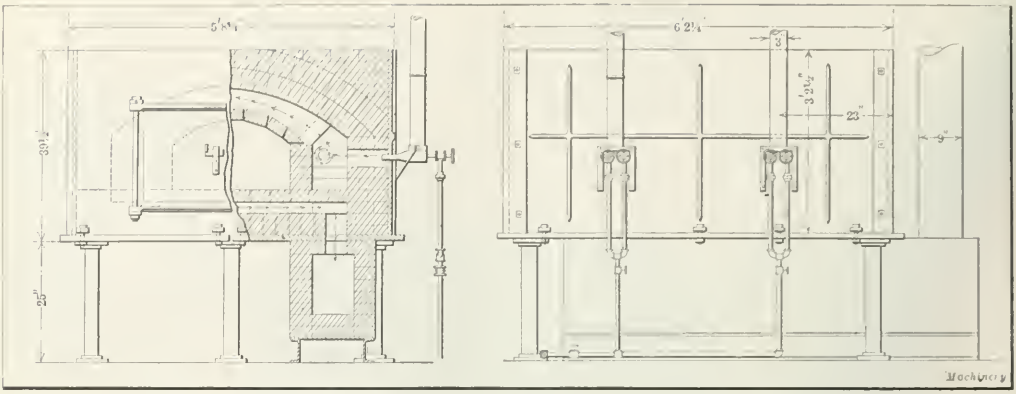


Fig. 21. Furnace built by the Laconia Car Co., for heating High-explosive Shell Blanks for Forging

Fig. 23 shows clearly how the punches and dies are held. It will be noticed that the piercing punches are shorter than the drawing punches and that they pass through the strippers *K*, which remove the pierced forging from the punch, as the forging is not forced through the die in being pierced.

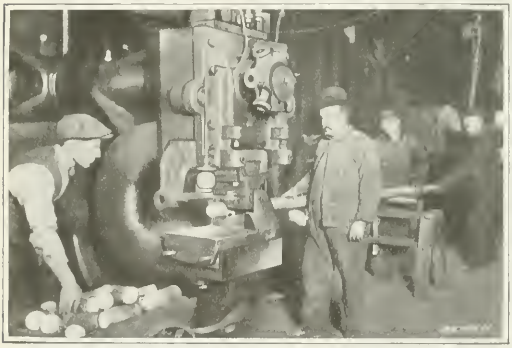


Fig. 22. Cutting off Blanks for Russian 3-inch High-explosive Shell Forgings in a Shearing Press

The strippers are operated by the V-shaped members *J*, which come up between them and close them in on the punch.

The piercing punches are made from special vanadium steel, and 5000 forgings are made before the punches are worn out. The drawing punches are also made from vanadium steel and turn out about 3000 before giving out. For the dies, white cast iron is used, and 4000 is the limit obtained from one die. The drawing dies are made of chilled cast iron and have a life of from 1800 to 2000 forgings. The forgings are not annealed, but are piled up in a sand-box and allowed to cool slowly. One team of men and one machine will produce 500 forgings in eight hours without any trouble.

Forging Large-caliber High-explosive Shells

At present there are two chief methods of making large high-explosive shell blanks. One of these does not differ materially from that used in the production of forgings for medium-caliber shells. In the large-caliber shells the hole in the nose—when the shell carries a nose fuse—is small in proportion to that used in the small-caliber forgings. Consequently, a greater amount of metal is turned in at the nose.

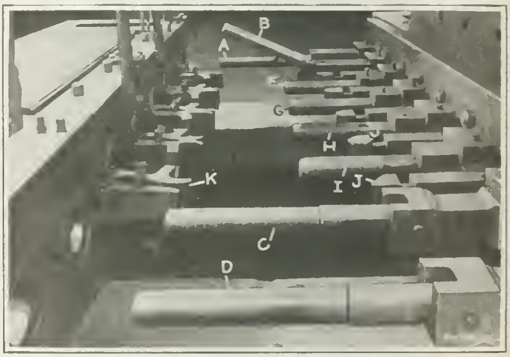


Fig. 23. Arrangement of Dies and Punches on Williams & White Bulldozer for forging Russian High-explosive Shells

One method of making these shells is shown in Fig. 24. The preliminary stages in the process shown by the diagram at *A*, *B*, *C*, *D* and *E* are the same as for making an ordinary forging. For instance, the billet is pierced, as shown at *A*, *B*, and *C* by being forced over punch *d* by punch *c* acting through die *a*. The frame carrying die-holder *b* then rises, and stripper-plate *e* removes the pierced forging from the punch as shown at *D*. The next step consists in drawing the pierced forging through dies, as shown at *E*. The forging is now heated on the nose end, taken to another press and dropped in the die as illustrated at *F*. The nosing-in punch then descends, as shown at *G*, and closes in the open end of the forging to the shape shown at *H*. Further operations consist in drilling out the nose for the fuse, threading it, etc., for the reception of the fuse. In

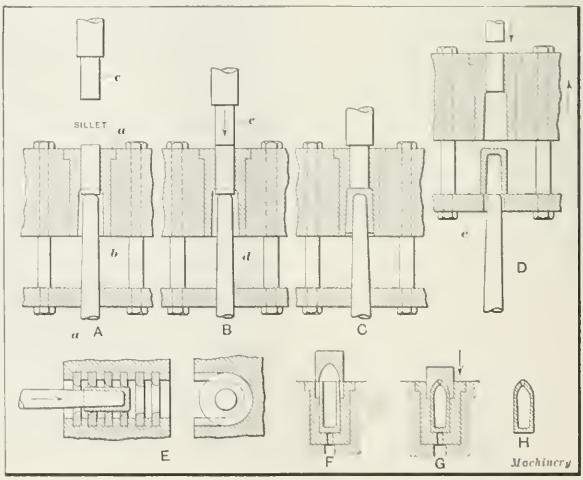


Fig. 24. Method of forging Large-caliber High-explosive Shells

this class of forging no machining whatever is done in the cavity of the shell.

Another method of making large-caliber shell forgings which are open both on the nose and base ends is to use seamless drawn tubing. The first operation consists in cutting off a piece of tubing of the required length. It is then heated on one end and taken to a hydraulic press, where, by means of a properly shaped die and punch the base end is upset in toward the center. The forging is next heated on the opposite end, taken to another press and nosed-in in a manner similar to that shown at *G* in Fig. 24. This method of making large forgings has the advantage of saving considerable material, both in the preliminary stages and in the final machining operations.

Forging Armor-piercing Shells

Armor-piercing shells are always made with a solid nose. The reason for this is that this type of shell is used for

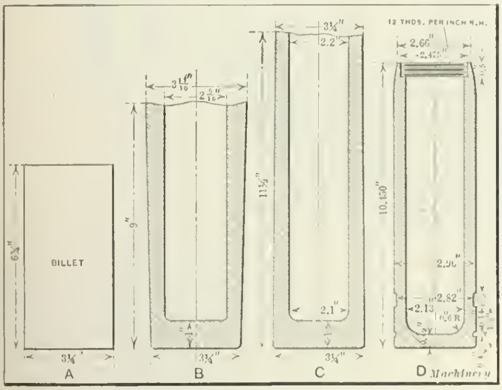


Fig. 25. Russian 3-inch High-explosive Shell from the Blank to the Finished Shell

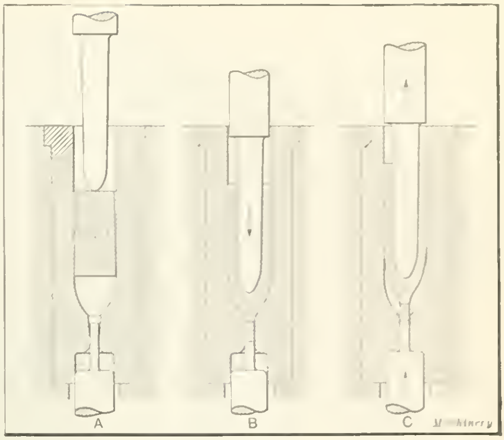
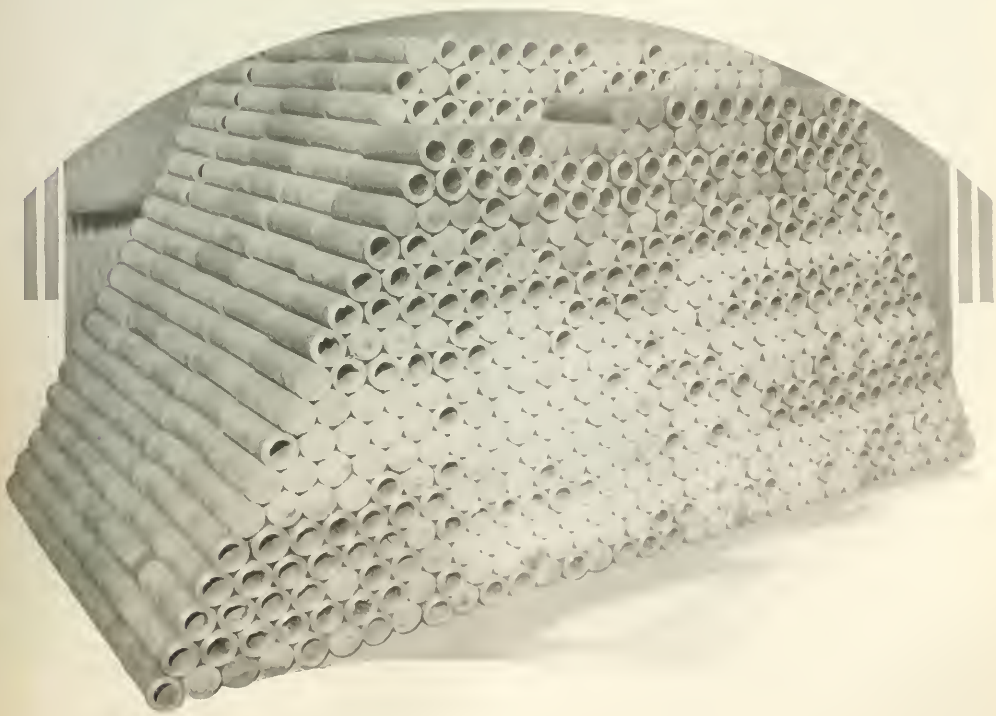


Fig. 26. Diagram illustrating Method of forging Armor-piercing Shells

piercing hardened armor, which, of course, calls for great strength in the nose. One method of making armor-piercing shells which is also applicable to the production of the type of high-explosive shell used by the U. S. government, is shown in Fig. 26. This method does not differ in principle from that shown in Fig 19, except that the shell is forged with the nose instead of the base down. Usually, the punch is not relied upon to center in the billet accurately, and when this is the case, a centering bushing is used The bushing is inserted in the top of the die, the punch is allowed to descend for a short distance into the heated billet and is then raised, the bushing is removed and the punch again advanced. When making a forging in the manner shown in Fig. 26, it is usually necessary to eject the forging and make it follow the punch, from which it is removed by a stripper as the punch rises.



MACHINING HIGH-EXPLOSIVE SHELLS

A VARIETY of methods are used in machining the British 18-pound (3.29 inch) high-explosive shell shown in Fig. 27. In the greater number of cases, however, the shell is machined from bar stock. There are two principal methods used in machining from bar stock. One of these, outlined in Table 1 and described in the following, consists in cutting up bars of hot-drawn stock into billet lengths; these are then drilled and reamed, and afterward turned, etc. The other, while similar in the final operations, starts with turning. A bar generally sixteen feet long is centered on both ends, then put in the lathe and turned down to approximately the finished size. After this, it is cut up into shell lengths, drilled, reamed, threaded, etc.

Cutting off 18-pound Shell Blanks

Many different methods are in use for cutting off shell blanks. Usually, however, several blanks are cut off at one time. The Earle Gear & Machine Co. has devised a fixture for the Lea-Simplex cold saw by means of which nine bars can be cut off at one setting. The average cutting time for nine bars is nine minutes, and the production on 3¼-inch bars is about sixty per hour.

Drilling and Reaming

After cutting off, the next operation is rough-drilling. This is usually performed in a high-power drilling machine as shown in Fig. 28. The shell blank is held in a special fixture, shown in Fig. 29. This comprises two jaws, operated by left- and right-hand screws by means of handwheel *A*. The top part of the fixture is of yoke form and carries the drill guiding bushing *B*. In this particular case, the drilling is done with a "Hercules" 1 13/16-inch drill, rotated at 115 R. P. M. and fed down into the work at a feed of 0.017 inch per revolution of the work. The hole drilled is 8⅞ inches deep, and the production nine per hour. To start the drill central with the blank, a bushing is slipped into the top of the jig and when the drill has once started properly this is removed.

The second operation consists in rounding the bottom, that is, removing the vee left by the end of the drill. This is done with a counterboring tool which is rotated at 115 R. P. M. and fed down by hand. The machine used is a Baker high-power drilling machine and the production is thirty per hour. The third operation consists in reaming the hole to 1.885 inch diameter with a reamer rotated at 115 R. P. M. and fed at the rate of 0.032 inch per revolution to 8 15/16 inches deep. The production is twelve per hour.

Turning Band Groove, Waving, etc.

The fourth operation is performed on a No. 2-A Warner & Swasey turret lathe in the order shown by the diagram Fig. 30. This consists first in rough-turning the external diameter with box-tool *A* for a distance of about 6⅜ inches from the base end and removing ¼ inch from the diameter at a feed of 0.041 inch per revolution of the work; second, boring gas plug recess, facing end, turning and forming radius with tool *B*; third, rough-forming band groove with tool *C*; fourth, finish-facing plug recess and end with tool *D*; fifth, forming waves in band groove from cross-slide with tool *F*; sixth, finish-boring, counterboring and chamfering plug recess with tool *G*; seventh, under-cutting band groove with tool *H*. As will be seen the waving is done from the cross-slide, and at the same time the work is supported by a roller support from the turret. For the finishing cuts, the work is rotated at 187 R. P. M., and the production is six and one-half to seven per hour.

The fifth operation consists in rough-turning the nose in a Reed-Prentice 20-inch engine lathe, as shown in Fig. 31, with a single tool operating at a feed of 0.071 inch per revolution, and with the work revolving at 56 R. P. M. The shell is held in a special draw-in collet *A* which is supported by a steadyrest, as shown. Three cuts are required to finish the nose of the shell to form, the tool being controlled in its movement by a cam located at the rear of the machine. The production is twelve to fourteen per hour.

The sixth operation is performed on a No. 2-A Warner & Swasey turret lathe, as shown in Fig. 32. In this set-up the shell is rough-faced to length and the clearance angle cut on the nose. The recess is then cut at the bottom of the thread with recessing tool *A* and the hole reamed for thread-

TABLE I. ORDER OF OPERATIONS, MACHINES AND TOOLS USED, AND PRODUCTION FIGURES ON 18-POUND BRITISH HIGH-EXPLOSIVE SHELLS

Number of Operation	Character of Operation	Machine	Tools	Feed in Inches	Speed, R. P. M.	Production Per Hour
0	Cutting Off Bar Stock (9 Bars)	Earle Gear & Machine Co.	Huther Saw	....	....	60
1	Drilling Hole	Baker Drill	"Hercules"	0.017	115	9
2	Rounding Bottom of Hole	Baker Drill	Morrow Mfg. Co.	Hand	115	30
3	Reaming Hole	Baker Drill	Morrow Mfg. Co.	0.032	115	12
4	Turning, Facing, Waving, etc.	2 A Warner & Swasey	Edgar-Allen Steel	0.041	187	6½ to 7
5	Rough-turning Nose	Reed 20-inch Lathe	Edgar-Allen Steel	0.071	56	12 to 14
6	Facing, Turning, Recess, etc.	2 A Warner & Swasey	Edgar-Allen Steel	0.028-0.058	78	15 to 17
7	Finish-turning	Reed 18-inch Lathe	Edgar-Allen Steel	0.047	100	12 to 15
8	C. Bore and Drill Screw Hole	Barnes Drill	....	....	....	40
9	Tapping Screw Hole	Barnes Drill	Peter Bros. Chuck	....	40	40
10	Face Recess in Base	Fay & Scott 16-inch Lathe	Edgar-Allen Steel	0.031	180	40
11	Threading Nose	Holden-Morgan	....	....	....	20
12	Recessing and Threading Base	Holden-Morgan	....	....	....	13
13	Washing and Inspecting	....	....	....	....	......
14	Screwing in Base Plug	Vise	Wrench	....	....	30
15	Cutting Off Projection	Jenckes Lathe	Edgar-Allen Steel	Hand	180	32
16	Riveting Gas Plug	High-Speed Hammer	....	....	500 Blows	120
17	Facing Base End	Jenckes Lathe	Edgar-Allen Steel	0.031	180	20
18	Cutting Air Grooves in Waves	Brown-Boggs Press	....	....	....	240
19	Pressing on Copper Band	Goldie & McCulloch Press	....	....	....	40
20	Finishing Copper Band	Warner & Swasey Lathe	Edgar-Allen Steel	Hand	120	40
21	Varnishing	Bowser Varnish Machine	....	....	....	120
22	Baking	Crawford Furnace	....	....	....	30
23	Cleaning, Insp. Screw in Plug	....	....	....	....	......
24	Stamping	Holden-Morgan Stamping Machine	....	....	....	60
25	Inspecting	....	Gages, etc.	....	....	......

Machinery

ing to 1.906 inch diameter, 1.2 inch deep, with tool *B*. A light cut is then taken across the radius on the nose with tool *C* which carries a roller pilot and is operated from the cross-slide. The work is rotated at 78 R. P. M. for the profiling or the radius cut at a feed of 0.058 inch per revolution. The feed is reduced to 0.028 inch per revolution for reaming. The production is fifteen to seventeen per hour.

The seventh operation consists in finish-turning from the band groove to the nose on an F. E. Reed 18-inch engine lathe as shown in Fig. 33. Here it will be seen that the cross-feed screw has been removed and the movement of the cross-slide is controlled by a former at the rear. The shell is held at the closed end by a two-jaw chuck, and located by a stop-screw *A*; a plug is screwed into the open end and is supported on the tailstock center. The work is rotated at 100 R. P. M. and the feed is 3/64 inch per revolution. One man runs two machines and the production is twelve to fifteen per hour from each machine. The eighth operation is to counterbore and drill the grub-screw hole *A*, Fig. 27, in the nose of the shell for fastening the fuse in place.

The ninth operation on the shell consists in tapping the screw hole with a Peter Bros. tap chuck held in a Barnes drill. It requires two taps to finish this hole and they are operated at 40 R. P. M. The production is forty per hour. The tenth operation is to face the recess in the cavity in the base end of the shell where the gas plug is to be inserted. This is performed in a Fay & Scott 16-inch engine lathe, and one cut is taken with a tool held in a special holder. The tool is started at the outside of the recess and works in toward the center. The work is rotated at 180 R. P. M. and the feed is 1/32 inch per revolution; the production is forty per hour.

Threading Nose and Base Ends

The eleventh operation consists in threading the nose of the shell. This is performed in a Holden-Morgan thread milling machine, as shown in Fig. 35. A hob similar in construction to that described in the following in connection with Fig. 34 is used for cutting the thread, and one revolution of the work completes the thread, which requires 1.10 minute. The production is twenty per hour from each machine, one operator attending to two machines. The twelfth operation

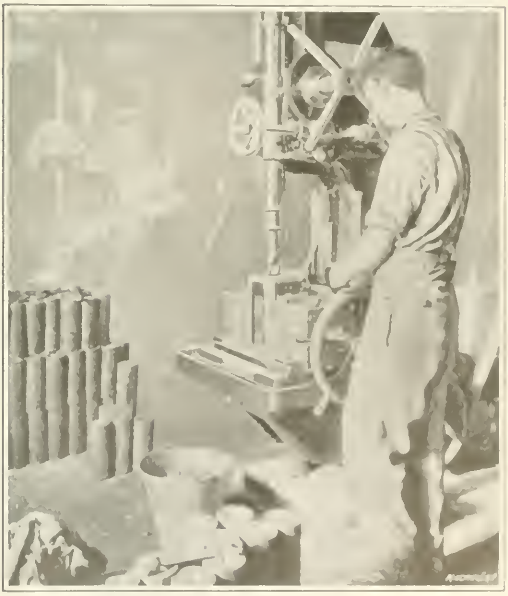


Fig. 28. Baker High-power Drilling Machine at Work on British 18-pound High-explosive Shells

consists in recessing and threading the base end of the shell in a Holden-Morgan threading machine of the same type as those shown in Fig. 35. Here one man also runs two machines, one being set up for recessing and the other for threading. The production is 130 in ten hours from the two machines. The thirteenth operation consists in washing in hot soda water, after which the shells are inspected.

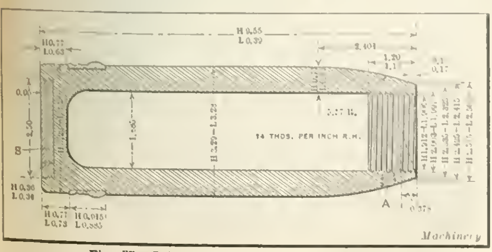


Fig. 27. British 18-pound High-explosive Shell

Machining the Gas Plug

Before any other operations are performed on the shell, however, the gas plug is made. The gas plug *B*, Fig. 27, is

made from a forging and is faced, turned and threaded on the Holden-Morgan special plug milling and threading machine shown in Fig. 34. The plug is held by the tail in a special draw-in chuck. The first operation is to rough-turn and face the end of the plug, two cuts being taken. The tools used are located one behind the other in tool-holder *A* that is fastened to the front of the cross-slide operated by handwheel *B*. On the rear of the same slide is a special holder *C* that carries the threading tool. This consists of a hob built up of a series of concentric disks provided with cutting teeth and held on a special arbor that is driven by a separate belt *D*. To cut the

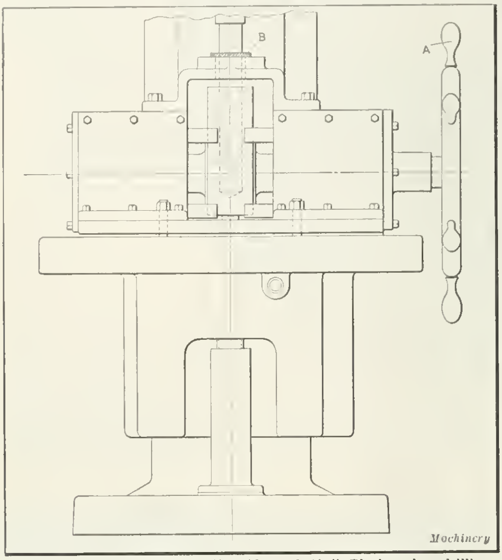


Fig. 29. Fixture used in holding 18-pound Shell Blanks when drilling

thread, lever *E* is pulled down, withdrawing a stop which allows the spindle to "feed" back into the housing. The spindle driving mechanism is then shifted to slow speed, and the spindle moves back at the required pitch—slightly over one complete revolution of the work (which takes forty seconds) finishing the thread. The work is rotated at 200 R. P. M. for turning and facing, and the production is twenty per hour.

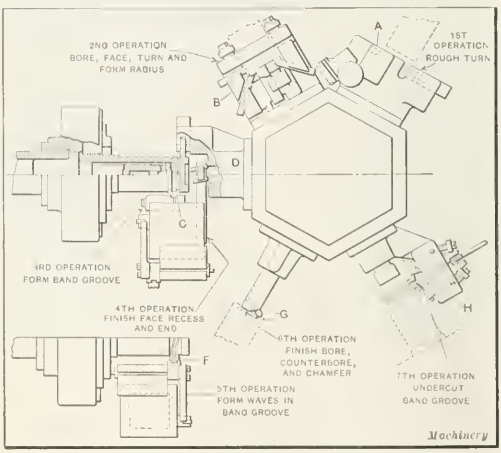


Fig. 30. Diagram showing Set-up for performing External Turning, Facing and Waving Operations

Final Machining, Stamping, Varnishing and Inspecting

The fourteenth operation consists in screwing in the base plug, which is first coated with red lead. Two men are employed for this operation, one inserting the plug and the other screwing it in with a wrench. The production is thirty per hour. The fifteenth operation consists in hogging off the

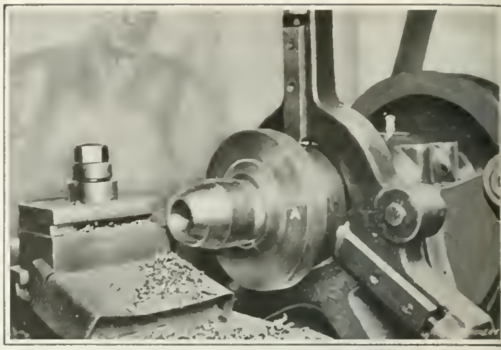


Fig. 31. Rough-turning Nose in an Engine Lathe

projection on the base plug in a Jenckes lathe. First, a facing cut is taken along the plug, then the teat is cut off and finally a finishing cut is taken. The production is thirty-two per hour, and the lathe is operated at 180 R. P. M., hand feed being used.

The sixteenth operation consists in riveting in the gas plug with a "High-Speed" hammer operating at 500 blows per minute, as shown in Fig. 36. The shell is held on an arbor

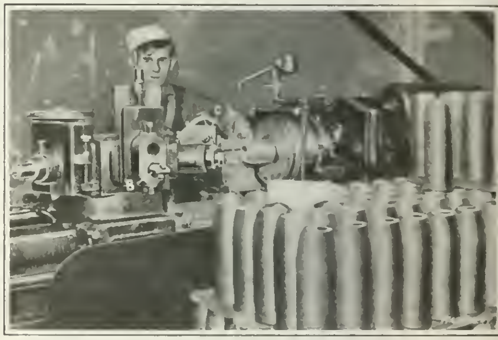


Fig. 32. Performing Sixth Operation on a 2-A Warner & Swasey Turret Lathe

and is spun around by the operator as the hammer descends. The production is 120 per hour. The seventeenth operation consists in facing the base in a Jenckes machine, one cut being taken at a spindle speed of 180 R. P. M. and 1/32 inch feed per revolution of the work. The depth of cut is 3/32 inch. The eighteenth operation is cutting the air grooves in the waves in the band groove. This is accomplished in a Brown-Boggs inclinable press which carries a fixture in which the shell is located. The cuts are made with a punch, shaped like a cold-chisel, held in the ram of the press, and the production is 240 per hour. In the nineteenth operation the copper band is pressed into the band groove in a Goldie &

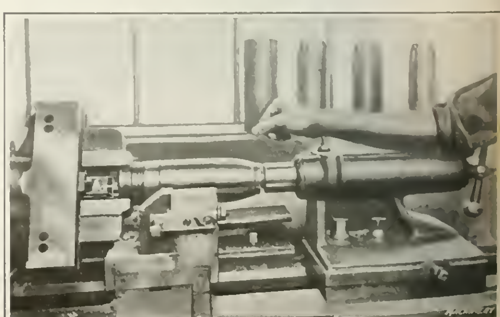


Fig. 33. Finish-turning External Diameter on an Engine Lathe

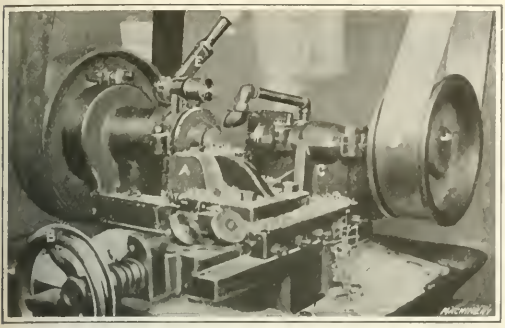


Fig. 34. Machining Gas Plugs on Holden-Morgan Special Plug Machine

McCulloch hydraulic press of the six-cylinder type. Three squeezes are required to compress this band and the production is forty per hour.

For the twentieth operation the shell is brought back to a Warner & Swasey brass working lathe, where the copper band is turned to shape. The work is rotated at 120 R. P. M. and roughing and finishing cuts are taken. The roughing cut is

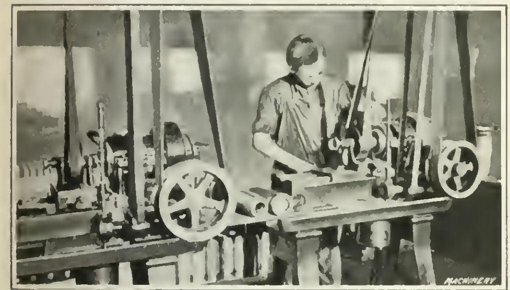


Fig. 35. Threading Nose and Base Ends of Shell in Holden-Morgan Special Thread Milling Machines

taken from the front slide and the finishing cut from the rear. The shell is supported by means of a steadyrest. The production is forty per hour.

The twenty-first operation is varnishing with a Bowser siphon tank, as illustrated in Fig. 37. The varnish is poured

Fig. 36. Riveting in the Gas Plug in a "High-Speed" Hammer

into the shell until it is full; then the shell is turned upside down and the varnish allowed to drain out. The number of pieces varnished per hour is 120. The twenty-second operation is baking in a Crawford sectional furnace which is built by the Oven Equipment Co., New Haven, Conn. Two hundred and forty shells are placed in this furnace, which is heated to a temperature of 300 degrees F. and kept at that temperature for eight hours. The shells are allowed to remain in the furnace for this time and then are taken out and allowed to cool off in the air. The twenty-third operation

Fig. 37. Varnishing Interior of High-explosive Shells

is cleaning the nose of the shell with a rag and gasoline. The shells are then ready for inspection, after which the plug is screwed into the nose end.

The twenty-fourth operation consists in stamping in the

Fig. 38. Stamping in a Holden-Morgan Rotary Stamping Machine

Holden-Morgan machine shown in Fig. 38. The stamp [illegible] is oscillated by an eccentric and crank movement, and when the stamp is brought down in contact with the work by operating handwheel B the shell is rotated by it. The production in this operation is sixty per hour. The twenty-fifth operation is the final manufacturing and government inspection. 240 completed shells represents eight hours' work in this plant.

ANOTHER METHOD OF MACHINING 18-POUND BRITISH HIGH-EXPLOSIVE SHELLS

Another method which is not as widely practiced as that just described is outlined in Table II and in the following. Hot-drawn steel bars $3\frac{1}{2}$ inches in diameter by 16 feet in length are centered in both ends, by first scribing two diametral lines across the ends of the bar and then drilling the center holes with a portable drill. The bars are next set up on centers on an engine lathe and straightened with a jack until they run fairly true. The next step is to turn down one end of the bar to the required diameter for a length of approximately 18 inches; the purpose of this is to form a bearing for the steadyrest which is used during the turning operation and also to provide a starting point for the special turning head employed. The bars are turned down to a diameter of 3.285 inches ± 0.005 inch, and for this purpose a special traveling head, as shown in Fig. 39, is employed. This head carries five tools, three next to the chuck and two on the opposite side of the supporting bushing. The first two cutters are progressive roughing cutters, the third is a "smoothing" cutter, and the two cutters on the right-hand side of the supporting bushing take finishing cuts; the depth of the cut taken by the last finishing tool is very light. Accuracy for diameter is determined by a snap gage and a ring gage; the snap gage is used to make sure that the bar is not turned under size, whereas the ring gage follows along the bar after the turning head. Should it happen that the last tool is cutting too large, the operator takes a file and touches the high spots until the ring gage will pass.

TABLE II. PRINCIPAL OPERATIONS ON 18-POUND BRITISH HIGH-EXPLOSIVE SHELLS WHEN MADE FROM TURNED BARS OF STOCK

Number of Operation	Character of Operation	Machines	Tools	Feed in Inches	Speed, R.P.M.	Production Per Hour
1	Sawing to Shell Lengths............	Newton Cold Saw........	Huther Saw	....	.....	25
2	Drill, Ream and Form..............	Barnes 22-inch Drill......	Oil-tube Tools	0.013 to 0.093	37 to 145	3
3	Drilling and Tapping for Fixing Screw	Two-spindle Drilling Mach.	Errington Tap-Chuck	....	.....	48
4	Mill Threads in Nose..............	Lees-Bradner Thread Miller	Special Hob	....	.....	35
5	Drill Center in Base..............	Engine Lathe	Center Drill	....	.....	50
6	Waving and Under-cutting..........	Engine Lathe	Form Tools	....	.....	15
7	Weigh, Mark for Cut-off and Heat No.	Weighing Scale and Chart	Blue Chalk	....	.....	40
8	Face, Bore and Under-cut Base End..	Engine Lathe	Turning Tools	....	.....	8
9	Thread Base End..................	Lees-Bradner Thread Miller	Special Hob	....	.....	40
10	Screw in Gas Plug.................	Drilling Machine	"Flywheel Chuck"	....	.....	50
11	Face off Gas Plug and Roll..........	Engine Lathe	Turning Tools	....	.....	14
12	Press on Copper Band..............	West Tire Setter Co. Press	Steel Press Plungers	....	.....	45
13	Form Copper Band..................	Engine Lathe	Form Tools	Hand	.....	..
14	Mark	Noble & Westbrook.......	Lettering Dies	....	.....	..
15	Varnish Cavity	Special Fixture	Round Brush	....	.....	..
16	Final Inspection	....	Special Gages	....	.....	..

Machinery

Sawing the Turned Bars to Billet Lengths

Two Newton machines equipped with Huther inserted-tooth saw blades are used for cutting up the turned bars into shell blanks $9\frac{5}{8}$ inches in length. These machines, as shown in Fig. 40, hold four bars at a time, and are equipped with traversing work-holding fixtures which move the stock along after each successive cut has been completed, a stop being employed to control the length of the blanks. The work is held in the fixture by a special arrangement of clamps which are operated by compressed air cylinders working in conjunction with toggle joints. In order to facilitate loading the bars into the work-holding fixture, an auxiliary rack is provided in which four bars are placed before the four bars in the work-holding fixture have been completed. When the final blanks have been cut from the bars, the work-holding fixture is moved back to the starting point and the auxiliary rack—which is pivoted to the base that supports the traveling work-holding fixture—is swung up by means of a crane hoist. This brings the next four bars into position in the rack ready to be clamped.

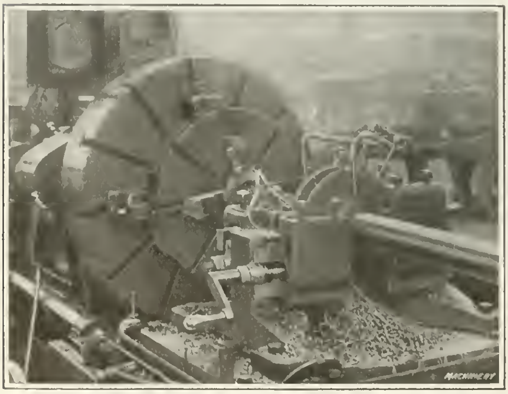


Fig. 39. Turning Long Bars from which Billets for High-explosive Shells are subsequently cut

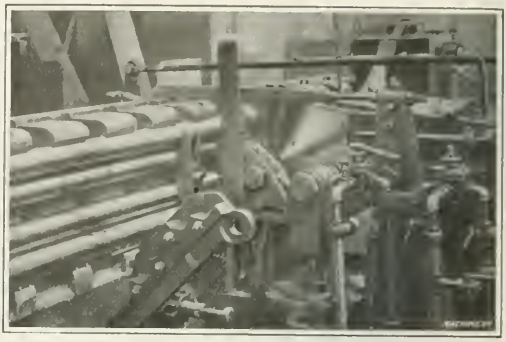


Fig. 40. Cutting Turned Bars to Shell Lengths in a Newton Cold Sawing Machine

The design of the traveling work-holding fixture is such that the bars cannot be completely cut up into blanks, the crop end of each bar having sufficient material for three shell blanks. These crop ends are cut up on another cold saw; one of the blanks produced in this way is already turned to size, while the other two blanks are cut from the rough end of the bar which was not reached by the special turning head shown in Fig. 39. These two rough crop ends are turned down to the required diameter on an engine lathe.

Drilling, Reaming and Turning Nose

The method used in this case for drilling, reaming and forming the nose of the shell is of considerable interest. In the first place, the development of fixtures for performing this work on the upright drilling machine is unusual, and in the second place this method has largely overcome the great difficulty experienced in securing early deliveries on all forms

of lathes for machining shells. The inverted tool method of handling this work is commendable in that chip trouble is largely overcome. The equipment used consists of a battery of eight self-oiling 22-inch all-geared drilling and tapping machines built by the Barnes Drill Co., and much of the credit for the development of this method of machining shells is due to the designers employed by this concern. Figs. 41 and 42 show one of these machines equipped for shell work, and reference to these illustrations will show that the shell to be machined is held by a chuck on the drill spindle, whereas the tools which perform the drilling, reaming and nose-forming operations, are carried by a rotary fixture *B* supported on the table of the machine. The fixture consists of a base-plate and rotating table upon which the tool-holders are mounted. The proper indexing of the various tools is provided for by means of a taper pin in the base of the fixture engaging corresponding holes in the rotating table which is rigidly retained by a clamp. The sequence of operations is as follows:

First Operation:—Spot-drill and rough-form nose with tools held in holder *C*. For this operation the spindle rotates at 92 R. P. M. with a down feed of 0.013 inch per revolution. The drilling is done by a short twist drill, and the rough-forming of the nose by three turning tools which are stepped in so that they cut to different depths, leaving an irregular surface which is finished in a subsequent operation. It will also be noticed that the shell is supported by a bronze-lined bushing so the work is adequately supported while being machined.

Second Operation:—Drill hole in shell to required depth with a drill *D* 1 13/16 inch in diameter. For this operation the spindle is rotated at 145 R. P. M. and at a feed of 0.013 inch per revolution.

Third Operation:—Rough-ream the hole with reamer *E*

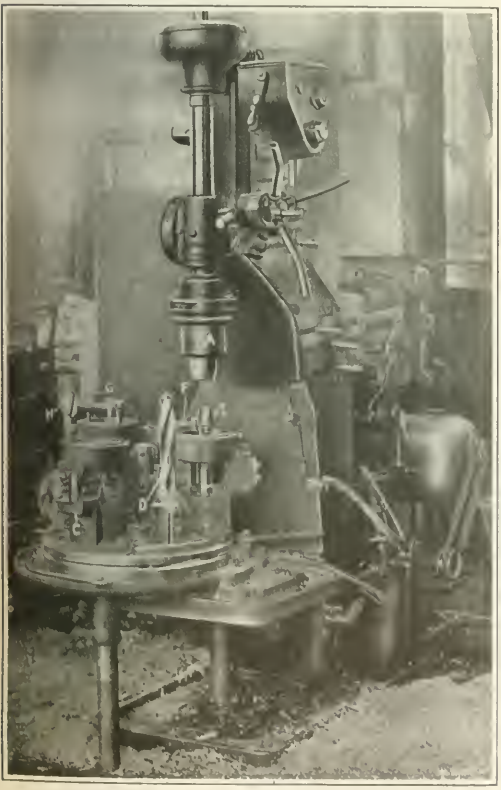


Fig. 41. Machining Hole and Nose of Shell Blank in Barnes Drilling Machine

Fig. 42. Close View of Fixture shown in Fig. 41, Illustrating Method of applying Tools to Work in an Inverted Position

which is formed at the end to finish the bottom of the cavity to the required shape. For reaming, the spindle is operated at 37 R. P. M. with a down feed of 0.093 inch per revolution. When the reamer reaches the pointed end of the hole as left by the twist drill, the power feed is disengaged and the spindle fed down by hand until the positive stop is reached.

Fourth Operation: Finish-form nose with form-cutter located in holder *F*, which is bronze lined. The spindle is rotated at 45 R. P. M. and fed down by hand.

Fifth Operation:—Cut step and bevel on nose of shell. The work is supported by a bronze-lined tool-holder *G*, and the machine is operated at the same speed and feed as for the fourth operation. The bevel on the inside of the nose is machined by a double-ended cutter of the proper form, which is supported at the center by a toolpost bolted to the base of the fixture. The step is formed by two forming tools carried by toolposts bolted to the base of the fixture.

Sixth Operation:—Finish-ream with reamer *H*. This operation must be performed with great care, as the specifications require that when an electric light be dropped into the hole the surface will show a uniform polish in all places. This operation is performed with the spindle rotating at 37 R. P. M. with a down feed of 0.093 inch per revolution.

By holding the shell in a fixture on the drill spindle, advantage is taken of the inverted principle which allows the chips to clear themselves more freely than would otherwise be the case. All the drilling and reaming tools used are of the oil-tube type and are supplied with forced lubrication. The chuck in which the work is held is arranged with three serrated eccentric jaws mounted on a rotating ring. To clamp the work in the chuck, the ring which carries the jaws is turned back against spring tension to allow the work to be pushed up into place. The ring is then released and snaps back to give the jaws a preliminary grip on the shell. When the machining operation is commenced the resistance of the work to the cutting action of the tools causes a further rotation of the ring on which the chuck jaws are carried, with the result that the jaws rock in on their eccentric pivots to secure a firmer grip on the work. After the machining operations have been completed, the work is removed from the chuck by a wrench which is slipped over the end of one of the jaws, and pressure is applied to rotate the chuck ring in the opposite direction from that necessary to tighten the jaws.

Drilling and Tapping for the Fixing Screw

The next operation is drilling and tapping the hole in the nose for the fuse fixing screw. This is accomplished in a

two-spindle drilling machine as shown in Fig. 43. The first spindle is used for counterboring and drilling. After the hole has been started with drill *A* it is removed and the smaller drill *B* inserted. The fixture carrying the work is now moved over to the second spindle of the machine and the hole threaded with tap *C*, which is held in an Errington chuck. For this operation, of course, it is necessary to remove the drill guide bushing.

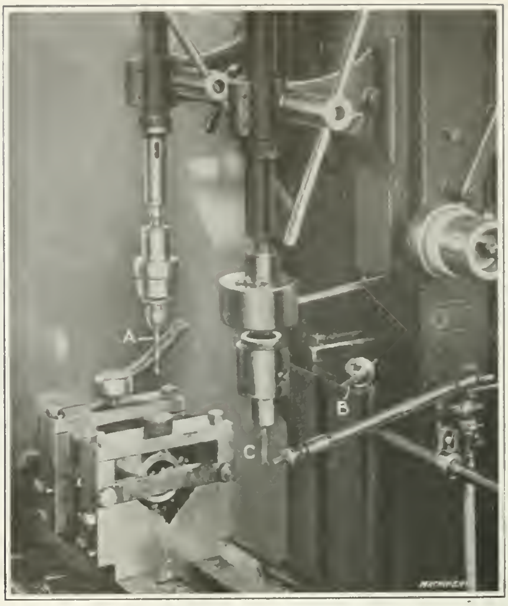


Fig. 43. Drilling and tapping Hole for Fuse Fixing Screw

Milling the Threads in the Nose

The shells are now taken to the special Lees-Bradner thread milling machine shown in Fig. 44. For this operation the shell is held in an air chuck with the open end out. The threading is done with a multiple type cutter *A*, of a length sufficient to completely cover the length of the part to be threaded and which is rotated by a separate belt *B*. The cutter-slide is fed toward the head of the machine, and the work rotated at the same time so as to cut a thread of the correct pitch. This is controlled through a change-gear system located at the left-hand end of the machine.

Turning, Under-cutting and Waving Band Groove

The machining of the band groove is the next important operation, but before this is accomplished a center hole in the base end of the shell is drilled. After this operation, the shells go to the preliminary inspection department where the thread in the nose is tested with a thread plug gage. A driving center is then screwed into the nose of the shells, and they are returned to the machining department. The band groove is machined as shown in Fig. 45. The roughing out of the band groove is done by means of a formed tool held on the rear cross-slide, which leaves sufficient stock to form the waves. The next step is to under-cut the sides of the band groove, and this is accomplished by two tools held in the holder *B* When one tool is in action, the other clears the end of the shell. The machining of the waves is performed by tool *C* held in holder *D*. This holder forms part of a slide which carries a roller that engages with cam *E*. Spring *F* keeps the roll in contact with the cam, so that when the latter rotates an oscillating movement is imparted to holder *D*.

Preliminary Inspection and Machining Gas Plug Seat

After the band seats have been machined, the driving centers are removed from the nose of the shells and the latter are subjected to a preliminary inspection. This consists in weighing in order to determine the amount of stock which must be removed from the base to bring the shells to standard weight. The normal weight of the finished shell is 14 pounds, 13.15 ounces, and a tolerance of 1 ounce is allowed. Experiments have established the fact that each ounce of weight on the shell is equivalent to 0.026 inch in length at the base, so that by removing metal on this basis the weight of the shell may be reduced to normal. The inspector who weighs the shells has a chart before him on which the various weights of shells are typewritten, together with the corresponding amount of metal in thousandths inch which must be removed from the base in order to bring the shell to normal weight. At this stage the shells also have the heat number of the steel bar stamped on the base, and as the metal is to be removed from the base the inspector transfers this heat number to the side of the shell. After he has weighed the shell and determined the amount of metal that must be removed, he marks the number of thousandths inch to be removed on the side of the shell with blue chalk, and the shells are then sent on to the lathe department where the correction for weight is made while the hole is being bored to receive the gas plug.

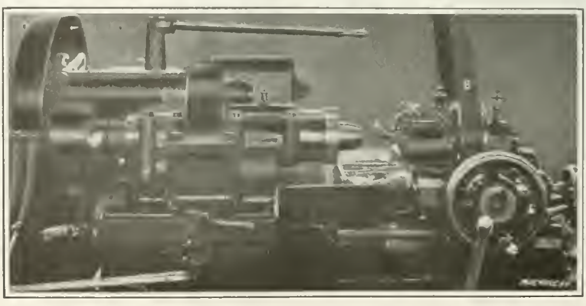


Fig. 44. Milling Threads in Nose in a Special Lees-Bradner Thread Milling Machine

The engine lathe used for facing the base end is equipped with a special micrometer attachment which enables quick settings to be made. This attachment, as shown in Fig. 46, consists of a bracket bolted to the lathe bed, on which the spindle of a micrometer *A* is supported. The connection between the micrometer and the supporting bracket is cushioned by means of a spring, so that when the lathe carriage is brought up against the micrometer spindle, the spring will take up the strain and prevent the instrument from being damaged.

In operation, the shell is gripped in a Hannifin air chuck and the facing tool brought into contact with the base of the shell. The micrometer spindle is then screwed up against the end of the lathe carriage and a reading taken, after which the spindle is backed away the necessary number of thousandths inch which the inspector has found must be removed from the shell to bring it to normal weight. The carriage is now moved out until the tool clears the work, then moved to the left until it contacts with the micrometer spindle. After this setting, the cross-slide is fed in until the tool passes beyond the circumference of the hole subsequently to be bored. The cross-slide is then backed away from the work and the boring tool *B* held in the tailstock spindle is fed in to bore the hole for the plug. The turret toolpost is then revolved to bring the reaming tool into position to take a finish cut on the side and bottom of the hole. The tool used for this purpose has a double cutting edge with the edges located at right angles to each other. After the finish cut has been taken, the turret toolpost is again rotated to bring the under-cutting tool into the working position, and the under-cut is made.

The shells now go to another Lees-Bradner thread milling machine of the type shown in Fig. 44, where the threads for the gas plugs are milled. These plugs are drop-forgings provided with a triangular

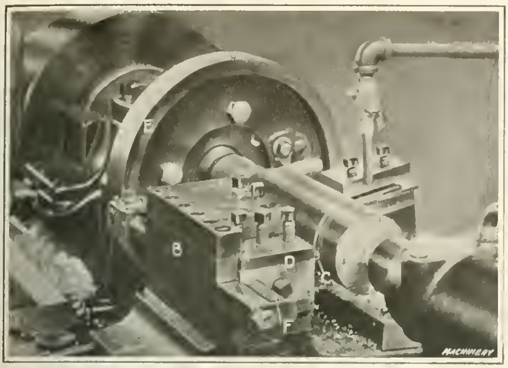


Fig. 45. Turning, undor-cutting and waving Rifling Band Groove

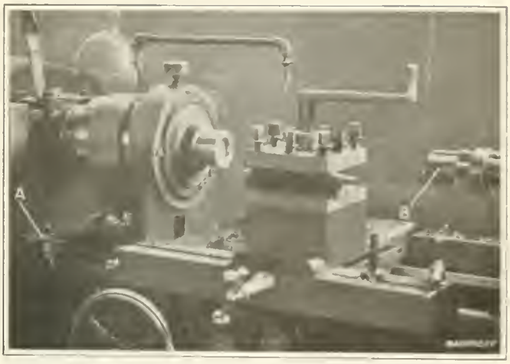


Fig. 46. Facing-off Base End and machining Gas Plug Seat

head to fit the wrench used in screwing them into the shells. Before being screwed into place, the disks are painted with red lead on the bottom and threads and screwed loosely into the shells. The work then goes to an upright drilling machine, Fig. 47, equipped with a special fixture for use in driving the gas plugs down firmly into the shells. The machine spindle, as will be seen, carries a heavy flywheel *A* to give the necessary momentum. The fixture *B* in which the work is held is pivoted on the table of the drilling machine so that it may be swung out of the way of the flywheel for setting up the work and removing the shell after the plug has been driven home, a stop being provided for locating the work under the spindle. The end of the spindle is fitted with a wrench which engages the triangular nut on the disk when the spindle is fed down. When engagement is made in this way the momentum of the flywheel drives the disk home with sufficient force to screw it firmly into place, after which the continued motion of the spindle results in twisting the corners off the nut.

It is now necessary to remove the projection from the base of the gas plug, and face off the base of the plug. For this purpose the shells are taken to an engine lathe equipped with a Hannifin air chuck and a turret toolpost. The projection is removed by a roughing tool, after which the turret head is revolved to bring a finishing tool into position to take a light cut across the entire base of the shell. The turret head is again rotated to bring a third tool carrying a hardened tool steel roller into position. This roller is used to spin over the slight seam between the plug and cavity in the shell. The result is that any slight burr which was raised at the joint during the turning operation is rolled down, making the joint so smooth as hardly to be seen.

Pressing and Forming the Copper Band

The shells now to go to a West Tire Setter Co. banding press, where the copper band is pressed into the groove. After this has been done the shells are passed on to an engine lathe equipped with a Hannifin air chuck and formed tools for forming the bands. Two forming tools are used for this purpose, the roughing tool being a radial tool carried at the front of the fixture bolted to the cross-slide, whereas the finishing tool is of the tangential type and is located at the back of the fixture. The shells are then taken to a Dwight Slate stamping machine, where they are marked. They are then washed in hot soda water to remove the grease, after which they receive a final washing in alcohol to remove all traces of soda. As the shells come from the alcohol bath they are taken out and placed on an inclined table, on which they roll down until they come into contact with an accumulation of shells at the base. These shells are in a convenient position for the man who performs the painting operation on the inside. The device used for this purpose consists of two rollers which are normally located beneath the surface of the bench. When the operator is ready to paint a shell, he takes it from the bench and places it in position over the hole through which the rollers are raised by depressing a foot-treadle. The result is that the shell is held between two rollers which impart a rotary motion to it. The painter then takes a round brush of suitable size, dips it into the shellac pot and pushes it into the shell. An experienced painter can varnish shells very rapidly by this method.

Fig. 47. Fixture used for driving in Gas Plugs

After the varnish in the shells has dried, they are inspected. The production is 1000 per day of twenty-three hours. Eight shells from each day's production are sent to the proving grounds for test, and as soon as a favorable report has been obtained, the shells are shipped to the loading factory.

MACHINING RUSSIAN 3-INCH HIGH-EXPLOSIVE SHELLS

Following the forging of the Russian 3-inch high-explosive shell, Fig. 48, as previously described the first machining operation is cutting off the open end. This is done in a Curtis & Curtis shell cutting-off machine as shown in Fig. 49. The forging is located by means of the gage shown at the front of the machine, and the cutter-head, carrying four radial cutters, is rotated about the stationary shell. The cutters are automatically fed into the work and at the end of the cut are returned to the starting point. The cutting is done at a work speed of 6[illegible] surface feet per minute and a lubricant called "Cut-[illegible]ol" is used for cooling and lubricating the work. The wall of the shell is about $\frac{1}{2}$ inch thick, and the cutting off is done at the rate of fifty shells per hour. On an average, 100 shells are cut off before the cutters require grinding. The base end is now cen-

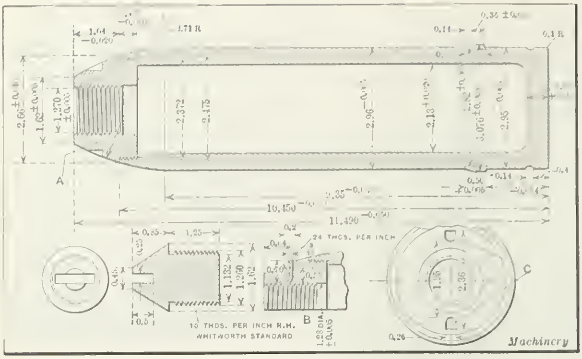


Fig. 48. Russian 3-inch High-explosive Shell and Plug

tered in a Rockford drilling machine provided with a special arbor mounted on the table over which the shell is slipped. After being centrally located, the shell is drilled and countersunk with a combination center reamer.

Heat-treating Russian High-explosive Shells

It is the practice of one plant to heat-treat the Russian high-explosive shell before any of the important machining operations are performed—in fact, it is heat-treated after the centering operation just described. Fig. 50 shows the furnace used for heating the shell previous to quenching; this is designed and built by the Laconia Car Co., and is shown

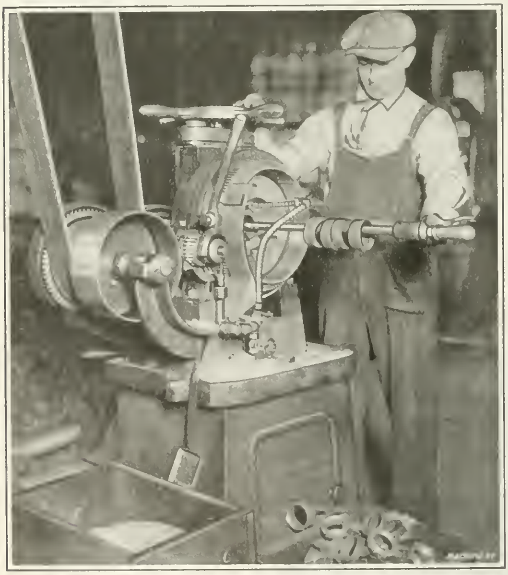


Fig. 49. Cutting off Open End of Shell Forging

in detail in Fig. 21. The shells are loaded into the furnace seven at a time by a special fork mounted on wheels, as shown in Fig. 50. The furnace holds thirty-five shells, and it requires thirty-five minutes to heat one lot of shells to the desired temperature—1470 degrees F. In removing the shells from the furnace, the fork is rolled under a layer of seven shells, which are pulled out, and the shells are gripped by a pair of tongs, and quickly immersed in a bath of running water. They are placed on racks at the bottom of the bath and allowed to get thoroughly cool before removing.

The tempering is done in lead baths, also designed and built by the Laconia Car Co. These are 34 inches wide, 34 inches high by 4 feet 9 inches long. The lead pot proper is of cast iron with one-inch walls, and measures 12½ by 14 by 24¾ inches. It is surrounded by a 1¼-inch fire-brick lining. One burner is used to heat the lead bath to 1100 degrees F. This one burner consumes 4½ gallons of fuel oil per hour. The shells are completely submerged in the bath for seven minutes, then taken out and allowed to cool slowly in the sand. To keep the shells below the surface of the lead bath, they are suspended on pins held on a crank, which is turned to force the shells down or bring them up as required. Five men, with the aid of three muffle furnaces and two lead pots, can heat-treat 100 shells per hour.

Rough-turning External Diameter

Following heat-treating, the next operation is rough-turning; this is accomplished in a 16-inch lathe, as shown in Fig. 51. The shell *A* is supported at the closed end on the lathe center, and is supported and driven from the open end, on the taper mandrel

Fig. 50. Heating Russian High-explosive Shell Forgings for Hardening

B. This resembles a reamer in shape, but, of course, is not provided with cutting edges. A single cutting tool is used and the depth of the cut varies from 3/16 to ¼ inch on the diameter. The work is rotated at a surface speed of from 60 to 70 feet per minute, and the feed is 1/16 inch per revolution.

Machining Interior of Russian High-explosive Shell

The boring, counterboring and reaming operations on the interior of the Russian high-explosive shell are performed on a turret lathe, as shown in Fig. 52. The order of operations is as follows: First, bore mouth of shell with boring tool *A*; second, rough-drill entire length of shell with tool *B*; third,

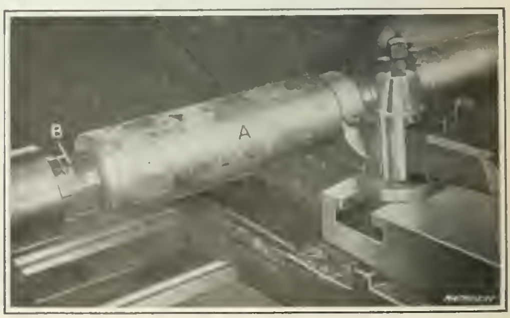


Fig. 51. Rough-turning External Diameter

finish-drill with tool *C;* fourth, finish bottom of shell with tool *D;* fifth, finish-ream entire length of shell with tool *E;* and sixth, counterbore with tool *F*.

Following the operations on the inside, the shell is held in a three-jaw chuck on a Davis lathe, and the solid end is rough-faced. After this, the shell is again chucked and the mouth is recessed preparatory to threading. Following this, the shell is held in a four-jaw chuck, as shown in Fig. 53, the outer end being supported by a steadyrest. The operations performed at this setting consist in roughing out the thread with tool *A*, taking a light cut across the end with tool *B* and finishing the thread with tap *C*.

Final Turning, Facing and Banding Operations

The base end of the shell is now finish-faced, the corners rounded slightly, and the band groove cut. The next step is to machine the under-cut in the band groove, which is performed by means of a special fixture. After this, the adapter or nose is fitted into the end of the shell, and the end of the shell is machined to shape. This operation is performed by inserting a nose plug that is used as a center as shown in Fig. 54. The radius turning is done by means of a former-plate *A*, against which the roll *B* held on the carriage is pulled by a heavy weight attached to chain *C*. Grinding of the body of the shell is now performed on a plain grinding machine, in which the three-operation method is employed. This is followed by pressing on the band which is done in a West Tire Setter Co. shell banding press. The rifling band is now formed to the required shape in a Jenckes machine, as shown in Fig. 55. Here, it will be seen that the shell is held in a three-jaw chuck, and the band is formed to shape by a single forming cutter. Proper location of the shell in the chuck is obtained by a gage located within the chuck.

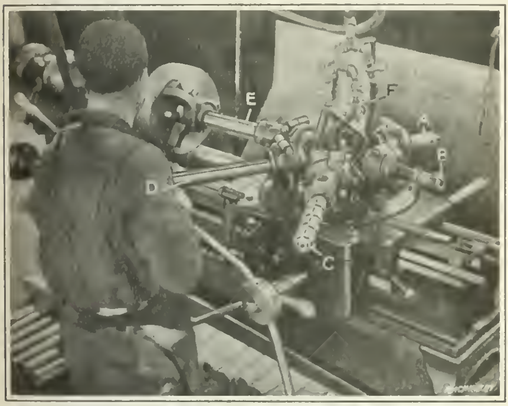


Fig. 52. Boring, counterboring and reaming Cavity of Russian High-explosive Shell

Fig. 53. Facing and threading Nose of High-explosive Shell

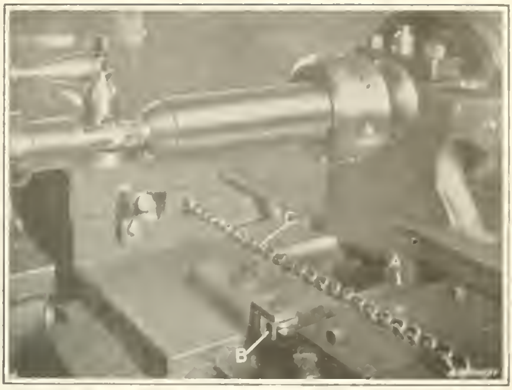


Fig. 54. Turning Radius on Nose of Shell

Machining the Adapter or Nose

The nose or adapter *A*, Fig. 48, for the Russian high-explosive shell is turned from bar stock in a $3\frac{1}{4}$-inch Gridley automatic turret lathe. The first operation after feeding the stock to the stop is drilling and rough-turning the outside and thread diameter. These operations are performed from the turret and the work speed is 120 R. P. M., the feed of the tools being 0.009 inch per revolution of the work. The tools held on the second turret face counterbore and finish-turn the thread diameter, and at the same time the forming tool is brought in to form the nose to shape. At the third station, the thread is rough-cut with a die and finished at the fourth position. The threading is performed with the work rotating at 36 R. P. M. The production on this part is six to seven pieces per hour.

The second operation on the adapter is boring out the center hole and cutting the internal thread. This is done on a

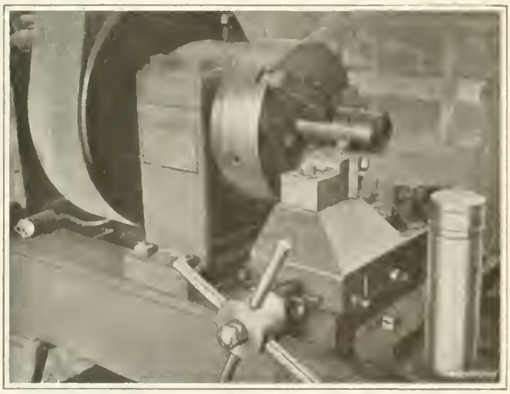


Fig. 55. Turning Copper Band on Jenckes Machine

14-inch lathe. The first step is to take a light finishing cut from the hole, after which it is threaded. The production is about four pieces per hour. The drilling, counterboring and tapping of the hole for the set-screw *B*, Fig. 48, comes next, and this is performed on a three-spindle sensitive drilling machine. The production is twenty pieces per hour. The two wrench holes *C* are then milled in a hand milling machine, one at a time. The production is sixty per hour.

MACHINING 75-MILLIMETER SERBIAN HIGH-EXPLOSIVE SHELLS

After the forging has been completed, the first machining operation on the Serbian 75-millimeter high-explosive shell shown in Fig. 56 is cutting off the open and closed ends. (See Table III.) This is done on an Espen-Lucas cold-saw, as shown in Fig. 57, at the rate of 160 per day. In this

TABLE III. ORDER OF MACHINING OPERATIONS ON 75-MILLIMETER SERBIAN HIGH-EXPLOSIVE SHELLS

Number of Operation	Character of Operation	Machine	Tools	Feed in Inches	Speed, R.P.M.	Production Per Hour
1	Cutting off Open and Closed Ends	Espen-Lucas Cold Saw	....	....	.	16
2	Centering	Engine Lathe	Combination Drilling and Centering	....	..	30
3	Facing and Beveling	21-inch Engine Lathe	....	....	84	5.5 to 6
4	Rough-turning	17-inch Engine Lathe	....	0.024	57	5.5 to 6
5	Semi-finish Turning	17-inch Engine Lathe	....	0.040	71	9 to 10
6	Rough-bore, Finish-bore, Tap	Double Spindle Flat Turret	Boring Tools, Tap	....	..	3.5
7	Rough, Finish, Knurl Band Groove	21-inch Engine Lathe	Cutting Tools, Knurl Under-cutting Tool	....	..	9 to 10
8	Finish-turning	17-inch Engine Lathe	Turning Tool	....	..	10 to 11
9	Final Finish-turning	17-inch Engine Lathe	Turning Tools	....	.	12
10	Remove Base End Projection	Band Saw	....	....	..	120
11	Face Base End	17-inch Engine Lathe	....	....	..	11 to 12
12	Drill, Turn, Face, Chamfer, Bore, Neck, Thread, Form, Cut off—Ogive	4¼ Gridley Single Spindle Automatic	....	0.008–0.012	80–140 ..	8–6 ......
13	Cut Internal Thread—Ogive	Automatic Threading Lathe	Circular Tool	....	72	......
14	Cut External Thread—Ogive	Pratt & Whitney Turret Lathe	Expanding Thread-Stud Mandrel	....	24–60	......

Machinery

operation, in addition to cutting off the excess stock on the open end, about 3/16 inch of stock is removed from the closed end of the forging. By referring to the illustration it will be noticed that three shells are loaded in one side of the machine by the swinging arm carrying the three gages while the saw is operating on the three shells on the other side.

Following this operation comes the centering, which is done on an engine lathe, as shown in Fig. 58. The mandrel on which the work is held carries two sets of three fingers that are expanded by a tapered draw-in bar operated by a handwheel at the rear of the spindle. A combination drilling and centering tool is used, and the production is 300 shells per day.

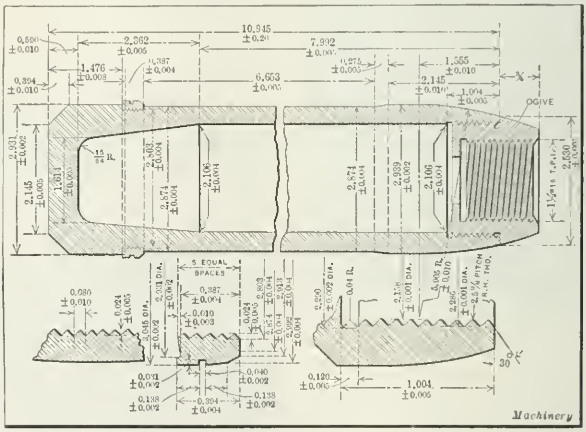


Fig. 56. Serbian 75-millimeter High-explosive Shell

Turning and Boring

The shells now go to the turning department, where the first operation is facing and beveling the closed end. Reference to Fig. 56 will show that the Serbian shell has a pronounced bevel at the base end, and this is roughed out at this time and the base faced, leaving a teat about 11/16 inch diameter. The facing and beveling is done on a 21-inch engine lathe, using two tools, one of which cuts the bevel and the other faces the end. The cutting speed is 65 feet per minute; the production is fifty-five to sixty shells per day.

The next operation is rough-turning as shown in Fig. 59. This is accomplished on a 17-inch engine lathe, at a work speed of 44 surface feet per minute. The amount of metal removed averages ⅜ inch on the diameter, and the feed is 0.024 inch per revolution of the work. This rough-turning operation leaves the shell about 0.050 inch larger than the finished size. The production is fifty-five to sixty shells per day. Following this a semi-finish cut is taken from the external diameter on a 17-inch engine lathe. For this operation the work speed is 55 surface feet per minute. The amount of metal removed is 0.025 inch on the diameter, and the feed is 0.040 inch per revolution. The production is ninety to one hundred shells per day.

The machining operations on the cavity of the shell are performed on double-spindle flat turret lathes. In the first position the operation performed is rough-boring with a single-point tool, removing ¼ inch of stock from the diameter; second, roughing out taper with a flat boring tool and recessing mouth with another tool held in the same bar; third, finish-boring full length of hole with a combination straight and taper boring tool, also boring diameter to be threaded; (The boring tool-holder used carries two blades, one set at right angles to the other; the first tool

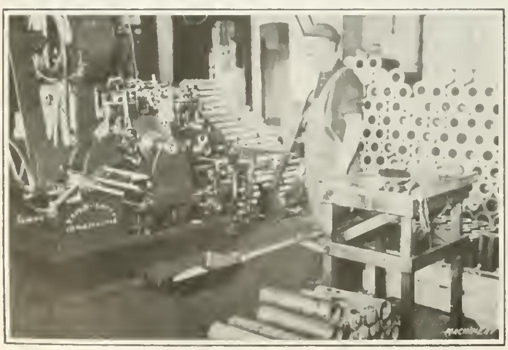


Fig. 57. Cutting off Excess Stock from Open and Closed Ends of Forging

Fig. 58. Centering Closed End of Forging

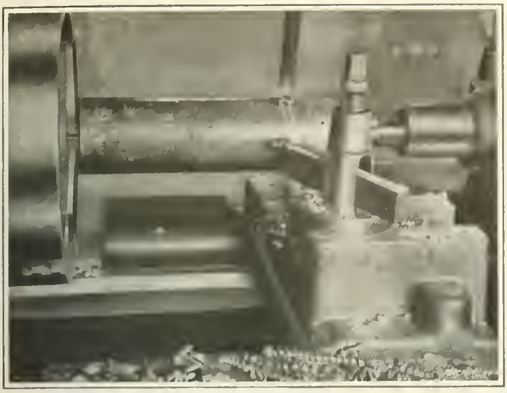


Fig. 59. Rough-turning External Diameter of Shell

bores the taper section and part of the straight section, whereas the second tool finishes the straight section only.) fourth, tapping mouth end of shell. The production is thirty-four shells per day.

A center plug is now screwed into the open end of the shell and it is taken to the 21-inch engine lathe shown in Fig. 60. The lathe is provided with a turret toolpost, and carries three cutting tools and a knurl. The first operation is to cut the groove with a broad-nose tool; second, cut two concentric rings (one for crimping in cartridge case) with a forming tool; third, under-cut base side of band groove 0.010 inch under-cut; fourth, knurl band groove. The production is from ninety to one hundred shells per day. The shell is now taken to a 17-inch engine lathe, where a light cut is taken from the external diameter, leaving it 0.015 inch over size. The

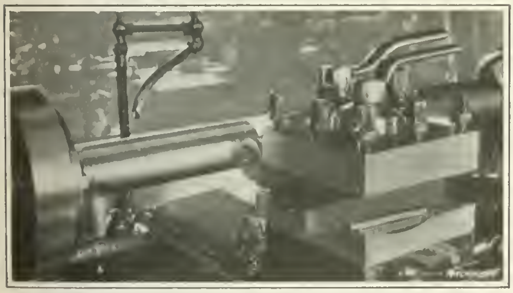


Fig. 69. Turning and Knurling Band Groove

turning commences at the rifling band groove and terminates at a point about two inches from the nose. The production is 100 to 110 shells per day. Following this is the final finishing. This is also accomplished in a 17-inch engine lathe. Two tools are used for this operation; one is set to the finished size of the shell at the base end back of the band groove, and the other is set for the reduced size. The purpose of this reduction is to allow clearance for the shell in passing through the gun. The production is 120 shells per day. The projection on the base end of the shell is now removed on a band saw. This is done at the rate of two shells per minute. After sawing off the center projection, the base end is squared up on a 17-inch engine lathe. The turret toolpost carries two tools; one of these faces the end and the other trues up the bevel. The production is 110 to 120 per day. Before any other operations are performed on the shell, the ogive is assembled.

Machining Ogive for Serbian High-explosive Shell

The ogive which fits in the nose of the Serbian 75-millimeter high-explosive shell is turned out from bar stock containing about 50 points carbon. The first operation is performed on a 4$\frac{1}{4}$-inch Gridley single-spindle automatic. The bar is fed to the stop located on a "corner" of the turret slide, and the first operation is to drill the small hole, and at the same time take a light cut from external diameter and face end of work; second, bore hole from turret, also chamfer inside with a hook tool; third, neck at base of thread with a regular Gridley internal necking tool, and at the same time form outside diameter to full width with a forming tool carried on the cross-slide; fourth, cut off. For centering, boring and facing, the stock revolves at 140 R. P. M. and the feed is 0.010 inch per revolution. For forming, the speed is slowed down to 80 R. P. M. and the feed to 0.008 inch per revolution. The cutting off is done at a spindle speed of 140 R. P. M. with a tool feed of 0.012 inch. Production is eight per hour.

The cutting of the internal thread is the next operation, and this is done on an "Automatic" threading lathe, using a circular tool on the bar. The spindle of the machine rotates at 72 R. P. M. and it takes from fifteen to twenty passes of the tool to complete the thread. The production averages six pieces per hour. Following this, the thread on the external diameter is cut. This is accomplished on a turret lathe, where the work is held on an expanding threaded-stud mandrel. The first operation is to face the seat on the under side of the ogive that comes in contact with the front end of the shell; second, thread external diameter; third, chamfer thread and burr hole. The facing and burring operations are accomplished at a spindle speed of 60 R. P. M., whereas for threading the speed is cut down to 24 R. P. M. This finishes the operations on the ogive with the exception of assembling it into the shell and taking a cut over the circular portion.

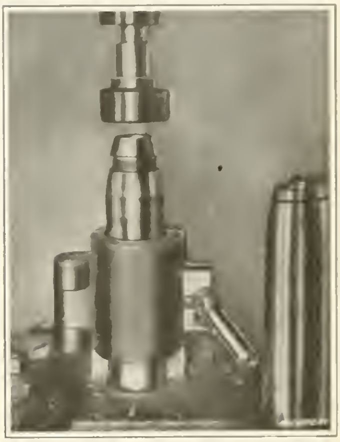


Fig. 61. Assembling Ogive in Shell Nose

Setting in the Ogive

After the ogive has been completely machined, as previously described, it is assembled in the nose of the shell. The assembling is done on a drilling machine as shown in Fig. 61. The shell is gripped in a hinged fixture fastened to the table of the drilling machine and a special tool similar in shape to an inverted cone, the inside surface of which is serrated, is used to assemble the ogive in the shell. The ogive

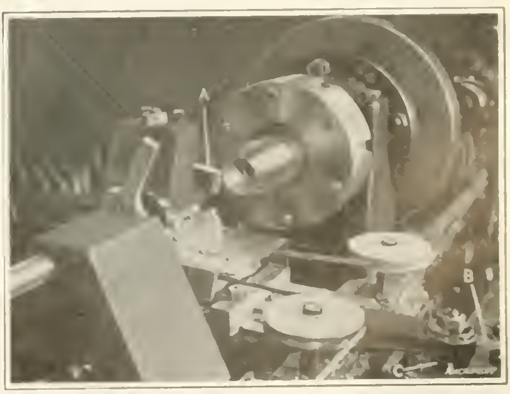


Fig. 62. Turning Ogive in Open End of Shell

Fig. 63. Spraying Interior and Exterior of Shell with Copal Varnish

is started into the shell by hand and then the tool is brought down in contact with it, driving it down to the seat.

The shell is now taken to a 17-inch engine lathe where the radius is turned, as shown in Fig. 62. Here it is gripped in a a collet chuck, being located centrally in this chuck by means of a special gage located on the tailstock spindle. After clamping, the turning tool *A* is brought in contact with the work and is guided in its operation by means of a former-plate *B* that is fastened to a fixture held to the bed of the lathe. The movement of the cross-slide is controlled by a roller *C* that contacts with this former-plate, the latter being kept in contact with the plate by means of two ropes to which weights are attached and which run over pulleys, as illustrated. The production is seventy per day.

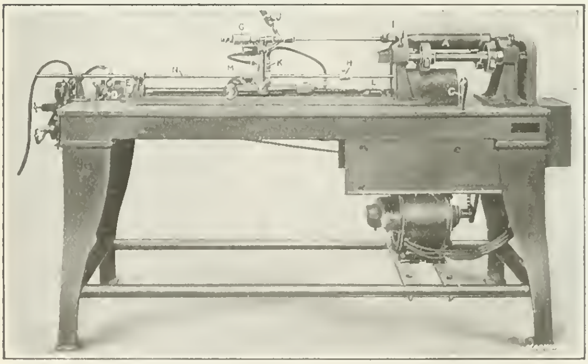


Fig. 64. De Vilbiss Spraying Machine for coating Interior of High-explosive Shells

Following the turning of the nose, the copper band is now pressed into the groove in a West Tire Setter Co.'s banding press. The bands are annealed before being pressed on the shell and two squeezes are necessary to compress the band into the groove. The copper band is now turned to shape in a 14-inch engine lathe carrying a special forming tool that covers the entire width of the band. This operation is handled at the rate of ninety shells per day. The shells are now inspected before they go into the hands of the government inspector. The inspection operation consists in checking up the diameter of the band and the ogive to see that they are held tightly in place. The shell is now stamped on a Noble & Westbrook stamping machine. The stamp is in the form of a roll that is passed over the end of the shell, pressure being applied by means of a foot-treadle. Prior to the varnishing which follows, the shells are washed, after which they are dried.

Varnishing Interior and Exterior of Serbian High-explosive Shells

The shells now go to the lacquering and spraying department where they are sprayed inside and outside and painted on the outside previous to shipment. For the spraying of the outside of the shell, a special De Vilbiss spraying torch is used as shown to the right in Fig. 63, whereas the internal diameter is sprayed on a special machine shown in the background of the same illustration. Copal varnish is used for spraying; this prevents the high-explosive from contacting with the shell.

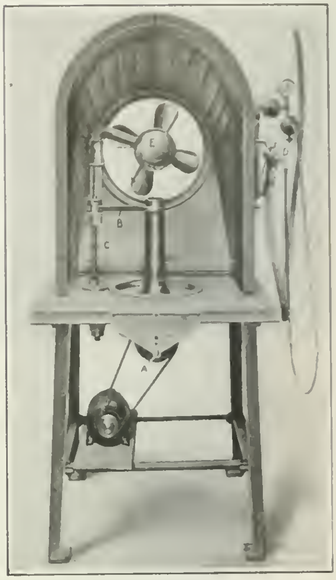


Fig. 65. De Vilbiss Spraying Device used in coating Exterior of High-explosive Shells

The operation of the internal spraying device is more clearly shown in Fig. 64. For this operation the shell *A* is placed on two pairs of rollers *B*, which are rotated by a one-half horsepower electric motor. The shells revolve at the rate of 300 R. P. M. and they are placed on the rollers and removed from them after the spraying is done and while the rollers are still in motion. The rollers are driven by means of a chain from the motor through a countershaft. The operation of the spraying member of the machine is as follows: With the rollers in motion and the machine in the position shown in Fig. 64, lever *C* is thrown to the left to start the machine. This releases a catch that holds lever *D* in a neutral position. The releasing of the catch allows a coil spring to pull lever *D* into the position shown, this lever being connected to the valve *E*. When this valve is operated, the air passes through it to a cylinder provided with a piston, the forward motion of which operates a cone clutch that starts carriage *F* moving to the right. When the carriage *F* strikes stop *H*, the rod upon which it is held moves forward with the carriage until the coil spring is pulled over the center line of lever *D*, at which point valve *E* is operated to return the carriage. At the same time that carriage *H* starts to move to the left, the air valve starts the spraying device *G* to work.

There are two nozzles in the end of torch *I* that throw a stream of varnish in two directions. The end of the shell as well as the sides are covered as the carriage moves to the left. The varnish or other material used flows down through the flexible metal hose *J* from a five-gallon container suspended above the machine. When the spraying torch reaches the point where the shoulder of

Fig. 66. Painting Exterior of High-explosive Shells

the ogive is coated, a cam mounted on the bed of the machine trips the air valve K, which stops the spraying. This valve, of course, is in circuit with the valve which starts the spray so that the air passes through both of them. (Valve K is opened on the forward stroke by cam L, but the other valve is closed at that time and the spray does not start.) The carriage continues to the left until it strikes stop M, which moves the rod N back to the point where the lever D is pulled back by the spring. A trip serves as a stop to hold lever D in a neutral position until it is again thrown. The throwing of lever D into the neutral position releases the air pressure on the piston holding the clutch in engagement, and a spring pushes the clutch out, stopping the motion of the carriage. The production is 400 shells per day.

The special De Vilbiss machine for spraying the exterior of high-explosive shells is shown in Fig. 65. The spraying of the outside is done after the inside has been sprayed. In spraying, the shell, as shown in Fig. 65, is placed on a vertical revolving spindle which is driven by a one-sixth horsepower electric motor at a speed of about 250 R. P. M. through a belt and friction disk drive. The amount of spray is adjusted by changing the position of the wheel which engages with the friction disk. Lever A serves to move the wheel in and out of engagement and is used to stop and start the machine between the spraying of the shells. The adjustable guard B is mounted on post C and swings in against a stop which pulls it into position and covers the copper driving band of the shell, protecting it from the varnish. The shell is sprayed, while revolving, with a De Vilbiss standard type L "Aeron" shown at D, the operator holding this device in his hand as shown in Fig. 63. The exhaust fan E removes the vapors caused by the spraying operation. This fan is operated by a one-half horsepower motor, entirely enclosed to protect it from the vapors, and the motor is automatically cooled by the clean air being drawn through it by the action of the fan. The production on this machine is between 400 and 500 shells per day.

After spraying, the shells are placed in a Steiner baking oven heated to 300 degrees F. where the shells are baked for eight hours. They are then taken to the Canadian Fairbanks-Morse painting machine shown in Fig. 66 where they are given a coat of yellow paint. This painting machine consists of a stand on which there are six spindles, each of which rotates continuously. The shells are placed upon the spindles, and as they rotate the painter holds his brush on the shell and applies the yellow paint. The band is not

Fig. 66. Grinding Base End of 120-millimeter French High-explosive Shell Forgings in a Gardner Disk Grinder

painted. One man can handle 250 shells per day with this machine, although it is usually used with a battery of two painters and one cleaner, when the average production is 750 shells. Once more the shells are placed in drying ovens that are kept at a temperature of 150 degrees, and ten hours in these ovens completes the drying of the shell. It takes twenty hours to dry in the atmosphere; therefore, this cuts the time exactly in half. After drying, the shells are wrapped in oil paper and packed ready for shipment.

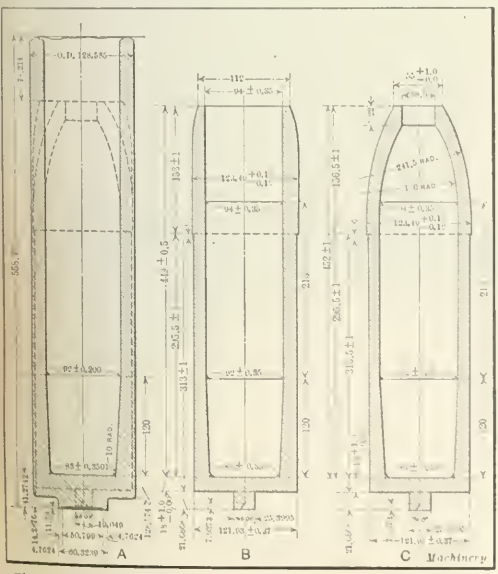


Fig. 67. Principal Dimensions of Forging and Condition of French 120-millimeter High-explosive Shell after First Series of Machining Operations

MACHINING FRENCH 120-MILLIMETER (4.72 INCH) HIGH-EXPLOSIVE SHELLS

The following description applies to the manufacture of the French 120-millimeter high-explosive shell which is made from a seamless steel forging of the proportions shown at A in Fig. 67. The forging is machined to the shape shown at B and is then nosed-in, after which a second series of operations is performed, bringing it to the shape shown at C. The first operation is to pickle the forgings to remove the scale. This is done in a sulphuric acid solution of the following proportions: sulphuric acid 1 part, water 10 parts. The temperature of this solution should not be raised above 150 degrees F., as a temperature higher than this produces fumes that are very annoying. The forgings are pickled in this solution for one hour and then washed in a bath of hot limewater to remove all traces of the acid.

Sorting and Grinding Base End

The next operation consists in sorting the forgings for size, with particular reference to the diameter of the cavity. The forgings are received in the plant in three lots: those exactly 94 millimeters (3.7 inches), those below, and those above this dimension. As a certain thickness of wall must be maintained in this shell, the variation on the inside diameter of the forging is carried to the external diameter, and on forgings in which the cavity is larger than the exact size of 94 millimeters, the external diameter is made slightly larger to allow for this. It is therefore necessary that the forgings be sorted and machined in different lots. After sorting, they are taken to the Gardner double-spindle disk grinder shown in Fig. 68, where the projection on the closed end is surfaced for centering. Here the forging is held in a special cradle fixture fastened to the swinging table and is held in place by a clamp as shown. The wheel used is a carborundum cylinder wheel, 16 inches diameter, with a 2-inch rim. The speed of the wheel is 2500 R. P. M., the amount of stock removed 1/32 to 1/16 inch, and the production about thirty per hour. The complete order of operations is given in Table IV.

TABLE IV. ORDER OF MACHINING OPERATIONS ON FRENCH 120-MILLIMETER HIGH-EXPLOSIVE SHELL

Number of Operation	Character of Operation	Machine	Tools	Feed, Inches	Speed, R.P.M.	Production Per Hour
1	Disk Grinding Base End	Gardner Grinder	"American" Wheel	....	2500	30
2	Cut off Open End	Engine Lathe	"Cyclops" No. 5	Hand	56	15
3	Drill Center	U. S. Elec. Tool	Center Drill	Hand	Work 60 Drill 7250	45
4	Face Closed End	Engine Lathe	"Cyclops" No. 5	Hand	....	6
5	Rough-turn	"Lo-swing" Lathe	"Cyclops" No. 5	....	56	4
6	Nose-in Open End	Beaudry Hammer	....	....	....	30
7	Face End and Bore	Engine Lathe and J. & L.	....	....	....	15
8	Heat-treat	Frankfort Furnace	....	....	....	25
9	Inspect for Hardness	Brinell Test	....	....	....	60
10	Recenter Base End	Williams Tool Co.	Center Drill	....	....	200
11	Bore and Thread Nose	Flat Turret Lathe	Murchey Taps	....	....	7
12	Finish-turn	"Lo-swing" Lathe	"Novo Superior"	0.020	40	4
13	Grind	Norton Grinder	Norton Wheel	....	....	8
14	Pressing Copper Band	West Tire Setter Co.	....	....	....	...
15	Turning Copper Band	16" Engine Lathe	....	....	....	20
16	Cutting off Projection	Williams Cutting-off Machine	....	....	....	24
17	10 Testing Operations	Gages and Weighing Scales	....	....	....	...
18	Testing for Strength	Metalwood Co. Press	....	....	....	...

Cutting Off Open End of Shell and Centering Closed End

From the disk grinder, the forgings are taken to the lathe shown in Fig. 69, where the open end is cut off, bringing the forging to the desired length. The forgings are held on an expanding mandrel operated by a special air chuck as shown in Fig. 70. Here the forging is shown by heavy dotted lines, and as will be seen it is gripped near the open end by an expanding collar *A* provided with a series of serrations around its periphery. The forging is located by adjusting screw *B* and is forced up tight against this stop before the air cylinder is operated. Clamping is effected throughout rod *C*, which is connected to collar *A* by pin *D*, rod *C*, in turn, being drawn back to expand collar *A* by a Hannifin air chuck cylinder located at the rear end of the machine spindle. For this operation, the work is rotated at 70 feet surface speed and the production is fifteen per hour. After cutting off, the shell is gaged to length by the gage shown in Fig. 71. This gage has gradnations on the bar, giving the limits.

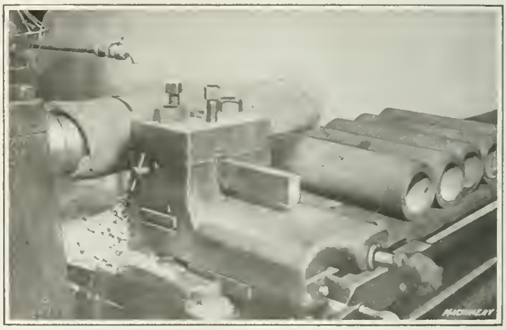


Fig. 69. Cutting off Open End of High-explosive Shell Forging

The centering of the closed end is the next operation. This is accomplished in an engine lathe in an interesting manner as shown in Fig. 72. The lathe is provided with a Hannifin air chuck, operating an expanding mandrel of the type shown in Fig. 73, on which the forging is held. This mandrel differs somewhat in construction from that shown in Fig. 70 in that in addition to clamping the forging it is also required to center it accurately from the internal diameter. In construction, this mandrel comprises a main sleeve *A*, which is screwed onto the spindle of the machine, and inside of which passes a rod *B* and sleeve *C*. Rod *B* and sleeve *C* are provided with tapered bearings that operate three clamping blocks *D* and *E* against the tension of flat springs *F* and *G*. These blocks, of course, are located equidistantly around the circumference of the mandrel and engage the interior of the forging near the base end and about $1\frac{1}{2}$ inch from the open end, respectively. Sleeve *C* of the chuck is forced forward when rod *B* is drawn back and *vice versa*.

Centering is done with a United States electric drill held in a cradle *A*, which is fastened to the cross-slide of the lathe and consequently moves with it. As shown in Fig. 72, the centering tool is guided by plate *B* which is fastened to the

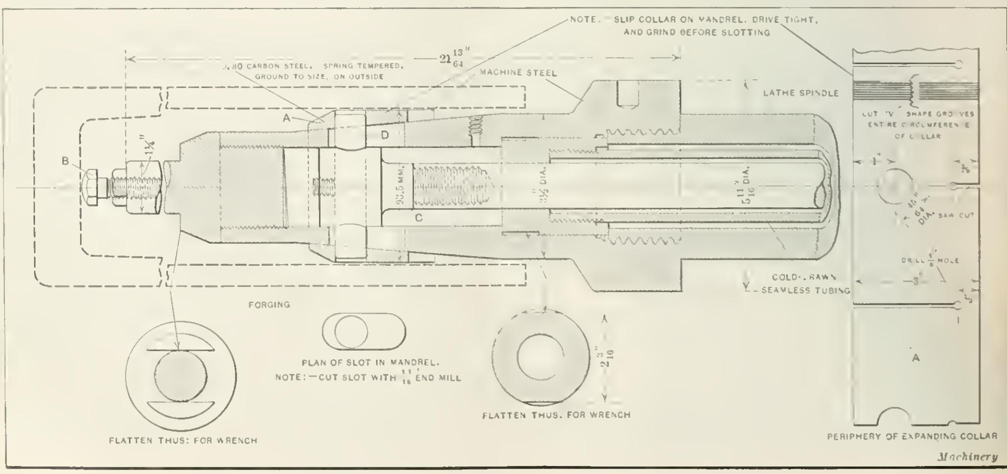


Fig. 70. Expanding Mandrel used in holding Shell Forgings when cutting off Open End

Fig. 71. Gage used in testing Length of Trimmed Forgings

cross-slide and holds the tool in line with the axis of the machine and drill spindles. The center hole is drilled and countersunk ⅝ inch deep. The work is rotated at 25 feet surface speed and the drill at 175 surface feet. The production is forty-five shells per hour.

Facing Off Closed End and Gaging for Length

After centering, the closed end of the forging is faced off to the required length as shown in Fig. 74. In this operation, the forging is held on an expanding air-operated mandrel of the type shown in Fig. 73. The desired length is secured by a swinging tool-setting gage *A* held in a bracket that is fastened to the bed of the lathe. In facing, from ½ to ⅞ inch of stock is removed; the work is rotated at 70 surface feet per minute and the feed is by hand. The production is six shells per hour.

The next operation consists in gaging the trimmed forgings for overall length as shown in Fig. 75. Referring to this illustration, it will be noted that the gage used consists of a plate, two pillars and a cross-bar. The plate is provided with a slot so that the teat on the end of the shell does not interfere with the correct measurement of the overall length. The gage used in testing the length of the shell after cutting off the open end is also shown in this illustration to the right. The allowable limit on length is 4 millimeters.

Rough-turning External Diameter

The rough-turning of the external diameter is accomplished on a "Lo-swing" lathe as shown in Fig. 76. Two tools are used for this operation that remove about 3/16 inch of stock from the diameter. One tool starts at the center of the forging and the other works from the closed end, so that the time required to turn the entire length of the shell is only equal to that which would be necessary to turn one-half the length with one tool. For this operation the shell is held on an expanding mandrel of the type shown in Fig. 73. The first cutting tool turns straight for a short distance until it approaches the nose, when it is backed out to enlarge the shell

Fig. 72. Centering Closed End of Forging

at that portion where it is nosed-in. The shells are turned in this operation to within 2 millimeters, 0.0787 inch, of the finished size, the remainder being left for grinding. The test for diameter is then made with a set of Johansson gages, after

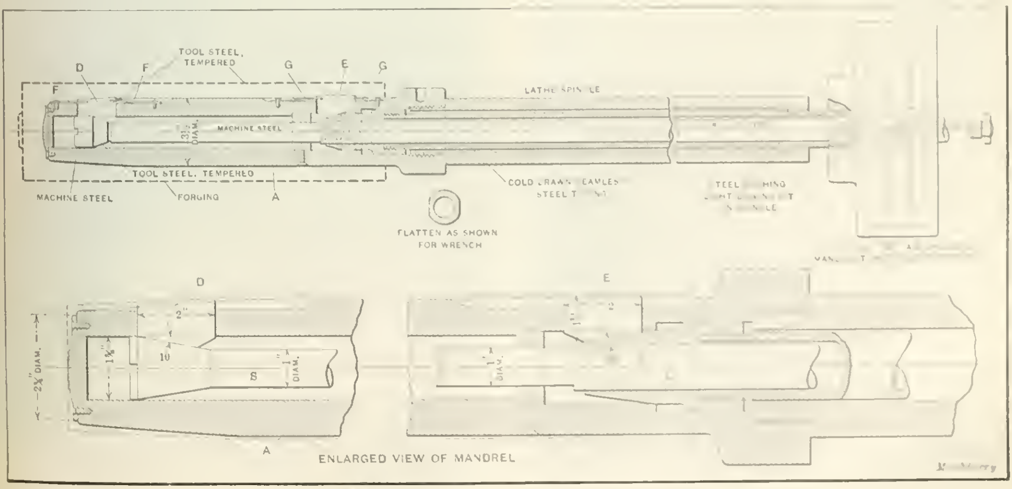


Fig. 73. Air-operated Mandrel used in holding Shell Forgings when centering and turning

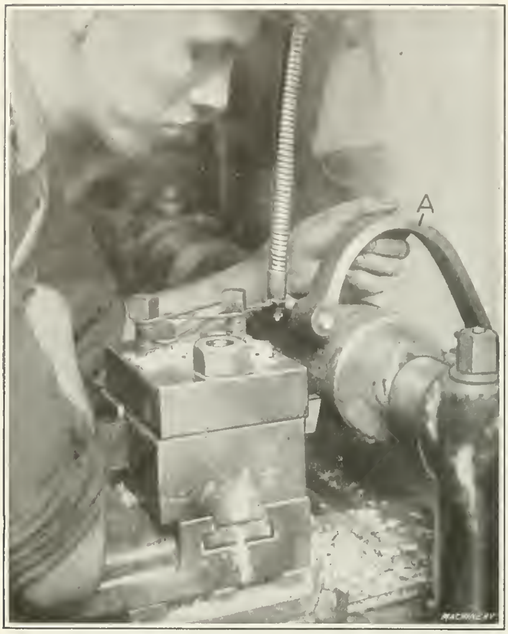


Fig. 74. Facing off Closed End of Forging to Length

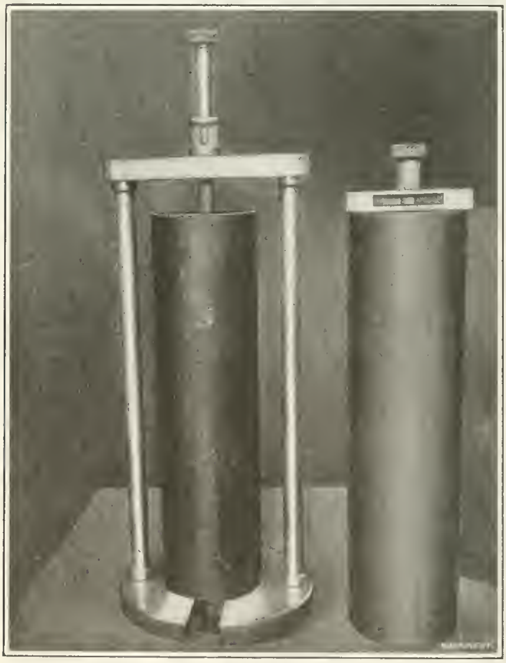


Fig. 75. Gaging Total Length of Trimmed Forging prior to turning

which the shell is heated for nosing-in. The production is four per hour.

Nosing-in Open End and Heat-treating

For nosing-in, the shell is heated for a distance of six inches back from the open end in the Frankfort furnace shown in the background in Fig. 77. The shells are left in the furnace for thirty minutes and heated to a temperature of 1600 degrees F. The furnace is heated by natural gas, and holds ten shells at one time. The nosing-in operation is accomplished in a 500-pound Beaudry hammer as shown in Fig. 77. For this work four men are required. One rotates the shell on its axis; another feeds the shell into the hammer dies, which are split and of the right shape; the third operates the hammer; and the fourth takes the nosed-in shell out of the hammer and brings another one to the machine ready for nosing-in. The nosing-in is started with light blows, so as to make the metal flow as evenly as possible; the blows are then increased in severity until the shell has received about twenty-five blows, which is ordinarily sufficient to complete the operation. An improvement made over this method, however, consists in eliminating one man by rotating the shell on its axis

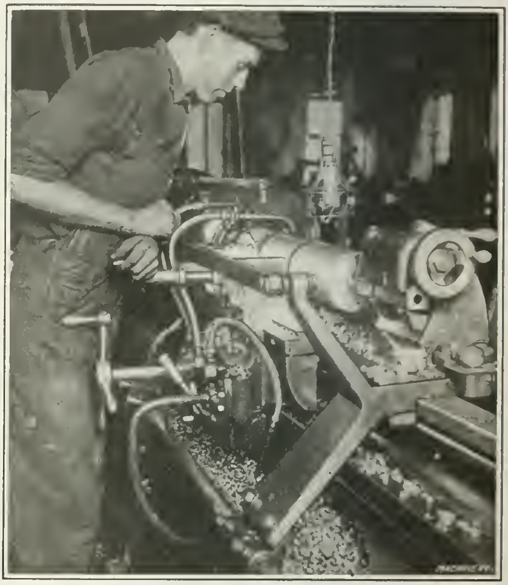


Fig. 76. Rough-turning External Diameter in a "Lo-swing" Lathe

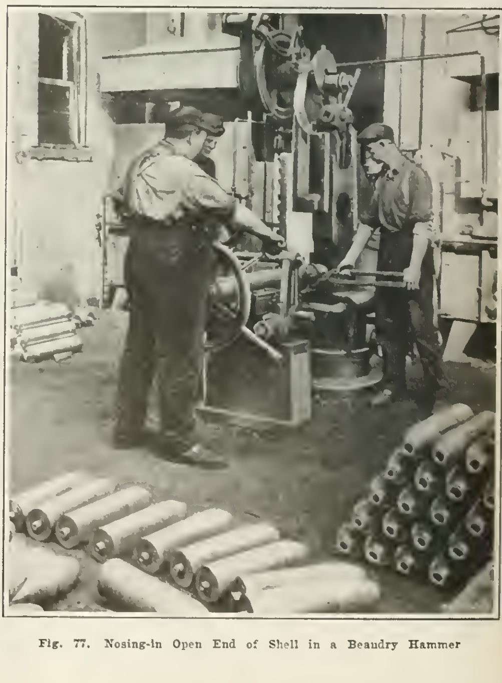


Fig. 77. Nosing-in Open End of Shell in a Beaudry Hammer

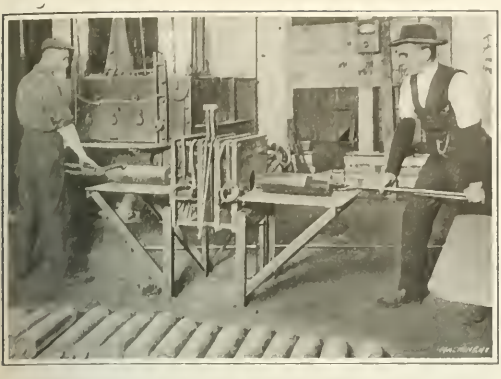


Fig. 78. Heat-treating Furnace and "Brush" for removing Scale prior to immersing Heated Shell in Cooling Bath

by means of an air drill. The production is thirty per hour.

After nosing-in, the shell is taken to a lathe where it is gripped in a chuck, the nose bored out, and the end faced off to length. The next operation is heat-treating. The heating is done in a Frankfort furnace of the type shown to the left in Fig. 78. The shell is left in the furnace for twenty-five minutes at a temperature of 1800 degrees F. As soon as the shell reaches the desired temperature, it is quickly removed

Fig. 79. Dipping French High-explosive Shells in Special Cooling Bath

from the furnace and placed in the cooling bath, shown in Fig. 79 and in detail in Fig. 80. Formerly the brushing device shown in the foreground of Fig. 78 was used to remove the scale, but this has been found unnecessary. Each cooling bath accommodates only one shell and is so arranged that the water circulates inside the cavity as well as around the external circumference. The shells are left in the cooling bath for five minutes, after which tempering follows. The quenching device shown in Fig. 80 does not provide for rotating the shell when cooling. A later improved device incorporates a rotating table for revolving the shell and thus obtaining a more uniform hardness. The tempering operation which follows is accomplished in a Frankfort furnace, where the shell is heated to 970 degrees F. and then taken out and allowed to cool off in the air.

Inspecting for Hardness

The final inspection for hardness is accomplished by means of a hydraulic testing machine, working on the Brinell ball principle, as is shown in Fig. 81. The ball used is 10 millimeters in diameter, and the pressure is 3000 kilograms (6613.8 pounds) for a period of fifteen seconds. The diameter of the impression made with this ball must be 3.4 millimeters (0.1139 inch). This corresponds to a hardness on the Brinell chart of 321. After this testing operation, the shells are then

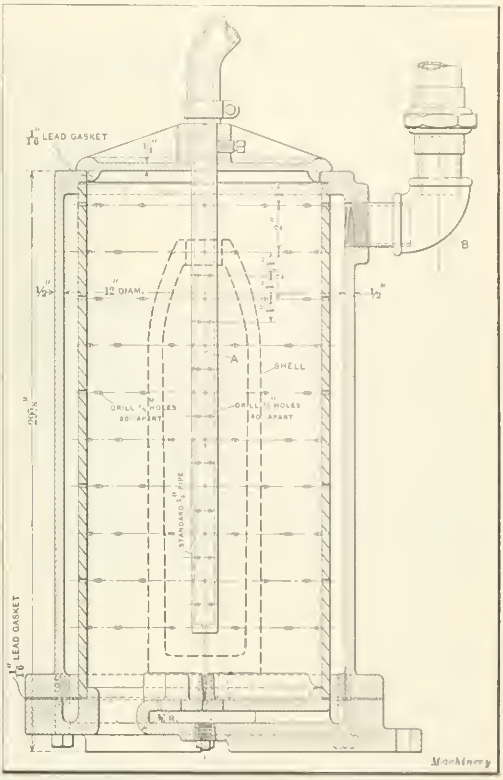


Fig. 80. Details of Cooling Bath shown in Fig. 79.

ready for grinding as will be described later. This Brinell test factor indicates an ultimate strength of about 124 kilograms per square millimeter.

Pickling and Drying Partially Machined Shells

After heat-treatment and testing for hardness, the shells are pickled to remove the scale formed in heat-treating, and dried before any further machining operations are performed on them. For pickling, the shells are placed, open end up,

Fig. 81. Testing Hardness of French 120-millimeter High-explosive Shells

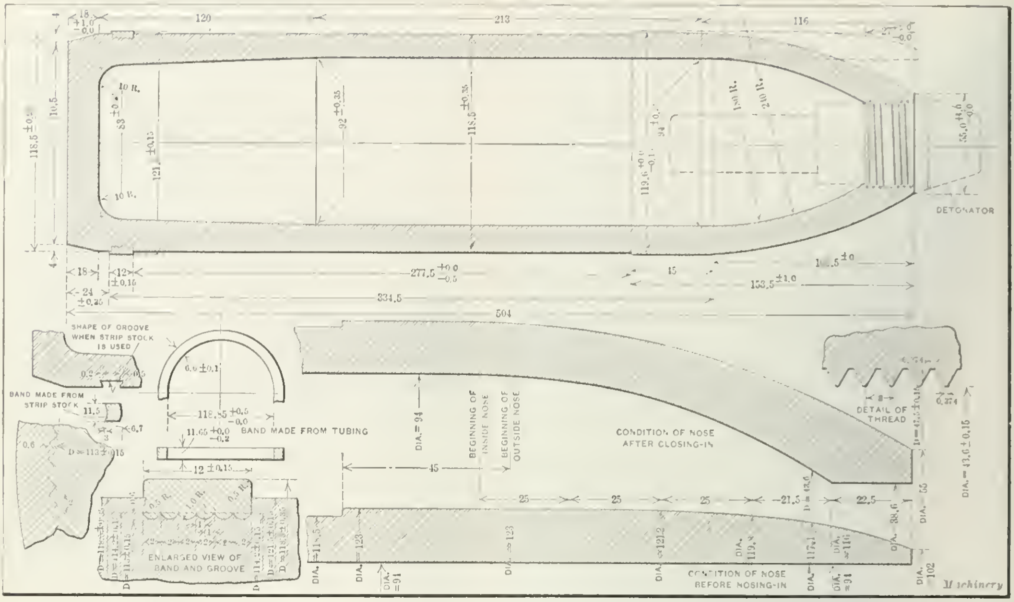


Fig. 82. Illustration showing French 120-millimeter High-explosive Shell, giving Finished Dimensions and Limits

in a wooden rack and are immersed in a bath consisting of ten parts water to one part sulphuric acid. The shells are left in this solution for forty-five minutes, and in lifting them out they are tipped so that the pickling solution runs out quickly. After immersing in the acid bath, the shells are washed in a solution of strong lime-water, then in clear running water, and then dried in a coke furnace. This furnace is 24 inches wide, 12 inches high by 48 inches long, and is tilted from the floor so that the shells, when fed in at one end, roll down and out of the other. The temperature of this coke furnace, which is simply an ordinary box furnace heated by coke, is about 400 degrees F. It holds ten shells, which are left in it for forty minutes, after which they are taken out and allowed to cool in the air.

Boring and Threading Nose End

Following the pickling of the partially machined shell, the first operation consists in recentering the base end, which is done on a Williams Tool Co. cutting-off machine that has been fitted up for centering. Here a light cut is taken to true up the center. The time required is about ten seconds per shell.

Following this, the shells are taken to the Jones & Lamson turret lathe shown in Fig. 83. For this operation, the work is held in a "Whiton" chuck and supported by a three-roll steadyrest. The first operation consists in rough-boring the hole in the nose; second, finish-boring hole with an expanding boring-bar; third, reaming to 43.6 millimeter diameter; fourth, rough-tapping with Murchey collapsible tap; fifth, fin-

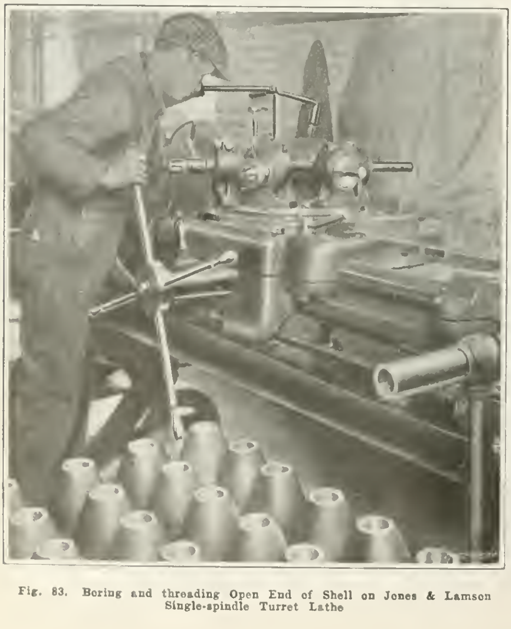


Fig. 83. Boring and threading Open End of Shell on Jones & Lamson Single-spindle Turret Lathe

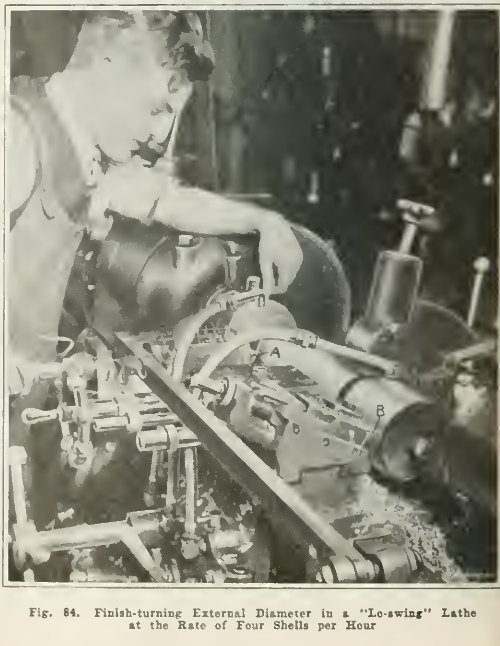


Fig. 84. Finish-turning External Diameter in a "Lo-swing" Lathe at the Rate of Four Shells per Hour

ish-tapping with Murchey tap. For boring, the work is rotated at 50 surface feet per minute, and for tapping at 30 feet per minute. The production is seven shells per hour from each machine. The shells are now removed from the chuck and the thread finished to exact size by means of a master tap. This is really an inspection operation. The shells are now washed in a steam bath to remove all the oil and grease and are then dried out thoroughly. Hardened center plugs are now screwed into the open end of the shell to serve as a center point when grinding and turning the external surface in subsequent operations.

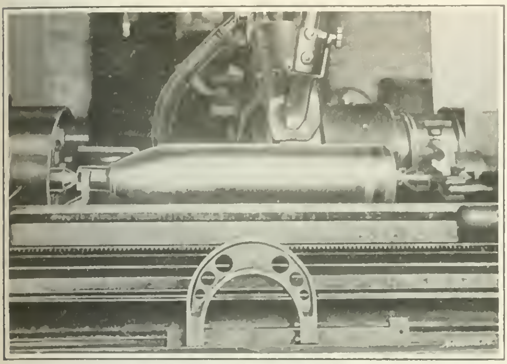


Fig. 85. Grinding Body of Shell on Norton Plain Grinding Machine

Finish-turning External Diameter of Shell

The finish-turning operation is done on the "Lo-swing" lathe shown in Fig. 84. Here two tools are used to finish the straight portion, and when these have traveled about 6 inches on the shell, the third tool *A* comes into operation to turn the radius on the nose. Another tool, not shown, turns the band groove to width and depth, then an under-cutting tool is brought in to finish the under-cut, and finally the groove is knurled. The last operation is to bevel the closed end with tool *B*. When a copper ring is used for the rifling band, only one side of the groove is dovetailed, but when a copper strip is used, both sides must be dovetailed. For the various turning operations, the work is rotated at a surface speed of 50 feet per minute, and the feed for the external straight turning is 0.020 inch per revolution. The production is four shells per hour.

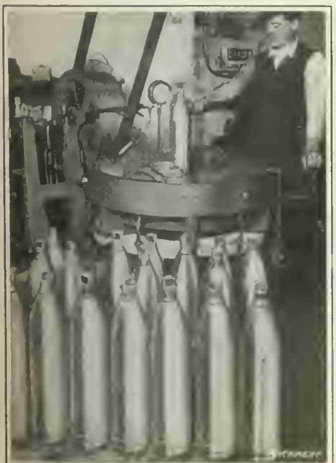


Fig. 86. Pressing on Copper Driving Band in a West Tire Setter Co. Banding Press

Grinding External Diameter

In the grinding operation which follows finish-turning and is illustrated in Fig. 85, about 0.020 to 0.030 inch of material is removed from the diameter of the shell. The machine used is a Norton plain grinder carrying a Norton alundum 20-inch diameter by 2-inch face wheel, grain 46, grade M, rotated at 1275 R. P. M. The grinding is done only on the straight portion, starting at a short distance from the base end, and proceeds straight until the enlargement near the nose is reached. The wheel is then backed away from the work the required distance, and the straight portion finished on the nose to the point where the radius merges. Owing to the length of the work, the traverse method of grinding is used. The wheel is trued up after grinding every three shells. The production is eight shells per hour from each machine.

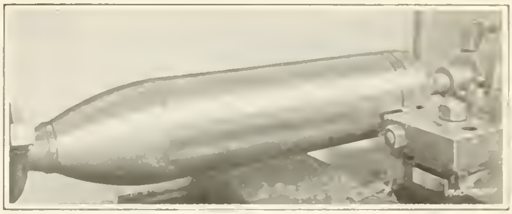


Fig. 87. Turning Copper Driving Band

Pressing On and Turning Copper Bands

When the copper band is of the ring type, the pressing on is done in a West Tire Setter hydraulic banding press as shown in Fig. 86. The inside diameter of this band is slightly larger than the external diameter of the shell, and is located in the correct position by means of the compressing dies, six of which are held in the machine. It requires from two to three squeezes to finish the pressing, and the production is twenty shells per hour. Before pressing on, the copper rings are heated to a dark red, then dipped in water and cooled to the temperature of the surrounding atmosphere. Following the pressing on of the band, the shells are taken to a 16-inch engine lathe, as shown in Fig. 87. The first operation is to take a rough cut over the external diameter of the copper band with a turning tool, after which a form tool is brought into

Fig. 88. Weighing French 120-millimeter High-explosive Shell

Fig. 89. Gaging External Diameter and Thread in Nose

Fig. 90. Gaging Contour of French 120-millimeter High-explosive Shell

position and finishes the copper band to shape and diameter. The production is twenty per hour.

After turning the copper band, the center projection is cut off from the closed end of the shell. This is done on a Williams Tool Co., cutting-off machine at the rate of twenty-four per hour. The center plug in the open end of the shell is also removed, leaving the shell in a suitable condition for weighing and inspecting.

Inspection

The first inspection is for weight as shown in Fig. 88. The correct weight is 16 kilograms, 750 grams, and the tolerance is ± 200 grams (35 pounds, 6.97 ounces, ± 7.05 ounces.) The first gaging test made is that for "bulge diameter." This test is illustrated in Fig. 89, where it will be seen that two ring gages are used. The diameter over the bulge is 119.6 millimeters plus 0.00 millimeters minus 0.15 millimeter. The "go" size must pass over the bulge, and the "not go" size must stop on it, as shown in the illustration. The next test that is made is over the copper band, and for this, snap gages of the horseshoe type are used.

Fig. 91. Gaging Concentricity of Shell

The limits are 121.5 millimeters plus 0.15, minus 0.00 millimeters. The third test is for over-all length, which is accomplished by means of a gage similar to that illustrated in Fig. 75. With a gage of a similar kind, the thickness of the closed end is measured from the nose. The next test is the diameter across the nose. This is made with a flat gage and the limits are 55 millimeters plus 1.0, minus 0.00 millimeters. The master thread gage is next screwed into the nose to see if the thread is O. K.; after this the plug is also tried for diameter at root of thread. These gages are all shown in Fig. 89. The next test that is made is for the contour. This is accomplished as shown in Fig. 90. A long flat gage that covers the entire length of the shell and also the contour at all points is laid across the shell, as illustrated, and by this means the inspector determines whether the shell has been turned and finished to the correct shape or not. Every point on the shell must check up to the templet. The next test is made with a similar gage and consists in testing the angle at the closed end of the shell, as shown in Fig. 92. The maximum diameter is 118.5 plus 0.25 millimeters, and the minimum diameter is 110.5 millimeters.

Testing for Concentricity

The next important test is for concentricity as illustrated in Fig. 91. A counterweight gage A having two arms and counterweighted on one end is fastened to the base end of the shell. The shell rests on hardened strips which are fastened to a cast-iron plate. It is located at right angles to the hardened pieces by pins driven into the plate, then is rolled over and must balance perfectly when the gage is in place. The heavy side of the shell is first found by rotating it on the parallel ways and then the weight is located on the light side. The moment of rotation must equal the amount

Fig. 92. Gaging Angle on Base End of Shell

of eccentricity from the center of gravity of the shell, which is worked out from the following formula:

$$WS = PR$$

in which W = weight of shell;
P = weight used on stem of gage;
R = distance from center of shell to center of weight P;
S = maximum eccentricity from center of gravity, which on this size of shell is 0.7 millimeter.

Fig. 93. Testing for Strength in a Metalwood Hydraulic Press

As W, P, and R are known, S may be solved in the equation given. If S is found to be 0.7 millimeter or less, the shell is passed. If, however, S is found to be more than 0.7 millimeter, the eccentricity is too great. P and R may be standardized for the maximum eccentricity, thus avoiding calculating.

Testing French High-explosive Shells for Strength

Every shell after machining and inspection is tested for strength in a hydraulic press of the type shown in Fig. 93. This particular machine is made by the Metalwood Mfg. Co., Detroit, Mich. Previous to testing, the shells are filled with water and placed in the machine shown in the illustration. The pressure is then turned on, which is equal to 650 kilograms per square centimeter or 9500 pounds per square inch. This pressure is maintained on every shell for about ten seconds, and it must show no leaks nor cracks. Following the testing operation, the shells pass through a final inspection, which consists in examining every shell for cracks, etc., and inspection by French officials. One shell in every hundred is given every test by an official. The last operation consists in greasing and packing the shells ready for shipment.

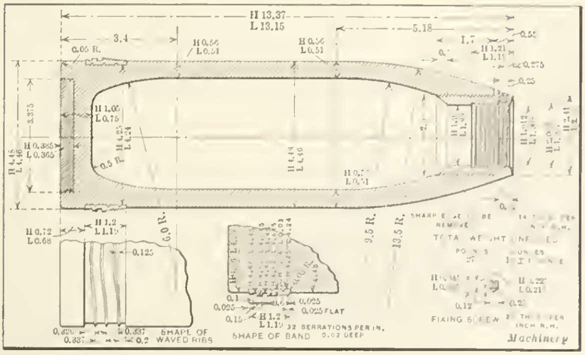


Fig. 94. British 4.5-inch Howitzer High-explosive Shell

MACHINING 4.5-INCH BRITISH HOWITZER HIGH-EXPLOSIVE SHELLS

The British 4.5-inch howitzer high-explosive shell shown in Fig. 94, as previously described, starts with a cast billet about three feet long, which is subsequently cut up into shorter lengths and forged to approximate shape. There are some thirty-two odd machining and inspection operations on this shell, and the average time required to produce one shell complete and ready for shipment is one hour, thirty-six minutes. It should be mentioned, however, that the equipment used for this purpose was not originally laid out for handling this work. In fact, the only special equipment purchased to turn this car shop into a busy shell plant was small tools and a few attachments for engine lathes. This case is only one of the many examples to be found in Canadian plants where standard tools were quickly fitted up for handling shells.

The order in which the various operations are handled is given in the following: The first machining operation consists in cutting off the open end of the shell to the required length. Prior to this, however, the shell is marked off and the amount of material to be removed from each end is indicated. The cutting-off operation, as shown in Fig. 95, is accomplished in an axle lathe which has been fitted up for this work. This axle lathe is of the double-head type, so that two men can work on one machine. The production is 250 in ten hours. The wall of the forging is about 13/16 inch thick, the cut-off tool ⅜ inch wide, and the speed 15 R. P. M.; the cutting tool is fed in by hand.

Facing and Rough-boring

The second operation consists in facing off the closed end in a boring mill where twenty-four of the forgings are held in a fixture. Two tools are used. The depth of cut is ¼ inch and the feed 1/16 inch per revolution. The table of the machine is operated at 120 R. P. M. and the production is about 220 in ten hours.

The third operation consists in rough-boring the interior to 3⅜ inches diameter in a four-spindle rail drill operated by two men, as shown in Fig. 96. The hole is 9¾ inches deep and is finished in one cut. A cutting lubricant known as "Mystic," made by the Cataract Refining Co., is used to keep the tools cool. The shell being rough-bored is held in a spring collet type of chuck which is attached to a slide that works in guides located on the table. The boring tools are rotated at 50 R. P. M. and the spindle moves down with a speed of about 1/16 R. P. M. The production is 240 in ten hours.

Fig. 95. Cutting off Open End of Forging

Fig. 96. Boring out Cavity of 4.5-inch Howitzer High-explosive Shells

Fig. 97. Finish-boring, reaming and facing 4.5-inch Howitzer High-explosive Shell

The fourth operation consists in centering the base end in an 18-inch engine lathe. The forging is held on an expanding mandrel and the center hole in the base end is first drilled and then centered with a centering tool. The production is 400 in ten hours.

Rough-turning

The fifth operation is rough-turning in an axle lathe. The shell again is held on an expanding mandrel and is turned up for a distance of 9¼ inches from the base end. The feed is 3/32 inch per revolution and the depth of cut is 7/32 inch. The speed of the work is 50 R. P. M. The production is 140 in ten hours.

Spot-drilling, Bottoming and Finish-boring

The sixth operation consists in spot-drilling on the inside with an end-cutter on a 28-inch upright drilling machine. The work is held in a collet chuck and about ¼ inch of metal is removed. The spot-drilling tool is rotated at 140 R. P. M., and is operated by hand feed. The production is 300 in ten hours. The seventh operation consists in hogging out the pocket at the bottom with a form cutter, held in a boring-bar in a wheel boring lathe of the vertical type. This tool is rotated at 48 R. P. M. and just cuts at the bottom; it is operated by hand feed. For this operation the forging is held in an expanding collet chuck and the production is sixteen pieces per hour.

The eighth operation consists in chamfering on a wheel boring lathe with a tool that chamfers the inside of the shell at the mouth only. This tool is rotated at 48 R. P. M. and chamfers for a distance of about 1½ inch down into the shell, enlarging the shell from 3⅜ to 4 3/16 inches. The ninth operation, as shown in Fig. 97, consists in finish-boring the inside of the shell and finish-chamfering the mouth. The first operation is to bore and face with an end facing tool that is located from the bottom; second, finish the pocket at the bottom; and third, chamfer. The machine used is a Bertram 26-inch engine lathe, provided with a turret. The shell is held in an expanding chuck and rotated at 80 R. P. M. The cuts vary from 1/32 inch to just cleaning up, and the production is eighty in ten hours.

Fig. 98. Waving and under-cutting Band Grooves

Grooving and Waving

The tenth operation is finishing the nose on the outside diameter with two tools. The first takes a straight roughing cut, the second turns the radius, and a third tool held in the same toolpost finish-chamfers the end. The machine used is a New Haven 24-inch engine lathe. The center on the tailstock is brought in to support the work, which is also held in a three-jawed chuck. The work rotates at 60 R. P. M. and the production is 220 in ten hours. The eleventh operation consists in taking a finishing cut over the base, roughing out the band groove, and finishing the external diameter back of the band groove, on a 24-inch New Haven engine lathe. The production is twelve per hour. The work is rotated at 60 R. P. M., and one turner and one form tool are used.

The twelfth operation is waving and under-cutting in a New Haven 24-inch engine lathe, to which has been applied a Bertram waving attachment, as shown in Fig. 98. The work is held in a chuck of the three-jaw type and is supported at the opposite end by the tailstock center. The waving tools are operated by a cam on the face of the chuck. The work is rotated at 40 R. P. M. and the production is twenty-five per hour.

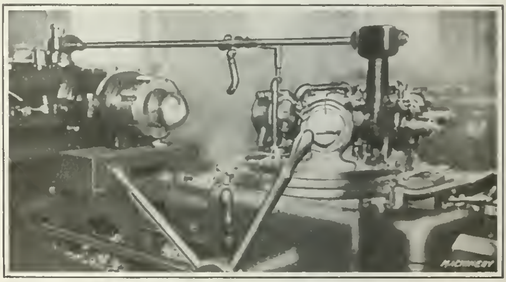


Fig. 99. Boring out Closed End of Shell for Gas Plug and threading

Nosing-in, Boring and Threading Nose

The thirteenth operation is nosing-in. This is done in a Williams & White bulldozer. The shell is heated in a furnace to a white heat—about 1800 to 1900 degrees F.—and is nosed-in in one blow. It requires three men to handle this operation; one looks after the furnace and two after the machine. The production is 400 in twelve hours. After cooling, the shell is brought back to the machining department where the fourteenth operation is performed. This consists in boring out the closed end of the shell for the gas plug and threading on a Jones & Lamson single-spindle flat turret lathe, as shown in Fig. 99. The operations are: first, drill 1⅜-inch diameter; second, hog out with a flat cutter; third, under-cut and face with a combination under-cutting and facing tool; and fourth, thread with a Jones & Lamson regular chasing attachment. The work for all operations except threading is operated at 30 surface feet per minute, and the production is ten per hour.

The fifteenth operation consists in machining the nose on a 20-inch Reed engine lathe, provided with a turret attachment, shown in Fig. 100. The operations are: first, bore, taking a 1/16-inch cut at a speed of 50 R. P. M., and face off to length; second, rough out inside radius with a boring tool, feeding by hand; third, finish inside radius to shape with a form cutter; and fourth, tap for a distance of 2 inches with a Murchey collapsible tap. The production is nine and one-half per hour.

Finish-turning

For the sixteenth operation a center plug is inserted in the open end of the shell. The external diameter is then turned all over in an 18-inch Canadian Machinery Corporation lathe.

As shown in Fig. 101, two cutters, which are held in the tool-post, are used for finishing. The cut is about 3/64 inch deep, and the operation of the tool-slide is controlled by a forming bar at the rear. The feed of the tools is 1/32 inch per revolution; and the speed, 100 R. P. M. The production is nine per hour.

Miscellaneous Operations

The seventeenth operation is sandblasting the inside with an air nozzle inserted in the shell; production, about 200 in ten hours. The eighteenth operation is preliminary inspection. The nineteenth is to screw in the base plug, and at the same time wrench off the projection with a heavy wrench. The twentieth operation is to face off the plug and round the edges of the base on a Canadian Machinery Corporation 18-inch engine lathe. The operations are: first, take a roughing cut across the base; second, roll in plate with a plain roller; and third, take a finishing cut across the base. For these operations the feed is by hand and the cuts vary in depth from 1/16 to 3/16 inch. The speed of the work is 120 R. P. M., and the production is fifteen per hour.

The twenty-first operation is stamping with hand stamps, the work being held in a fixture while this operation is being performed. Sixteen stamps are necessary and the production is 295 shells in ten hours. The twenty-second operation is re-tapping the hole in the nose of the shell with a Murchey tap, the shell being held in an Acme single-head threading machine, carrying a chuck instead of a die-head. The production is twenty-five per hour.

The twenty-third operation is screwing in the brass nose bushing by hand, holding the shell in a fixture. The twenty-fourth consists in turning the brass socket in a 20-inch McDougal engine lathe, one cutting tool being used. The production is twenty per hour. The twenty-fifth operation is cleaning out the shell with benzine and then varnishing it with a brush. The shell is laid down on the bench, rolled back and forth by the operator, and the interior varnished with a brush that is shaped like a toothbrush but is much larger. Two men are employed for this operation and the production is 400 in ten hours. The twenty-sixth operation is baking the varnish on the shell in an oven, which is heated to 300 degrees F. This oven is kept at a constant temperature and the shells are left in for eight hours. They are then taken out and left to cool in the air. The furnace holds 240 shells, so that the production is 240 in eight hours.

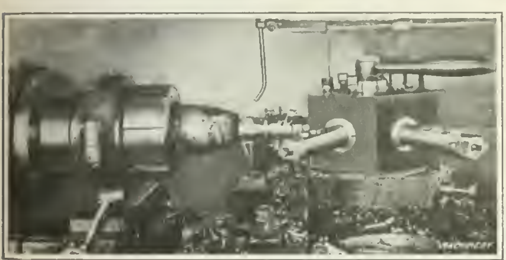


Fig. 100. Boring, facing and threading Nose End of Shell

Pressing on and Turning Copper Bands

The twenty-seventh operation is pressing on the copper band, which is done in a special banding machine having four hydraulic cylinders. The production is 225 in ten hours. Turning the copper band is the twenty-eighth operation, and this is done in a 22-inch Walcott & Wood engine lathe, equipped with a Lymburner Ltd. band turning attachment, as shown in Fig. 102. This attachment carries two forming tools, one on the front and one on the rear of the cross-slide. The operations performed are: rough-turn band with a tool on the top of the slide, operated by a turnstile at the front; rough-form band to shape with a form tool; and finish band with a forming tool held on a special attachment at the rear of the machine and operated by a separate handle. The work is rotated at 250 R. P. M. and the production is twenty-five per hour.

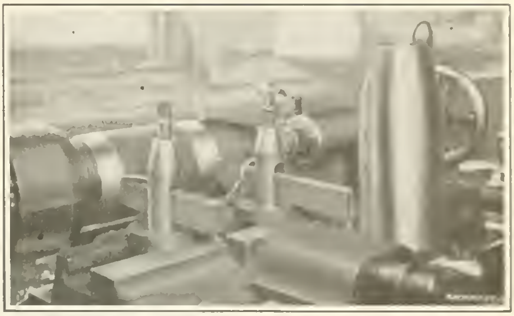


Fig. 101. Turning External Diameter to Size and Shape

The twenty-ninth operation is the final inspection. The thirtieth, applying the first coat of paint, the base of which is white lead; the thirty-first, applying the second coat of yellow paint. After drying, the shells are again inspected and packed ready for shipment, the plug, of course, being screwed into the nose to prevent foreign matter from getting into the cavity of the shell, and also to protect the threads in the nose from bruises. The plug is retained in the shell until it is removed for loading; it is then replaced and not removed again until the shell reaches the field of operations, where it is taken out and the detonating fuse substituted.

MACHINING 9.2-INCH BRITISH HOWITZER HIGH-EXPLOSIVE SHELLS

Starting with the finished forging, which is made with a closed-in nose, and has been carefully annealed, the first machining operation on the 9.2 British howitzer high-explosive shell shown in Fig. 103 consists in drilling a two-inch hole through the nose and in facing off the nose end of the shell until the required length is obtained. These operations are performed on a six-foot radial drilling machine as shown in Fig. 104, using a two-station jig that enables one side to be loaded while the machining operations are being performed on a forging located on the other side. The jig A is in the form of an angle-plate, and the radial arm of the machine is moved to bring the tool in line with the work. The drilling is done at a cutting speed of 60 to 65 feet per minute with a down feed of 1/64 inch per revolution. The production is five and one-half shells per hour, one man operating the machine.

Cutting-off and Rough-turning Operations

The next operation is cutting off the open end, which is done on a 24-inch Pond lathe. The forging is held in a "pot-chuck" (see Fig. 106) and is gaged from the end just machined. The surplus stock on the open end is cut off by means of a special carriage carrying two cutting-off tools, and oper-

Fig. 102. Turning Copper Driving Band

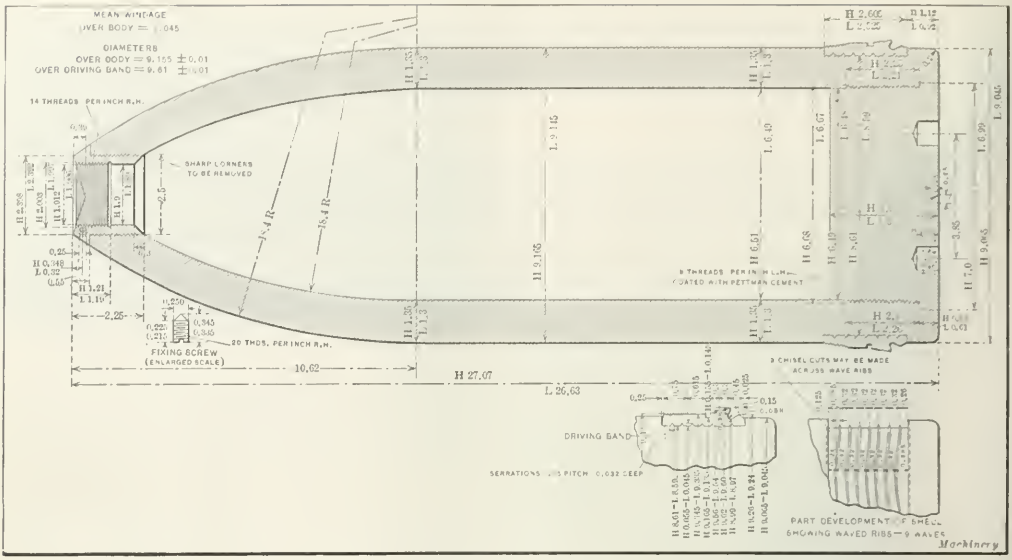


Fig. 103. British 9.2-inch Howitzer High-explosive Shell

ated by right- and left-hand screws, so that both tools are at work at the same time. The blades of the cutting-off tool are 3/8 inch wide, and the surface speed of the work is from 70 to 80 feet per minute. One man operates two machines and cuts off seven shells per hour.

After cutting off, the straight portion of the shell is rough-turned. For this operation the shell is held on a mandrel that has two sets of expanding plungers, and the work is done on a 24-inch Pond lathe. Two cutting tools are used that remove a total of 3/4 inch on the diameter in one cut. Each tool removes 3/8 inch, and works at a cutting speed of 70 to 80 surface feet per minute. As the forgings vary somewhat, it is often necessary to take two cuts to finish. The longitudinal feed is 1/8 inch per revolution of the work. At this setting, the nose of the shell is not touched, and the next operation is the roughing of the nose to the required radius. This is handled on a 24-inch Pond lathe as shown in Fig. 105. The shell is gripped from the internal diameter by expanding mandrel *A*, fastened to the faceplate as shown.

Two cutting tools are used which are guided in the correct path by a simple but satisfactory device. This radius device comprises a special carriage *B* that is carried on a bracket *C* bolted to the bed at the rear of the lathe. Located on carriage *B* is a stationary slide *D* to which is bolted link *E* that serves to connect cross-slide *F* with the rear carriage. The cross-feed screw ordinarily used is removed so that the motion of slide *F* in a radial direction is controlled by link *E*. In operation, as the front carriage is fed toward the faceplate, link *E* forces cross-slide *F* back and thus guides the cutting tools in a curved path. The correct starting and finishing points of the radius on the shell are obtained by adjusting screw *G*. The production for rough-turning the straight diameter and nose is one shell per hour.

Boring, Counterboring, Facing and Threading Operations

The next operation is boring, which is performed on a 36-inch Pond heavy-duty lathe provided with a rack tailstock, as shown in Fig. 106. For machining, the shell is held in a "pot-chuck" clamped to the faceplate and is additionally supported by a steadyrest as shown. The interior of this chuck is made an easy fit for the shell, the latter being held by contracting the chuck, which is split, by clamping bolts as shown. Two three-tooth boring reamers are used, one roughing and one finishing, which remove about 1/2 inch from the diameter between them. The roughing reamer is provided with high-speed steel blades which are serrated to break up the chip, whereas the finishing reamer is provided with smooth blades of high-speed steel. The cutting speed of the reamers is 74 to 78 surface feet per minute. The longitudinal feed is very coarse (1/2 inch per revolution) until the radius is reached, where it is reduced to 1/32 inch per revolution. The production is one shell per hour.

Following the operation just described, a series of operations is performed on the nose of the shell on a 24-inch Pond lathe provided with a four-sided turret. The shell is held in a "pot-chuck" in a

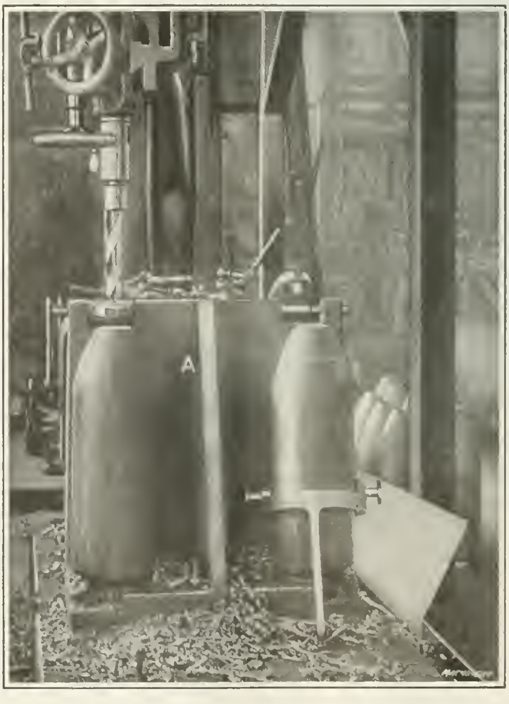


Fig. 104. First Machining Operation on 9.2 British High-explosive Shell Forging—drilling Hole in Nose and facing

similar manner to that just described, but of course the nose instead of the base end projects. The operations are: rough- and finish-bore opening, rough-face end, tap and finish-face end. The finishing cuts are taken at an average speed of 120 surface feet per minute and the feed is 1/32 inch per revolution. The production is two shells per hour.

The reverse end of the shell is now machined, and as was the case in the previous operation, is held in a "pot-chuck." The work is done on a 24-inch Pond lathe provided with a four-sided turret. The operations are: face off base end, bore aad counterbore, and chase thread for base plug. The cutting speeds are 120 surface feet, feeds 1/32 inch per revolution, and production one shell per hour.

Finish-turning, Grooving, Waving and Assembling Base Plug

The finish-turning on the external diameter comes next, and this is done on a 24-inch Pond lathe provided with a former-plate, somewhat similar in design to an ordinary taper-

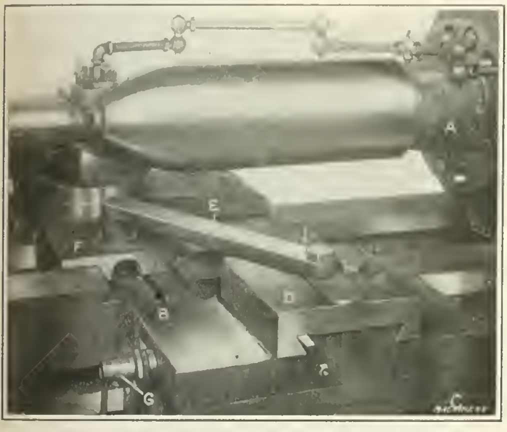


Fig. 105. Turning Radius on Nose on a 24-inch Engine Lathe

turning attachment. One cutting tool is used and one cut finishes the work. The speed is 120 surface feet, and the feed 1/32 inch per revolution. The production is two shells in three hours.

Following this operation the shells are taken to the 24-inch Pond lathe shown in Fig. 107, where the band groove is cut and the wave ribs produced. The shell is held on a special mandrel *A* (see Fig. 108 for details of construction) which is driven by a special faceplate *B*, Fig. 107. This faceplate carries cam *C* used in oscillating the rear waving slide *D* as described later. The lathe carriage is provided with a turret toolpost *E* carrying four tools that perform the following operations: Tools *F* are used to neck at the limits of the band groove; tool *G* roughs out the groove to the top of the ribs; tool *H*

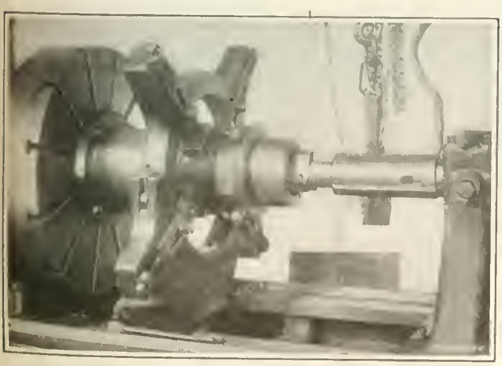


Fig. 106. Rough- and finish-boring Internal Diameter on a 36-inch Engine Lathe

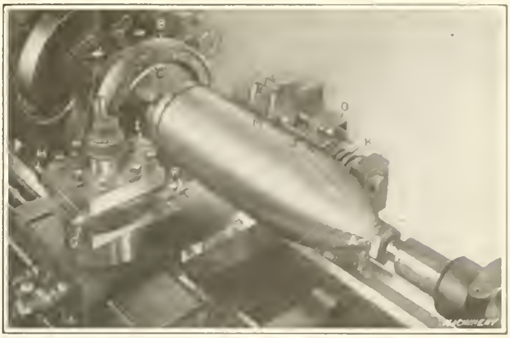


Fig. 107. Set-up on a 24-inch Engine Lathe for machining Band Groove and cutting Wave Ribs

under-cuts the edges of the groove; and tool *I* roughs out between the wave ribs. The wave ribs are produced by the special fixture *D* held on the rear of the carriage. This comprises a slide *J* which is oscillated by cam *C* against the tension of spring *K*, and carries a tool-holder *L* that holds the waving tool *M*. Tool-holder *L* is adjusted for position by screw *N*. This fixture is operated by bringing the cross-slide forward and moving the carriage over, until a roll (not shown) engages with cam *C* which imparts the required oscillating movement to slide *J*. The band grooves are cut and ribbed at the rate of eighteen shells in ten hours. Putting in the base plug and nose bushing is the next step, and this is done by hand. Each plug is carefully fitted and cleaned, and is left partially screwed in place until such time as the loading of the shell is finished.

Banding and Band-turning Operations

The pressing on of the copper driving band is performed in a Dudgeon hydraulic banding press. The copper bands are heated to a bright red in a "Best" oil furnace, and when they have attained the correct temperature they are quickly removed and placed in the banding press. The shell is now placed in the press, the band being slipped over it and located by the dies in the correct relation to the groove. The press

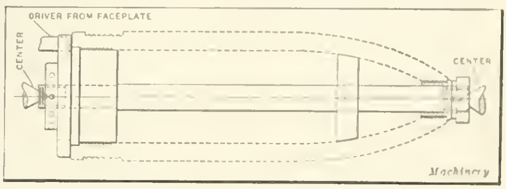


Fig. 108. Diagram showing Details of Construction of Fixture used for holding Shell when performing Operation shown in Fig. 107

is now operated, whereupon six dies are forced in radially and compress the band into the groove. After the first squeeze, the shell is turned around 30 degrees and given another squeeze. The production on this operation is about twenty shells per hour.

The copper band is turned on the Pond 24-inch lathe shown in Fig. 109. Here it is supported and driven from one end by a special driver *A*, Fig. 110, and is supported on the nose end by a revolving center *B*. The cross-slide carries a turret toolpost *A*, Fig. 109, holding four tools, which, in conjunction with a forming tool on the rear of the slide, rough- and finish-turn the band to shape. The production is three shells per hour.

Weighing, Cleaning, Varnishing, etc

Upon the completion of the machining operations, the shells are weighed, the limit in weight being 10 ounces either way from the standard, which is 252 pounds. Working from the nose end, the shell is now washed out with soda water and then dried, after which a coating of Copal varnish is sprayed in with a "Buffalo" air spray brush. The shell is swabbed outside, while hot, with a light machine oil and then baked for eight hours at a temperature of 300 degrees F.

Considering the weight of these shells, it is interesting to follow the way in which they are handled. A continuous track runs down the aisle of the shop between two rows of machines along which the shells are kept moving. Shells of this size are too heavy to handle by hand, so light air hoists are located over each machine to facilitate handling. Stamping, inspecting, etc. finish the operations on the shell, after which it is ready for packing and boxing.

ROUGHING OUT HIGH-EXPLOSIVE SHELLS IN HIGH-POWER DRILLING MACHINES

British 18-pound high-explosive shells are made from bar stock, as has been previously described, and the usual method is to rough out the hole in a high-power drilling machine. Figs. 111 and 113 show an efficient method of accomplishing this operation. The machines used are Baker Nos. 310 and 315 vertical high-power drilling machines (the latter size being of the extra-heavy pattern) equipped with a special

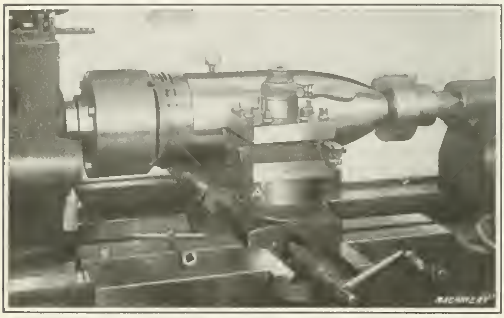


Fig. 109. Set-up for turning Copper Band to Shape on a 24-inch Engine Lathe

fixture *a* clamped to the table. This fixture is provided with four tool-steel holding jaws that support the bar in a vertical position, and are operated by right- and left-hand screws by means of a turnstile *b*. At *A* is shown the first rough-drilling operation, which is accomplished by means of a 1 13/16-inch diameter high-speed drill driven at 175 R. P. M. with a down feed of 0.020 inch per revolution. The drilling time is about three minutes per shell. *B* shows the second operation which consists in removing the vee left by the point of the drill, and rounding the bottom. *C* shows the final reaming operation; and *D* illustrates the special tool used for machining the exterior of the nose of the shell. The tool used for this purpose is designed along the principles of a hollow-mill carrying one inserted high-speed steel blade. In this set-up

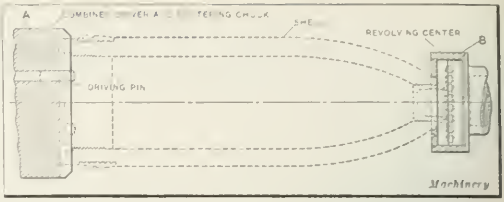


Fig. 110. Diagram showing Method of holding and driving Shell when performing Operation shown in Fig. 109

it will be noticed that a special bushed bracket is fastened to the top of the fixture, to support the large nose turning tool.

Previous to cutting the thread in the nose of the shell, it is necessary to recess it at the point where the thread terminates. This is accomplished by a recessing tool of the construction shown in Fig. 112. Referring to this illustration, it will be noticed that the tool consists of a holder *A* provided with a tang fitting into the drilling machine spindle. This carries sleeve *B* that is operated upon by a spring *C*, the latter lying in between the recessed shoulder of the sleeve and a washer *D* that is pinned to bar *A*. The recessing tool proper *E* is carried in an elongated slot in the lower end of bar *A* and is operated by means of an angular slot in the bar through a pin driven through the recessing tool. In operation, the drilling machine spindle is brought down until sleeve *B* contacts with the nose of the shell, whereupon further downward movement of the spindle compresses spring *C* and at the same time forces out the recessing tool *E*, cutting the annular groove in the interior of the nose. The last operation, as performed in the drilling machine, consists in threading, and it is accomplished with a collapsible tap as illustrated at *F* in Fig. 113.

The layout advocated by Baker Bros. for this work is a gang of six machines, consisting of two No. 315 extra-heavy pattern machines for the drilling and nose-turning operations, and four No. 310 machines for the bottoming, reaming, counterboring, facing, under-cutting and tapping operations. This gang of six machines gives a production of eight shells per hour, and leaves them ready for the lathe turning operations.

SURFACING GAS PLUGS ON BESLY RING WHEEL GRINDERS

The gas plug used in the base end of British high-explosive shells is made from a forging and must be faced on the end that is next to the shell. Several methods are used in surfacing the inner face of this plug, and a very satisfactory one is to grind it on a Besly No. 14-16 wet ring-wheel grinder, shown in Fig. 114, which is equipped with a special rotary chuck shown in detail in Fig. 115. Fig. 114 shows two operators

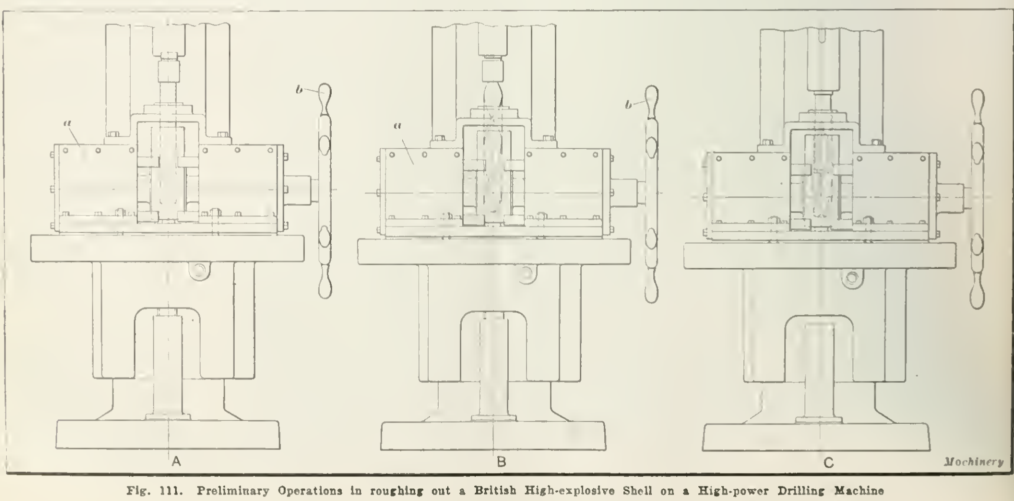


Fig. 111. Preliminary Operations in roughing out a British High-explosive Shell on a High-power Drilling Machine

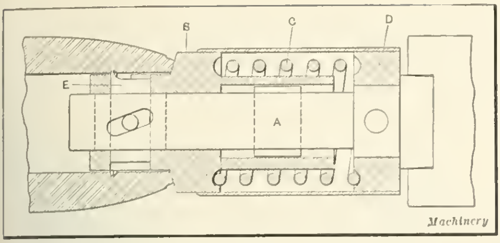


Fig. 112. Special Recessing Tool used for performing Operation E shown in Fig. 113

at work grinding the face of gas plugs. The jaws of this rotary chuck are threaded to grip the threaded body of the plug when the latter is machined, and consequently the base is finished true with the threaded body of the plug. For grinding, a cylinder type of wheel is used that is held in the standard Besly pressed-steel ring-wheel chuck. The wheel is about 16 inches diameter, 3 inches face. Gas plugs for British 4.5-inch high-explosive shells can be turned out from the rough at the rate of sixty to eighty per hour for one operator by this machine. The machine, of course, is double-ended, so that two operators can work on one machine at the same time. The action of the grinding wheel rotates the work while grinding, producing the desired accuracy.

The Besly No. 14-16-inch L type wet-wheel grinder shown in Fig. 114 is also used for grinding off the projections on gas plugs and facing the base end. On the 18-pound British high-explosive shell, the projection on the end of the gas plug is about 3/4 inch long and 7/8 inch diameter, of square section. (In some cases this section is made triangular in shape.) On the Besly No. 14-16-inch grinder, twenty-five shells can be ground per hour. The grinding machine, of course, accommodates two operators, giving a combined production of fifty shells per hour per machine. At the same time that the projection is removed from the gas plug, the surface of the gas plug is also ground, 1/32 inch of material being removed. The diameter of the plug on the 18-pound shell is about 2 1/4 inches (see Fig. 116). Where the projection on the gas plug is triangular in shape, the production can be greatly increased because this projection is only 3/8 instead of 3/4 inch high. On the type of gas plug here described, the production is about 100 shells per hour per operator, or 200 shells per machine. Fig. 116 shows a British high-explosive shell that has been finished off on the base on the Besly grinder illustrated in Fig. 114 and also the two types of gas plugs referred to. The one shown at *A* is of triangular section, whereas the one shown at *B* is of square section with a hole in the center.

TESTING HARDNESS OF HIGH-EXPLOSIVE SHELLS

When orders for high-explosive and shrapnel shells were first placed in this country and Canada, considerable trouble was experienced in getting shells to pass the government inspectors. While a large number of concerns were successful in getting the shells finished to the required dimensions, many experienced trouble in heat-treating shrapnel shells and attaining the desired physical properties. The government inspectors finally decided on using testing apparatus which could be applied to every shell after heat-treatment and thus check up the tensile strength of the shells. There are two well-known methods of testing the hardness of metals, namely, the scleroscope shown in Fig. 117 and the Brinell instrument shown in Fig. 81. Of these two, the Brinell is the older. The British government has been using both of these instruments for some time, but in general, on shell work the Shore method has been adopted because of the rapidity with which the test could be made. Also it did not injure the parts and could be used on hardened metal, for which the Brinell method is not as adaptable.

Fig. 114. Surfacing High-explosive Shell Gas Plugs on Besly No. 14-16-inch L "Wet" Ring Wheel Grinder

Extensive tests have shown that there is very little difference in the results obtained with the Brinell and the Shore method. What little difference there is, is due principally to the Brinell indenting pressure, which is applied slowly and then left on for fifteen seconds or more. The time taken and the extreme stress imposed, causes undue variation depending

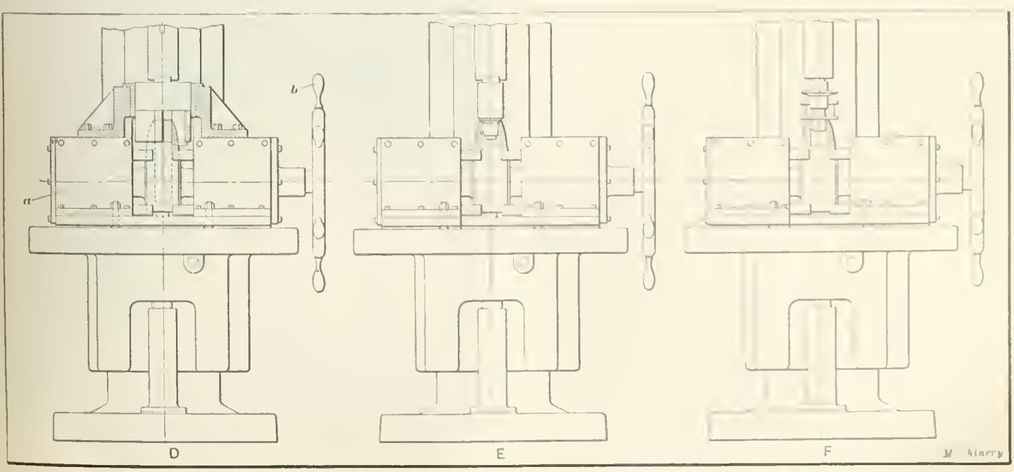


Fig. 113. Turning, recessing and tapping High-explosive Shells on a High-power Drilling Machine

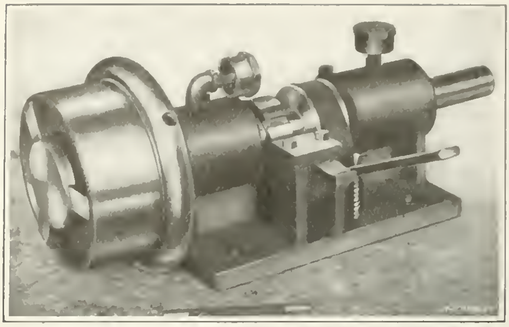


Fig. 115. Special Rotary Chuck used on Besly Disk Grinder for surfacing Gas Plugs

on the ductility of the metal. In fact, the Brinell reading is so influenced by ductility that claims have been made that it shows the ultimate strength; as a matter of fact, however,

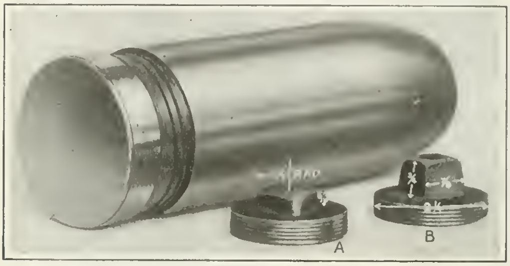


Fig. 116. Three-inch High-explosive Shell, showing Finish left by Besly Grinder; also Two Types of Gas Plugs

the reading taken by the Brinell method, is an expression of the elastic limit. The scleroscope, on the other hand, imposes a limited stress on the metal, and this is done instantaneously and causes only slight mechanical super-hardening, so it logically preserves the original values and thus serves to indicate the elastic limit without undue variation leaning toward the ultimate strength. It is for this reason that exact comparison between the two tests can only be made on one kind of metal at a time or in a given state of heat-treatment. On heat-treated steel used in shrapnel and high-explosive shells, the ratio is given by Shore as 6.4, meaning that if the scleroscope shows, for example, 50 hard, this multiplied by 6.4 would give the Brinell hardness, or a value of 320.

The method of testing shrapnel shells has previously been described in the April number of MACHINERY, so that attention will be directed here to the testing of high-explosive shells. In the first place, all high-explosive shells are not heat-treated, those used by the British government being a good example. These are made from a special tough alloy steel, the required physical properties of which are contained in the "raw" steel, so that it does not require to be heat-treated after machining. The high-explosive shells used by the French and Russian governments, however, are heat-treated either previous to or following the first series of machining operations. The specifications on the British high-explosive shell are:

	Per Cent	
Constituents	Min.	Max.
Carbon	...	0.55
Nickel	....	0.50
Silicon	....	0.30
Manganese	0.4	1.00
Sulphur	....	0.04
Phosphorus	....	0.04
Copper	....	0.10

This steel in an untreated condition must give a yield point of 19 tons and a breaking strength of 35 to 49 tons, with an elongation of 17 to 20 per cent. The method of using the scleroscope on the British high-explosive shell is to test each bar of stock after the first external cut or before any of the important machining operations have been performed on it, so that any defects in the material can be discovered before it has gone too far.

The French high-explosive shell is made from steel containing a lower percentage of carbon and no nickel. The specifications on the French high-explosive shell are:

	Per Cent	
Constituents	Min.	Max.
Carbon	0.30	....
Silicon	0.18	....
Manganese	0.50	0.80
Phosphorus	0.04	0.07
Sulphur	....	0.05

After hardening and tempering, a tensile strength of 125,170 pounds per square inch is required with an 18.3 per cent elongation. The elastic limit would be about 80,000 to 120,000 pounds per square inch, or as shown in Fig. 117, 43 to 52 hardness on the scleroscope and 275 to 333 on the Brinell instrument, respectively. The elongation and ultimate strength are determined by testing a shell, selected at random, to destruction.

The Russian high-explosive shell has a chemical composition somewhat similar to the French. It is hardened and tempered to show a physical property giving an elastic limit of not less than 62,000 pounds per square inch, a tensile strength of 118,000 pounds per square inch, and an elongation of 10 per cent. These properties in a steel of the chemical constituents given above would give a scleroscope hardness of 40 to 45 when heat-treated.

GRINDING HIGH-EXPLOSIVE SHELLS

The British high-explosive shell is not heat-treated, and consequently many manufacturers are finishing the external diameter to size and shape by turning; others, however, are using the grinding method. The turning method cannot be used as successfully on the Russian or French shells as on the British shells, because the former are heat-treated. The practice followed in grinding high-explosive shells differs in various plants. The diagrams Figs. 119 and 120 show several methods that are employed in grinding high-explosive shells on the Ford-Smith heavy-type, plain grinder shown in Fig. 118. Considerable improvements have been made in grinding high-explosive shells, especially as regards keeping the face

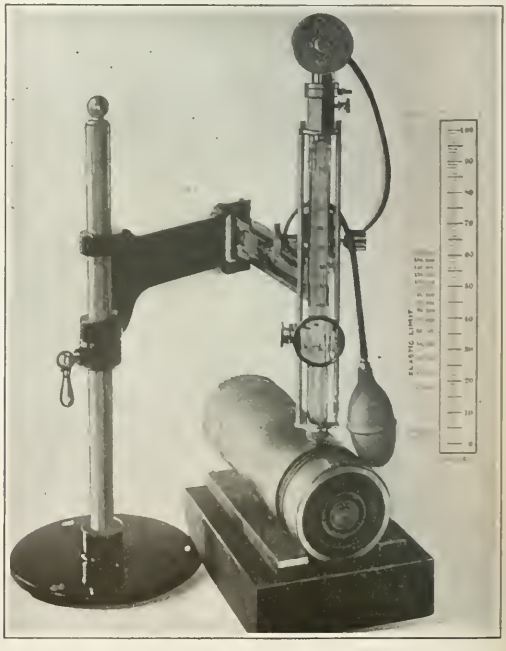


Fig. 117. Testing Hardness of High-explosive Shells with Scleroscope

of the wheel true. When this method was first adopted it was thought that it would be necessary to true up the entire face of the wheel with a diamond truing device after grinding a comparatively small number of shells. This, however, has not proved to be the case, and the truing up of the face of the wheel can be done quickly by hand by the use of a carborundum stick. A comparatively large number of shells can be turned out with one truing of the wheel, and on the Ford-Smith machine a special wheel-truing device, as illustrated in Fig. 121, is used. This will be described later.

The diagram Fig. 119 illustrates three different methods of grinding high-explosive shells of the 18-pound size. That shown at *A* consists in finishing the nose of the shell on the lathe, and then grinding the external diameter from the band groove to the radius, with a two-inch face wheel, by traversing the work past the wheel. In the method shown

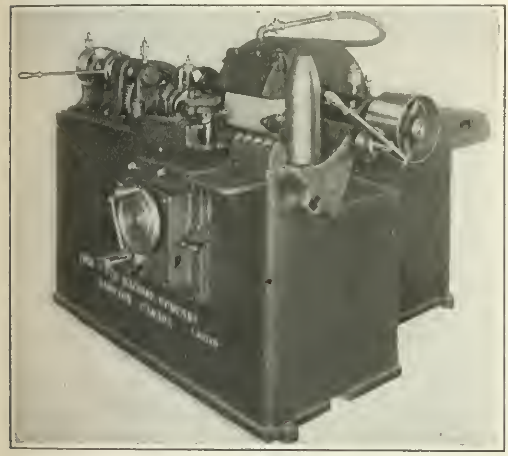


Fig. 118. Ford-Smith Plain Wide Wheel Shell Grinder

at *B* a six-inch face wheel is used; this finishes the entire body of the shell, except the nose, which is turned in the lathe in one straight-in cut. The method shown at *C* is that

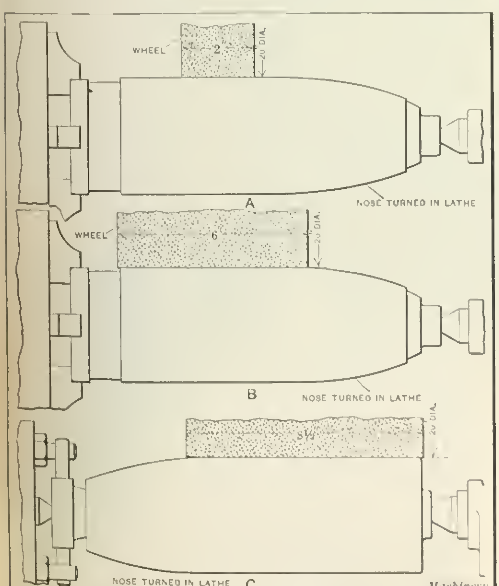


Fig. 119. Diagram illustrating Methods of finishing High-explosive Shell Bodies by turning and grinding

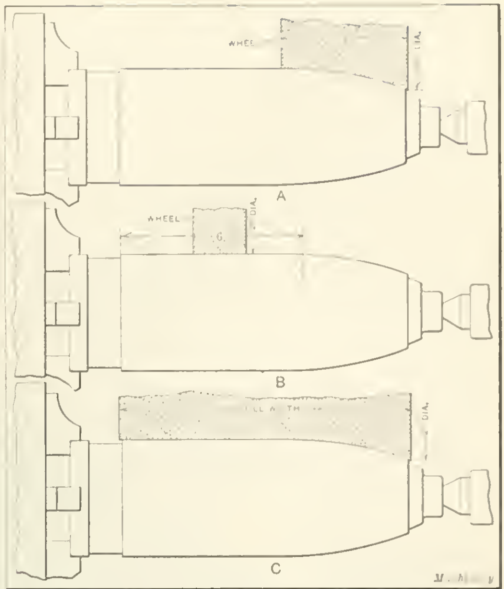


Fig. 120. Diagram illustrating Method of finishing High-explosive Shell by grinding

employed on the Ford-Smith grinder in British plants. The nose is turned in the lathe and the body is ground with a wide wheel, generally about 8½ inches. The grinding is done

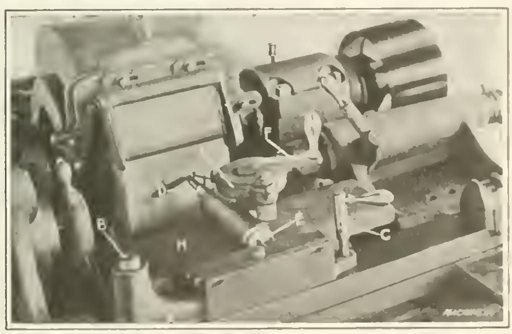


Fig. 121. Wheel-truing Device used on Ford-Smith Grinding Machine

completely across the shell, the band groove being cut in a subsequent operation. The production obtained on the 18-pound shell when these various methods are used differs considerably. When using the method shown at *A*, the production is about fifteen to twenty per hour; by method *B*, twenty to thirty per hour; and by method *C*, twenty-five to thirty per hour.

Fig. 120 shows methods of finishing high-explosive shell bodies by grinding all over. *A* and *B* show two methods of finishing high-explosive shells on a plain grinder. The procedure followed varies. In some cases the body is finished first and the nose later, whereas in others the nose, as shown at *A*, is ground first and then the body is ground as shown at *B*. The last method is that shown at *C* in Fig. 120. This is being used in Canada at the present time, and wheels as wide as 11½ inches face have been used, covering the entire length of the shell. On the 18-pound shell the production varies from twenty to twenty-five per hour, whereas on the 4.5 shell, using an 11½-inch face wheel, the production is somewhat less.

The special wheel-truing device used on the Ford-Smith plain grinder, shown in Fig. 118, is illustrated in Fig. 121. This

device is held on a swinging arm bracket A, fulcrumed on pin B, and located, when in position to true the face of the wheel, by stud C. The holder D, carrying the diamond tool, is provided at its rear end with a hardened cam surface that is kept in contact with the forming cam E by means of a spring located in the body of the attachment. The method of operating this device is as follows: After swinging the attachment into position and locking it, the wheel-slide is advanced until the diamond contacts with the wheel. Crank-handle F is then rotated. This carries a gear that meshes with another gear in the enclosed case G. The stud in this case extends down through the fixture and engages another gear operating in a rack. Consequently, the turning of this handle moves slide H back and forth, and traverses the diamond holder past the face of the wheel. This diamond truing device is only used occasionally to bring the wheel to the correct shape and to dress up new wheels. For slight dressing, as previously mentioned, a carborundum stick is used.

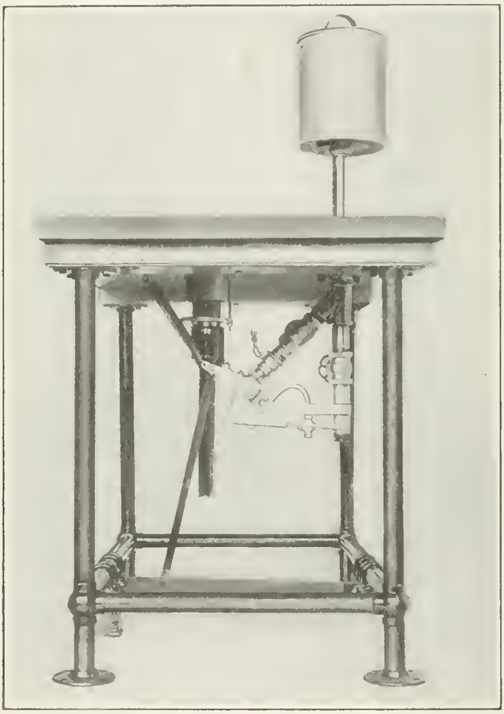


Fig. 122. Machine built by Spray Engineering Co. for spraying Interior of High-explosive Shells

VARNISHING INTERIOR OF HIGH-EXPLOSIVE SHELLS

A special machine for varnishing the interior of high-explosive shells is shown in Fig. 122. This machine, which is built by the Spray Engineering Co., Boston, Mass., is provided with an apparatus for spraying the necessary protective coating on the inside of the shell. The machine comprises a table with steel supporting frames, and with the operating mechanism placed beneath it. The usual coating material, such as varnish, asphaltum paint and similar compounds, is carried in a tank located above the operating table. The liquid passes down the hollow tank supports to an adjustable measuring device which controls the amount of material sprayed at each operation. A system of levers controls the motion of this device, cutting off the supply from the tank and admitting measured quantities of material to a channel leading to the spraying nozzle. The last part of this motion opens a connection to a compressed air supply which drives the coating material through the spray nozzles and distributes it evenly over the surfaces to be covered. A high working

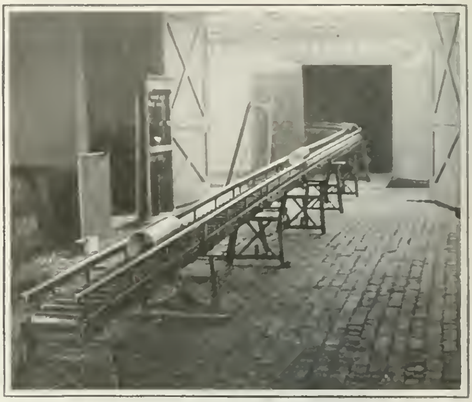


Fig. 123. Mathews Gravity Carrier transporting Shell Forgings

speed is thus obtained without waste of material and one setting of the measuring device insures delivery of a fixed quantity of the material to each shell.

To operate the machine the shell is inverted over the hole in the operating table. A slight pressure on the foot-lever connected with the operating lever moves the measuring device and admits compressed air. Upon the removal of pressure from the treadle, suitable coil springs return the mechanism to its original position, ready for the next operation. A particular feature of the machine is the device for admitting a fixed amount of coating material at each operation, which permits setting the mechanism to repeat any predetermined coating operation on a large number of similar parts. For readily changing over to different coating materials, drain valves and priming valves are provided, which permit a thorough cleaning of the measuring device and all pipe passages without taking the mechanism apart. The height of the spray head may be adjusted for coating shells of various dimensions, and auxiliary attachments including a movable spray head are used when it is required to cover a large surface or to meet other special conditions.

CONVEYING APPARATUS FOR THE RAPID HANDLING OF SHELLS

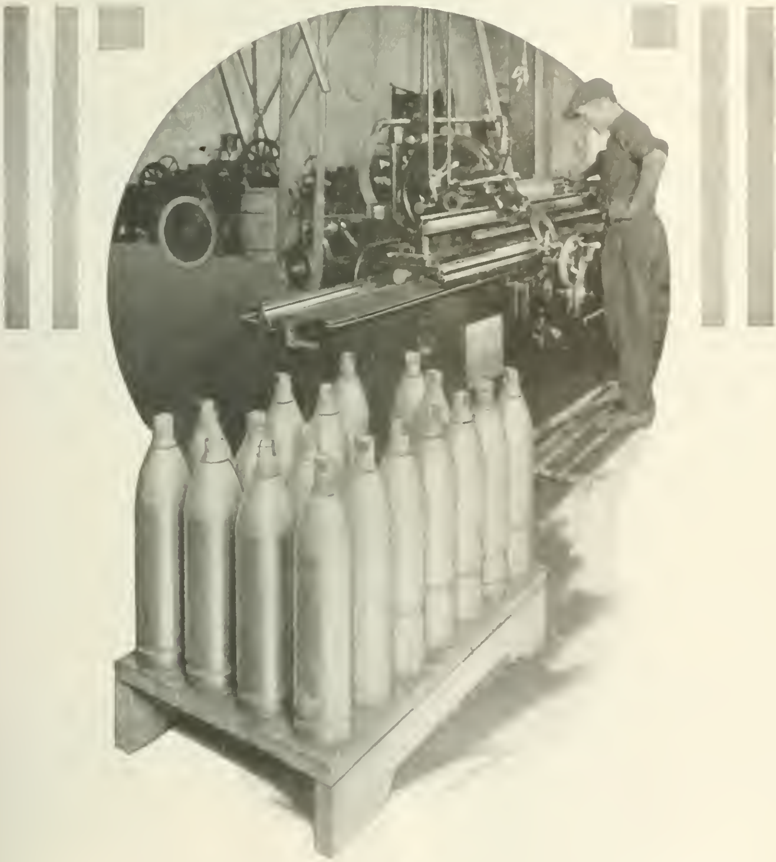
For conveying shell forgings from one department to another or from the shipping department to freight cars, etc., the Mathews Gravity Carrier Co. has designed conveying apparatus as shown in Figs. 123 and 124, respectively. Fig. 123 shows this gravity carrier being used for transporting forgings from a freight car to the machining department of a plant, whereas Fig. 124 shows a special arrangement of the carrier for handling shells that are boxed and ready for shipment. In this case the track part which extends into the shipping room is about two feet above the floor level and the

Fig. 124. Mathews Gravity Carrier with Elevator Unit loading Freight Car

inclined elevator arrangement lifts the boxes up so that they are located in the car four feet above the floor level. The idea of elevating the boxes is to have them within convenient reach of the shipper. The elevator is not necessary where the floor of the car is on the same level as the floor of the building.

The chief advantage of this conveying apparatus is that it is easily and quickly installed and is built up of separate units so that it can be added to without any extra cost except the cost for extra length of carriers and stands. The rollers are made from seamless cold-drawn steel tubing and run in ball bearings. The grade of the apparatus is from 2 to 3 per cent. Where it is necessary to lift the shells or other parts being transported from a floor into a car, a portable elevator is used as shown in Fig. 124. This elevator is driven by a one-horsepower motor and can be connected to a lamp socket. Another application of this system is where the carrier arrangement comes to the end of the building and it is necessary to return the work; to accomplish this, a double-deck arrangement is provided, the lower deck inclining one way and the upper deck the other way. Thus when the shells or work come to the end of the line, they are simply placed on the upper deck and are returned to the next series of machining operations, without any handling whatsoever. Another advantage of this system is that the shells or work do not need to touch the floor at all, and consequently expensive cement floors are not broken up by having heavy work dropped on them. Lifting the work off the carrier is also more convenient than lifting it from the floor.

The important feature of the Mathews gravity roller carriers is that natural gravity takes the place of other power conveyors, except where additional elevations are necessary or where shells, forgings and boxes must be elevated to upper floors. For this work the Mathews Gravity Carrier Co. makes automatic-incline or straight-lift elevators, which require only a very small motor.



DETONATING FUSES FOR HIGH-EXPLOSIVE SHELLS

THE British high-explosive shell described in connection with Fig. 3 carries a nose fuse of the concussion type, also shown in Fig. 9, which is made chiefly from brass parts with the exception of the adapter *B*, Fig. 125, and the gaine. These are made from soft steel. The body of the fuse, shown completely machined at *D* in Fig. 126 and at *C* and *D* in Fig. 127, is first cast in a sand mold in the form of a slug, as shown at *A* in Fig. 126. The composition from which this slug is made is about 59.18 per cent copper, 39.45 per cent zinc, 0.88 per cent manganese copper and 0.49 per cent phosphor copper. This composition is not arbitrary, but has been found to give the tensile strength required by the specifications.

The first operation consists in snagging and brushing the castings with a wire brush, but experiments are being made to force the casting through a simple shaving die that shaves off the straight surface and removes all objectionable projections. After casting, the slugs are sand-blasted or otherwise cleaned; they are taken to the Stewart furnace shown in Fig. 128 where they are heated to 1600 degrees F. The ovens of these Stewart gas furnaces are double ended, and a Zeh & Hahnemann percussion press, Fig. 130, is located at one end of the furnace. Three men are required for each forging press; one loads the furnace from the rear, the second man takes the heated forgings out of the front end of the furnace, puts them in the die and trips the press, whereas the third man removes them from the dies. After the slugs have reached a temperature of 1600 degrees F., they are removed from the furnace and placed in the dies shown in Fig. 129 and in Fig. 131 removed from the press. The furnace shown in Fig. 128 holds forty-eight slugs, and 1400 to 1500 forgings are secured from each press in a day of 9¾ hours. The ideal forging obtained from the dies is one in which there is 3/64 inch of material to remove all around. The dies shown in Figs. 129 and 131 are kept flushed with a compound consisting of 64 per cent oil, 32 per cent water, 3 per cent powdered graphite, and 1 per cent soda ash. The order in which these operations are accomplished, as well as the machines used, spindle speeds, and the production obtained, are given in Table V.

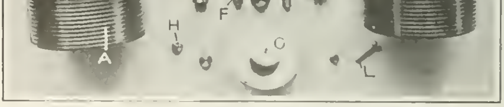


Fig. 125. British No. 100 Graze High-explosive Fuse dismantled and assembled

Fig. 126. Sequence of Operations on Body of British No. 100 Graze High-explosive Fuse

First Machining Operation on the Fuse Body

For the first machining operation, the brass body is held in an air chuck, as shown in Fig. 132, with the end subsequently to be threaded projecting. The first operation consists in turning the body and roughing the angle with the tool *G* in the front of the cross-slide. The second is facing end, also chamfering and roughing chamber with tool *A*; third, finish-counterboring and chamfering outside with tool *B*; fourth, under-cutting with tool *C*; fifth, taking cut across face with tool on rear of cross-slide; sixth, tapping

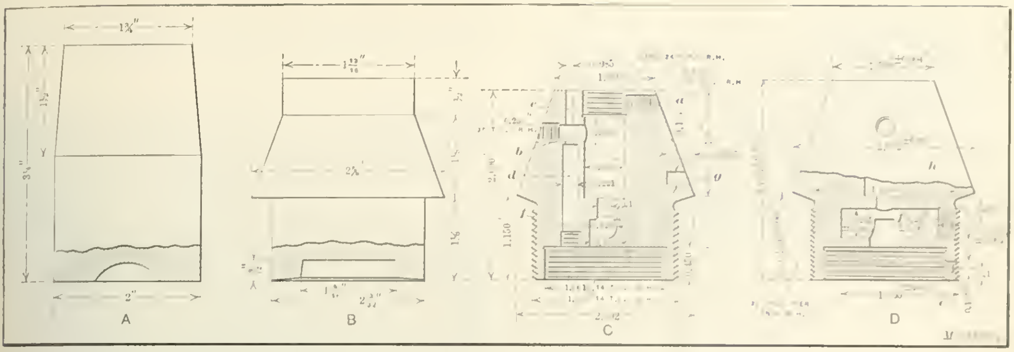


Fig. 127. Various Stages in the Manufacture of the British No. 100 Graze High-explosive Fuse

with tool *D*; seventh, threading with Geometric collapsing die *E*; eighth, drilling and reaming center hole with tool *F*. After threading in the machine, a hand threading operation is necessary to size the thread on the body. The lubricant used on this job is a mixed compound consisting of 1.06 per cent soda ash, 15.67 per cent mineral lard oil, and 83.27 per cent water.

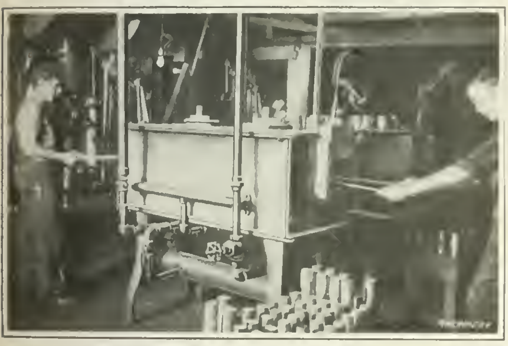


Fig. 128. Stewart Gas Furnace used for heating Castings previous to hot-pressing

Second Machining Operation on Fuse Body

The second machining operation on the fuse body consists in finishing the taper end. The threaded end, as shown in Fig. 133, is gripped in an air chuck and the following operations performed: First, face with cross-slide tool *G*; second, center with tool *A*; third, drill and rough-turn with tool *B*; fourth, rough-counterbore with tool *C*; fifth, recess with tool *D*; sixth, drill with tool *E*; seventh, tap with tool *F*; eighth, shave angle on body with shaving tool *H* held on rear of cross-slide. These operations practically finish the body with the exception of several drilling operations that are done on Leland & Gifford high-speed drilling machines by the aid of simple jigs.

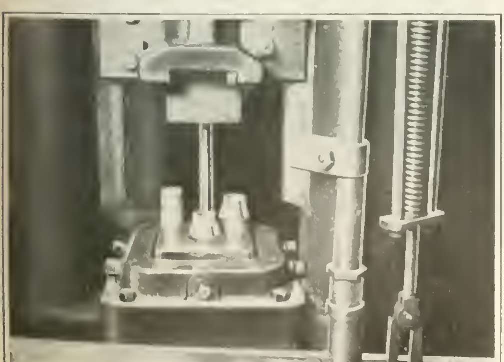


Fig. 129 Close View of Percussion Press shown in Fig. 130 showing Dies used and Casting before and after forging

Drilling Operations on the Fuse Body

Following the machining operations just described, the fuse body passes through a number of drilling, counterboring and tapping operations. These operations are all performed on Leland-Gifford drilling machines, as stated. By referring to Fig. 127, the sequence of operations may be followed.

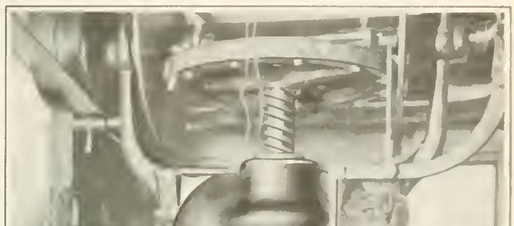


Fig. 130. Zeh & Hahnemann Percussion Press used in hot-pressing Fuse Bodies

The first drilling operation on the machined body consists in drilling the cap set-screw hole *a*, drilling and counterboring the centrifugal bolt hole *b*, and drilling the adapter set-screw hole *c*. For this operation, a three-spindle drilling machine is employed. The four operations are performed on the three-spindle machine because the cap set-screw hole *a* and the adapter set-screw hole *c* are the same diameter, and therefore machined by the same drill.

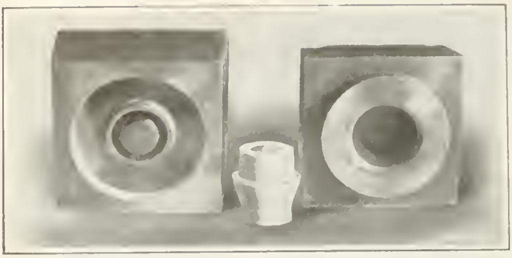


Fig. 131. Upper and Lower Dies used in Press shown in Fig. 130

The second set of drilling operations on the body consists in drilling the detent spring hole *d* with a drill in one spindle of a three-spindle drilling machine. The second spindle carries a counterboring tool that squares the bottom of the hole, and the third spindle carries a counterboring tool.

The third set of drilling operations on the body is the drilling of the hole for the reception of the detent and this is performed on a two-spindle drill press, each spindle carrying the same size drill, except that one is much longer than the other. The longer of the two drills is used with a special fixture for drilling two-thirds of the detent hole *e* from the bottom side. The hole is completed by drilling from the top, using a second fixture and the short drill in the second spindle of the machine.

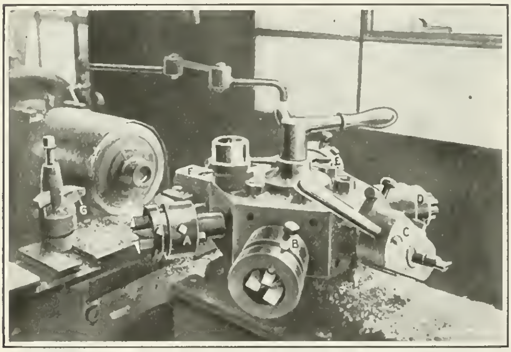


Fig. 132. Set-up on Warner & Swasey Brass-working Lathe for performing First Series of Machining Operations on Fuse Body

The fourth set of drilling operations on the fuse body is performed on a three-spindle drilling machine, and the first spindle carries a drill for drilling the central percussion pellet hole indicated at *f* in Fig. 127. The second spindle carries a counterboring tool, and the third spindle carries a bottoming tool.

The seventh operation on the fuse body is the milling of the oval wrench hole indicated at *g*. This is done in a single-spindle drilling machine, holding the work in a special fixture so that it may be moved backward and forward slightly to produce the oval hole required.

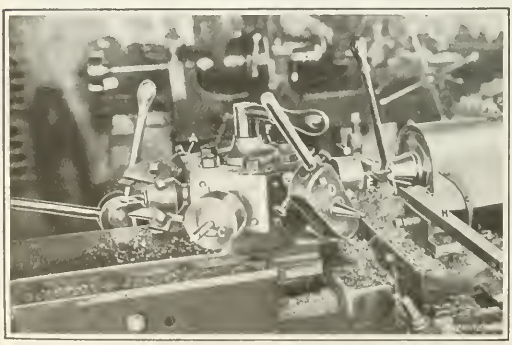


Fig. 133. Set-up on Warner & Swasey Brass-working Lathe for performing Second Series of Operations on Fuse Body

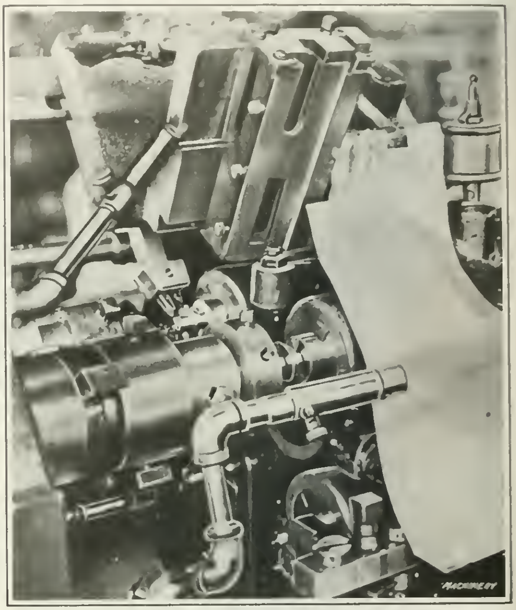


Fig. 134. Set-up on No. 55 Acme Multiple-spindle Automatic Screw Machine for machining Fuse Cap

The eighth operation on the fuse body is the recessing of the percussion pellet hole for the thread. This is indicated at *h* in Fig. 127. A single-spindle drilling machine is used equipped with a special fixture to provide for under-cutting.

The ninth set of operations on the fuse body consists in slightly countersinking or burring all of the holes. This is done with a large countersink in a single-spindle drilling machine, the fuse bodies being held by hand against the countersink.

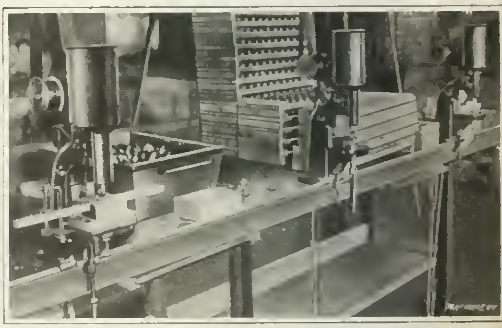


Fig. 135. Grant Riveting Machines used in riveting Needle in Percussion Needle Plug

The tenth and last set of operations on this part consists in tapping five holes, namely, the set-screw holes for the cap and adapter, the detent spring hole, the centrifugal bolt hole and the percussion pellet hole. Four separate machines are used for tapping, each of which carries a tapping head.

Machining the Fuse Cap

The fuse cap shown at *C* in Fig. 125 is made from brass rod $1\frac{3}{8}$ inch diameter in an Acme No. 55 multiple-spindle screw machine, as shown in Fig. 134. The order of opera-

TABLE V. ORDER OF OPERATIONS ON BRITISH NUMBER 100 GRAZE FUSE

Name of Part	Character of Operation	Material	Machine	Speed, R. P. M.	Production Per Hour
Body	First Machining	Cast Brass	Hand Screw Machine	376	12 to 15
Body	Second Machining	Cast Brass	Hand Screw Machine	570	8
Body	Drill and Counterbore	Cast Brass	Leland-Gifford Three-spindle Drill	6000	65
Body	Drill and Counterbore	Cast Brass	Leland-Gifford Three-spindle Drill	6000	65
Body	Drill	Cast Brass	Leland-Gifford Two-spindle Drill	8000	120
Body	Drill and Counterbore	Cast Brass	Leland-Gifford Three-spindle Drill	4000	60
Body	Mill Wrench Hole	Cast Brass	Leland-Gifford Single-spindle Drill	6000	150
Body	Recess	Cast Brass	Leland-Gifford Single-spindle Drill	4000	375
Body	Countersink	Cast Brass	Leland-Gifford Single-spindle Drill	250	120
Body	Tap Five Holes	Cast Brass	Drilling Machine	150	..
Cap	Form and Cut Off	1 3/8" Brass Rod	No. 55 Acme Auto.	520	150
Cap	Drill	1 3/8" Brass Rod	Leland-Gifford Single-spindle Drill	8000	200
Adapter	Form, Drill, Shave, Counterbore, Thread, Cut Off	1 11/16" Soft Steel Rod	No. 56 Acme Auto.	290	45
Adapter	Counterbore, Drill and Tap	1 11/16" Soft Steel Rod	Model A Cleve. Auto.	....	60
Graze Pellet	Form, Neck and Drill	9/16" Brass Rod	No. 52 Acme Auto.	980	300
Graze Pellet	Drill	9/16" Brass Rod	Leland-Gifford Single-spindle Drill	8000	50
Graze Pellet	Drill, Bottom and Counterbore	9/16" Brass Rod	Leland-Gifford Three-spindle Drill	6000	150
Percussion Pellet	Turn, Chamfer, Drill, Recess, Tap, Cut Off	11/32" Brass Rod	No. 52 Acme Auto.	980	360
Percussion Pellet	Drill and Ream	11/32" Brass Rod	Leland-Gifford Three-spindle Drill	4000 to 8000	..
Percussion Det. Plug	Machine	13/32" Brass Rod	No. 515 Acme Auto.	1230	720
Percussion Det. Plug	Drill	13/32" Brass Rod	Leland-Gifford Single-spindle Drill	8000	200
Percussion Needle Plug	Machine	9/32" Brass Rod	No. 52 Acme Auto.	980	695
Percussion Needle Plug	Drill Four Holes	9/32" Brass Rod	Leland-Gifford Single-spindle Drill	8000	100
Bottom Detent	Form and Center, Drill, Form Hole, Cut Off	7/32" Brass Rod	No. 515 Acme Auto.	1230	720
Top Detent	Rough-finish-turn, Form, Chamfer, Shave, Cut Off	5/32" Phos. Bronze	No. 515 Acme Auto.	1230	210
Top and Bottom Detent	Assemble	5/32" Phos. Bronze	By Hand	....	..
Detent Plug	Machine	9/32" Brass Rod	No. 515 Acme Auto.	1230	720
Centrifugal Bolt	Shave and Cut Off	7/32" Brass Rod	No. 515 Acme Auto.	1230	1020
Detent Spring Screw	....	Brass Rod	No. 515 Acme Auto.	1230	700
Cap Screw	....	3/16" Steel Rod	No. 515 Acme Auto.	1230	500
Cap Screw	Mill Slot	3/16" Steel Rod	Acme Screw Slotter	....	2500
Adapter Screw	....	3/16" Steel Rod	No. 515 Acme Auto.	1230	600
Adapter Screw	Mill Slot	3/16" Steel Rod	Acme Screw Slotter	....	1500
Detent Plug Screw	....	9/32" Brass Rod	No. 52 Acme Auto.	980	750
Detent Plug Screw	Mill Slot	9/32" Brass Rod	Acme Screw Slotter	....	1800

Machinery

tions is: first, form and center; second, drill, square and neck; third, thread with button die; and fourth, cut off. The production on this particular piece is given in Table V; after coming from the screw machine it is put through a

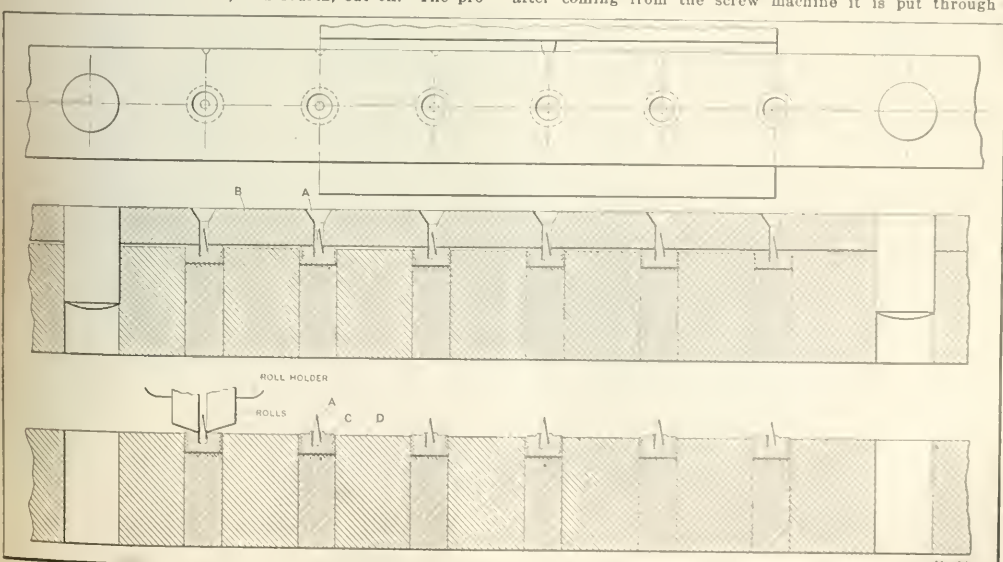


Fig. 136. Diagram showing Construction of Fixture used in assembling Percussion Needle Plug

Fig. 137. Baking Varnish on High-explosive Shell Fuses

chip separator where the oil and chips are separated. The next operation is drilling the two wrench holes, which is handled on a single-spindle drilling machine, the jig being shifted on the table to drill the two holes.

Operations on the Graze Pellet

The graze pellet shown at *D* in Fig. 125 is made from 9/16-inch brass rod in a No. 52 National-Acme multiple-spindle automatic screw machine. The operations are as follows: first, turn full diameter and also 0.370 diameter with a double tool, also drill and start neck; second, recess and continue neck; third, tap and finish neck; fourth, cut off. The piece is finished upon leaving the screw machine. The production is given in Table V, which also includes a complete summary of the operations performed on the various parts of this fuse.

There are two drilling operations on the graze pellet. The first consists in drilling the small fire hole through the entire length of the piece. This is done in a single-spindle drilling machine and is followed by the operations on the upper end of the piece, where the detonating cap is held. The operations on this end are performed in a three-spindle drilling machine; the first spindle carries the drill for producing the large hole, the second carries a counterboring tool and the third a facing tool for the bottom of the hole.

Operations on Centrifugal Bolt and Plugs

The centrifugal bolt *E*, Fig. 125, is made from brass rod and the operations are very simple, consisting merely in shaving and cutting off. The percussion detent plug *G* and the percussion needle plug *H* are also simple screw machine jobs. The needles are made of steel and are swaged down to a fine point and then hardened. The spinning in place of the needle point is done on the Grant rivet spinning machines shown in Fig. 135, on which a simple fixture shown by the diagram Fig. 136 is employed. Two girls are employed on this work; one inserts the needles *A* in plate *B*, and the plugs *C* in plate *D*, and the other operates the machine. The holes in the top plate are large enough to allow the needles to drop through freely and enter the plugs. Then the top plate is removed and the fixture placed on the table of the spinning machine. The spinning rolls are brought down in contact with the plugs consecutively and spin in the edge, holding the needles firmly in place. The plugs are prevented from rotating by steel inserts which are knurled on their top faces. Location of the various holes under the spinning machine is accomplished as shown in the plan view, Fig. 136.

The operations on the percussion detonator plug are performed on a single-spindle drilling machine, and consist in drilling the two small holes with the aid of a swivel jig.

The four small fire holes in the percussion needle plug are drilled after the needle has been swaged in place. The drilling operation is left until last, as otherwise the swaging operation would close up the fire holes.

Machining Operations on Percussion Pellet

The percussion pellet shown at *I* in Fig. 125 is made from 11/32-inch diameter brass rods in a multiple-spindle automatic screw machine. The first operation consists in turning with a box-tool, chamfering and squaring the threaded end, also drilling the hole and squaring the bottom; second, recessing; third, tapping; and fourth, drilling small hole and cutting off. The hole in the opposite end of the percussion pellet and the one in the side are drilled in a three-spindle drilling machine. The same size drill is used for drilling the large cross hole and the end hole. This drill is held in the first spindle, and a smaller drill, held in the second spindle, drills the small cross hole, whereas the third spindle carries a taper reamer for tapering the large cross hole.

Operations on Top and Bottom Detents

The bottom and top detents shown at *F* and *L*, respectively, in Fig. 125 are made with a simple tool equipment. The top detent *L* is made from 5/32-inch bronze rod in a screw machine, whereas the bottom detent *F* is made from brass rod 7/32-inch diameter in a screw machine. The operations on the top detent are: first, rough-turn and form head; second, finish-turn and chamfer; third, shave from head to point; fourth, cut off. The operations on the bottom detent are: first, form and center; second, drill; third, form hole; and fourth, cut off.

Operations on Ada ter

The adapter shown at *B* in Fig. 125 is produced in three operations, the first being performed on an Acme No. 55 multiple-spindle automatic screw machine. The first series of operations is as follows: first, rough-form and drill; second, shave and counterbore; third, thread outside diameter; and fourth, cut off. The second series of operations, performed on a Cleveland automatic screw machine provided with a magazine attachment, is: counterbore, tap and drill. The third operation is performed in a Leland-Gifford drilling machine and consists in drilling the two small holes. The other small parts, such as screws, etc., are regular screw machine jobs and are simple to manufacture.

Assembling

The assembling is done in the following order: First, the percussion pellet, spring and detonator plug are inserted in the cross hole; second, the graze pellet is dropped into place; third, the centrifugal bolt and screw are inserted from the side; fourth, combined detent, spring and screw plug are inserted from the base; fifth, the creeper spring is put in from the top and the cap screwed in place. The set-screw for the cap and the adapter are then inserted and finally the gaine is screwed in and the job is finished. The lacquering of the completed fuse is done by spraying as shown in the initial illustration on page 314 and lacquered fuses are

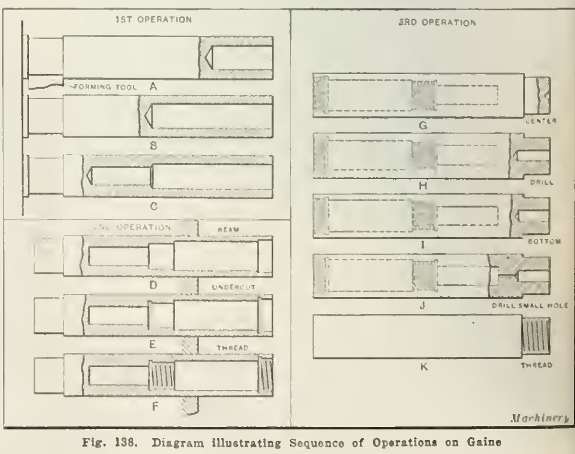


Fig. 138. Diagram Illustrating Sequence of Operations on Gaine

then put in the rotating oven shown in Fig. 137 and baked until the varnish is dry. This oven has six shelves that work on the principle of a Ferris wheel.

MACHINING BRITISH HIGH-EXPLOSIVE FUSE GAINE PARTS

The gaine which forms the exploder member of the British No. 100 graze fuse shown in Fig. 9 is shown assembled and in detail in Fig. 139. As will be seen from this illustration, the gaine comprises three parts, *viz.*, body *A*, center plug *B* and closing or bottom plug *C*. The body *A* of the gaine is made from cold-rolled steel, and in one plant the first operation is handled in a No. 53 Acme multiple-spindle automatic

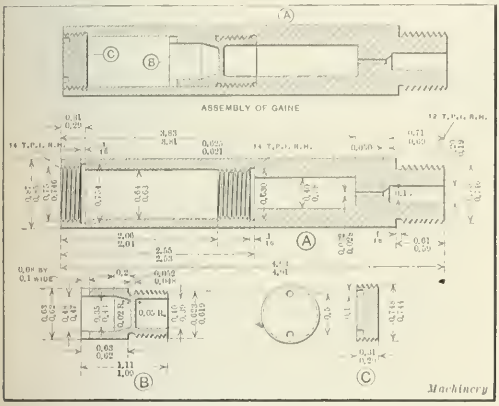


Fig. 139. Assembly and Details of Gaine used in British No. 100 Graze High-explosive Shell Fuse

in the order shown in Fig. 138. The order of machining operations performed at the first chucking is shown from *A* to *C* inclusive, and is as follows: First position, drill large hole one-third depth, using floating drill-holder, and form the thread diameter from cross-slide; second, drill large hole to shoulder; third, drill small hole; fourth, cut off.

In the drilling, a stepped lead cam is used so that the drills can be backed out to clean out the chips and assist the lubricant in getting to the cutting points of the drills. The outer surface of the gaine is not finished and the holes are not reamed. The cutting speed is 100 surface feet per minute, and the production is sixty per hour.

The second series of operations shown in Fig. 138 is performed on a No. 2 plain-head Warner & Swasey turret lathe, as follows: first, ream the four diameters of the hole with a stepped reamer; second, under-cut at the bottom of the two threaded sections (this is done with a tool having two cutting points properly spaced); third, tap the two holes with a double threaded tap. The production is thirty pieces per hour and the cutting speed, except for the tapping, is 100 surface feet per minute.

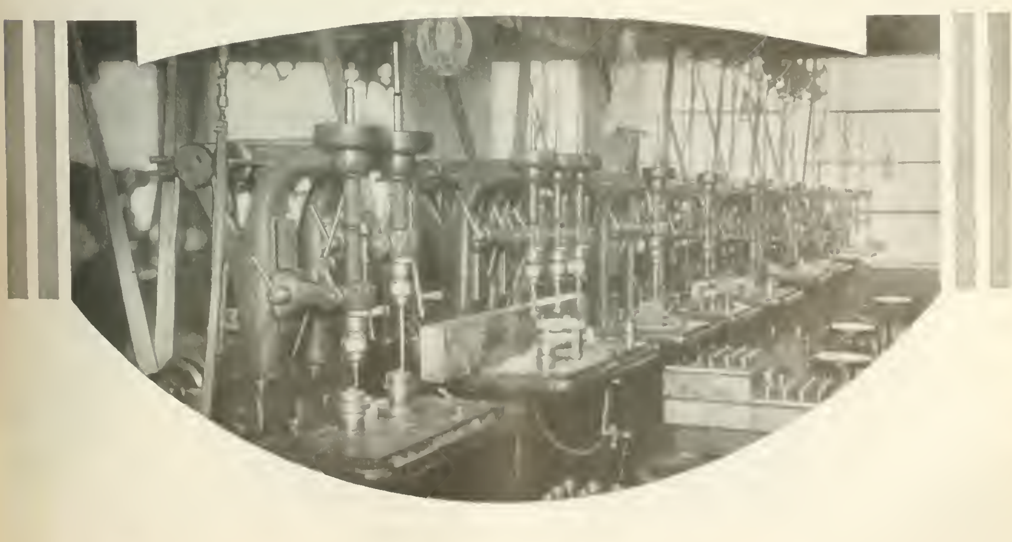
The third series of operations on the gaine body, shown to the right in Fig. 138, is performed on a No. 2 plain-head Warner & Swasey turret lathe, and the piece is held with the threaded end outward. The operations are: first, center; second, drill large hole; third, form bottom of hole; fourth, drill small hole with a high-speed drilling attachment; fifth, thread external diameter with a self-opening die. The cutting speeds on this operation are 100 surface feet per minute and the production is thirty pieces per hour. In the plant where this information was obtained, considerable trouble was experienced in drilling the small hole. Attempts were made to produce this hole in a high-speed drilling attachment, with poor results. The method shown at *J* is recommended as being more satisfactory, as in this case both work and drill revolve.

Machining the Center Plug

The center plug shown at *B* in Fig. 139 is made from hot-rolled machine steel and is completed in two operations. The first series of operations is performed on a No. 53 Acme multiple-spindle automatic. The operations are: first, form the entire length of the piece and drill small hole; second, shave outside diameter and square bottom of hole; third, thread; fourth, cut off.

The second series of operations is performed on a No. 2 plain-head Warner & Swasey turret lathe in the following order: first, center drill; second, drill; third, form hole with special counterboring tool; fourth, face end with tool on rear cross-slide. These pieces are handled at the rate of forty-five per hour. The work on this piece is completed by a simple slotting operation on an Acme screw slotter.

The machining of the bottom plug *C*, Fig. 139, is performed on a No. 53 Acme multiple-spindle automatic. This part is made of cold-rolled steel and turned at a speed of 100 surface feet per minute. The order of operations is: form external diameter; second, face end; third, thread; fourth, cut off. This piece is produced at the rate of 180 per hour. The drilling of the two holes in the end of this plug is performed in a drilling machine with the aid of a simple jig.



HIGH-EXPLOSIVE SHELL CARTRIDGE CASES

The cartridge case used in the British 18-pound quick-firing field gun is made from an alloy of copper and zinc, generally 70 per cent electrolytic copper and 30 per cent zinc. The exact composition of the alloy, however, is left to the discretion of the manufacturer, but the completed cartridge case must, of course, be of the required specifications for strength and elasticity. The number of redrawing and annealing operations on the cartridge case is never less than six, and in addition two tapering operations must be performed to bring the mouth of the shell to the correct diameter and the body to the right shape. The practice followed in plants making this cartridge case does not differ materially in regard to the number of drawing operations, but of course there is some difference in the methods used in handling the work. The following description covers the method used by a large concern that turns out 4000 18-pound cartridge cases per day of ten hours.

Blanking and Cupping

The first operation on the cartridge case is to cut out a blank 6.22 inches diameter from a sheet 0.380 inch thick. This operation is seldom handled by the firm making the cartridge cases, most firms preferring to buy the blanks from manufacturers that make a specialty of this business. The blank is usually cut out in a geared punch press, and the production is about 400 blanks per hour. Usually the blank is in the annealed condition when received by the cartridge case manufacturer. Assuming that the blank is purchased in the annealed condition, the next operation is cupping. In the plant where the following data was obtained, this operation is performed in a Toledo press as shown in Fig. 140. One operator can turn out 4000 cups in ten hours. On this operation, a production as high as 600 per hour can be obtained, but this pace cannot be kept up by one man. The shape and size of the cup after the cupping operation is shown at *B* in Fig. 143. Table VI gives the complete order of operations.

Annealing

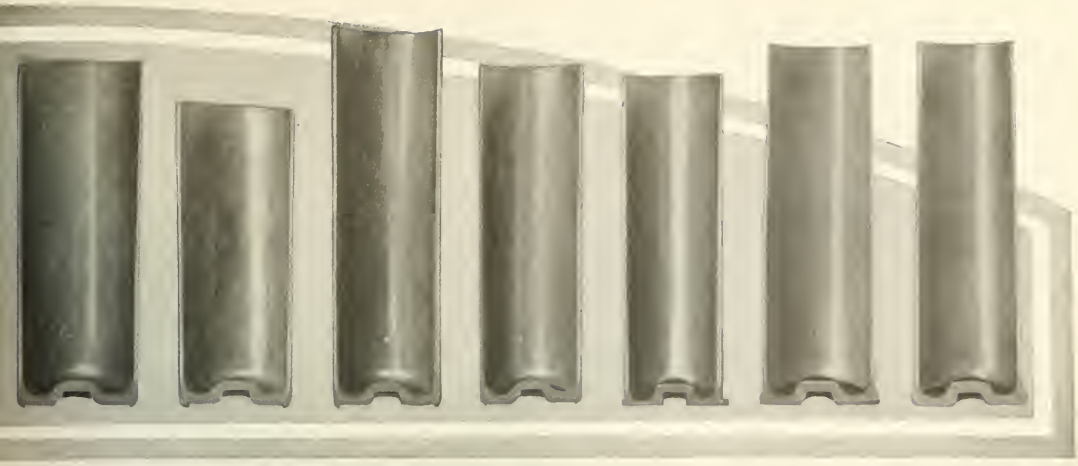
Following the cupping operation, the metal is hardened somewhat and consequently annealing is necessary to restore the required ductility. The hardness of the metal is also tested by means of the scleroscope after each press and annealing operation, and in this plant one per cent of the daily production is given this test. This subject will be fully dealt with later. The annealing is done in a special furnace as shown in Fig. 141. These furnaces are about 6 feet wide by 24 feet long, and the cases are loaded into trays and fed into the furnace at the loading end by a ram operated by compressed air. The trays used for this purpose hold, on an average, fifty-six cups, the number increasing as the diameter of the case is reduced, and each furnace holds eight trays. The furnaces are kept at a constant temperature of 1250 degrees F., and the cups are annealed for one hour and four minutes at this temperature. This is the average length of time that each tray is allowed to remain in the furnace. The loading and unloading is carried on every eight minutes. After annealing, the cups are removed from the furnace and immediately immersed in water. There are six pyrometers in each furnace for controlling the temperature, three on each side. These pyrometers are tested every fifteen minutes, as shown in Fig. 145, so that any variation in the temperature of the furnaces can be immediately checked up. After cooling in water, the cups are taken to the pickling bath, where they are immersed in a solution of twenty parts water to one part sulphuric acid. They are then removed from this pickling solution and immersed in a high caustic soda bath, after which they are washed in warm water to remove all traces of the acid.

It should be mentioned here that all firms engaged in this work do not follow this procedure in cooling and washing. One concern, in particular, believes that the rapid cooling of the cases in water affects their physical properties, and hence allows the cases to cool off in the air after each annealing operation. When cool, the cases are immersed first in a bath containing a weak solution of sulphuric acid and then in a weak bath of cyanide of potassium, after which they are rinsed in water.

First and Second Redrawing and Indenting Operations

Following the cleaning of the cups, they are taken to another Toledo press shown in Fig. 146, where the first redrawing operation is accomplished. For this, one machine and two men are required. The production is 400 per hour. It will be noticed in Fig. 143 at *C* that the thickness of the bottom of the case remains the same, the sides alone being reduced in thickness and in-

Fig. 140. First Operation—cupping in a Toledo Press



creased in length. It is important that this thickness at the base be retained. After this, the cases are annealed, washed, etc., as previously described. The only difference here is that the pan holds sixty-three instead of fifty-six cases, this being due to the smaller diameter of the cases.

The second redrawing operation, *D*, Fig. 143, is accomplished in the same manner as the first, and the production is also the same, 400 per hour, two operators being required. Following the second redrawing operation, the cups are not annealed but are taken directly to the first indenting operation, the result of which is shown at *E* in Fig. 143. This operation is accomplished in the Toledo press shown in Fig. 147. Here it will be noticed that for indenting the case is placed on the lower punch *A*. Upon the descent of punch *B*, the lower punch is forced down into the die, exposing the indenting punch that is located inside of it. The case also goes down into the die and consequently is prevented from being distorted. Upon the up stroke, the case is ejected from the die by the double action of the press, and to provide against any chances of its sticking on the punch *B*, an ejector *C* is provided. In this operation only one operator is required and the production is 300 per hour. The important point to observe in this case is the depth of the indent. This, as shown at *E* in Fig. 143, must be 7/16 inch. Following indenting, the cases are again annealed as previously described, the pans accommodating sixty-eight cases each.

Third and Fourth Redrawing and Second Indenting Operations

The third redrawing operation is accomplished in a No. 57 Toledo press, as shown in Fig. 148. The production on this operation is 200 cases per hour, and the case is drawn out to the length shown at *F* in Fig. 143, and also reduced slightly in diameter. Two operators are required for this operation. After redrawing, it is taken to the annealing furnace and annealed, washed, etc., as previously described. The annealing pans accommodate seventy-two cases each.

The fourth redrawing operation is accomplished in a No. 857 Toledo press; the production is somewhat less, being 150 cases per hour, and two operators are required. The result of this operation is shown at *G* in Fig. 143. Following the fourth redrawing operation, the cartridge case is given the second indent as shown in Fig. 150. Reference to *H* in Fig. 144 will show that the head of the case is somewhat flattened in this operation, leaving a projection raised around the outer rim. The depth from the flat surface of the head to the bottom of the indent is the most important dimension; this depth on the 18-pound cartridge case must be 17/32 inch. The production at this operation, two operators being employed, is 250 cases per hour. Following the second indent, the cases are again annealed as previously described, washed, etc. The pans, in this case, carry seventy-eight cases, a greater number being accommodated because of the reduced diameter.

The presses used in performing the cupping, redrawing, reducing and heading operations vary in ram capacity from 500 to 1200 tons pressure per square inch.

Fifth and Sixth Redrawing and Second Trimming Operations

Following the second indent, the fifth redrawing operation is performed. This is accomplished in a No. 857 Toledo press, and the production is 150 per hour. The condition of the case after this operation is shown at *I* in Fig. 144. Before annealing, the mouth end of the case is trimmed. This operation is necessary because the case becomes quite ragged on the mouth end and would tear in the sixth redrawing operation if the excess stock were not removed from the open end. The total length of the case after the fifth redrawing operation averages 10⅝ inches and it is trimmed to 10¼ inches. In many cases, as the punch wears small it is not necessary to perform this trimming operation because the wall is thicker.

The trimming of the mouth of the case is accomplished in the Toledo trimming machine shown in Figs. 149 and 151. A close view showing the shape of the simple disk cutter may be seen in Fig. 149. Two operators are necessary for this trimming operation; one holds the case on the arbor and the other does the trimming. The production is 350 per hour. Some changes have been made in this machine. The regular cutter-head has been removed and a cross-slide substituted. This cross-slide is operated by a lever, as shown, and carries a toolpost to which a circular friction disk cutter *A* is held, as shown in Fig. 149.

After trimming, the cases are again annealed, as previously described, each pan holding eighty-eight cases. The sixth

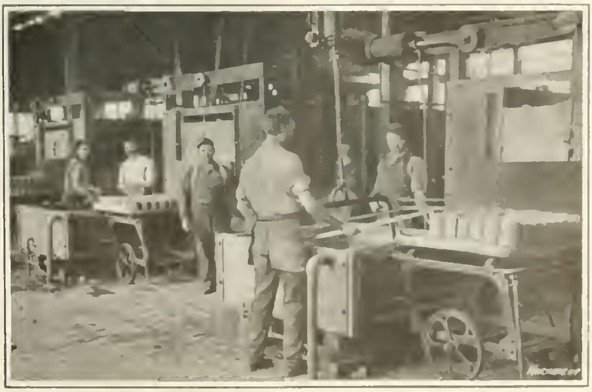
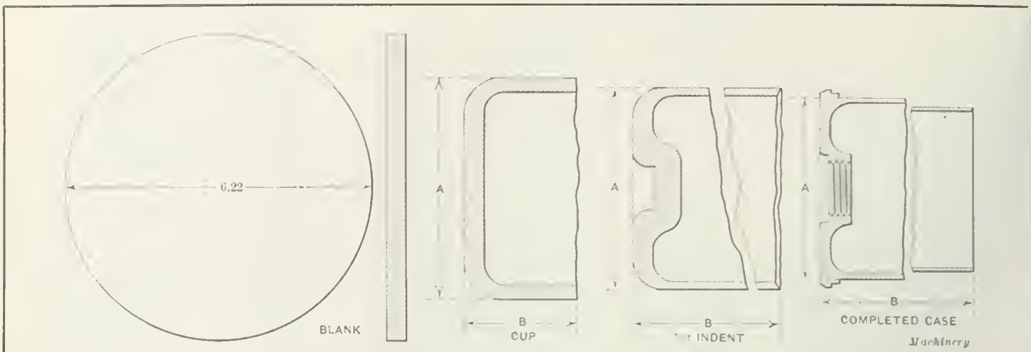


Fig. 141. Annealing Cartridge Cases

TABLE VI. ORDER OF OPERATIONS ON BRITISH 18-POUND CARTRIDGE CASE



Number of Operation	Character of Operation	A, Inches	B, Inches	Machine Used	Lubricant	Furnace Used	Temperature of Furnace Degrees F.	Bath	Production Per Hour
1	Blanking	6.220	0.380	Toledo No. 57 Press	....	....	......	....	400
2	Cupping	$4\frac{1}{2}$	$2\frac{5}{8}$	Toledo No. 59 Press	"New Era"	....	......	....	400
3	Anneal for 1 Hour 4 Minutes	...	...	....	....	Special	1250	Water Cooled*	420
4	First Redrawing	$4\frac{7}{32}$	$3\frac{17}{32}$	Toledo No. 59 Press	"New Era"	....	......	....	400
5	Anneal for 1 Hour 4 Minutes	...	...	....	....	Special	1250	Water Cooled*	472
6	Second Redrawing	$4\frac{3}{32}$	$4\frac{15}{16}$	Toledo No. 58 Press	"New Era"	....	......	....	400
7	First Indenting	$4\frac{3}{32}$	$4\frac{15}{16}$	Toledo No. 59¼ Press	....	....	......	....	300
8	Anneal for 1 Hour 4 Minutes	...	...	....	....	Special	1250	Water Cooled*	510
9	Third Redrawing	$3\frac{31}{32}$	$5\frac{3}{4}$	Toledo No. 57 Press	"New Era"	....	......	....	200
10	Anneal for 1 Hour 4 Minutes	...	...	....	....	Special	1250	Water Cooled*	540
11	Fourth Redraw	$3\frac{27}{32}$	$8\frac{1}{4}$	Toledo No. 857 Press	"New Era"	....	......	....	150
12	Second Indenting	$3\frac{27}{32}$	$8\frac{1}{4}$	Toledo No. 59¼ S Press	....	....	......	....	250
13	Anneal for 1 Hour 4 Minutes	...	...	....	....	Special	1250	Water Cooled*	585
14	Fifth Redrawing	$3\frac{25}{32}$	$10\frac{5}{8}$	Toledo No. 857 Press	"New Era"	....	......	....	150
15	First Trimming	$3\frac{25}{32}$	$10\frac{1}{2}$	Toledo Trimmer	....	....	......	....	350
16	Anneal for 1 Hour 4 Minutes	...	...	....	....	Special	1250	Water Cooled*	660
17	Sixth Redrawing	$3\frac{25}{64}$	$14\frac{1}{4}$	Toledo No. 856 Press	"New Era"	....	......	....	120
18	Second Trimming	$3\frac{25}{64}$	$11\frac{11}{16}$	Toledo Trimmer	....	....	......	....	350
19	Heading	$3\frac{25}{64}$	$11\frac{1}{2}$	Toledo No. 666 Press	....	....	......	....	150
20	Mouth Anneal 1 Minute	...	...	....	....	Special	800	Cool in Air	720
21	First Tapering	$3\frac{3}{8}$	$11\frac{1}{2}$	Toledo No. 114 Press	"New Era"	....	......	....	250
22	Second Tapering	3.34	$11\frac{5}{8}$	Toledo No. 114 Press	"New Era"	....	......	....	250
23	Machine Head and Mouth	4.065 head	11.58	Bullard, Trimming, Chamfering and Facing Machine	....	....	......	....	35
24	Inspect (ten operations)	...	...	Standard and Special Gages	....	....	......	....	400

Machinery

* After cooling in water, cases are dipped in weak sulphuric acid solution and rinsed in warm water.

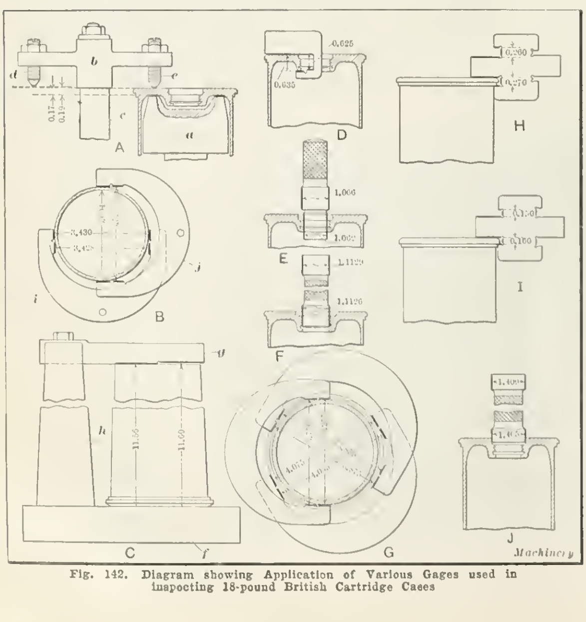


Fig. 142. Diagram showing Application of Various Gages used in inspecting 18-pound British Cartridge Cases

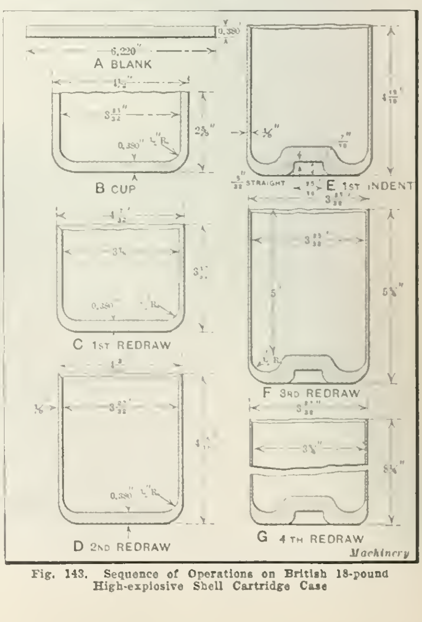


Fig. 143. Sequence of Operations on British 18-pound High-explosive Shell Cartridge Case

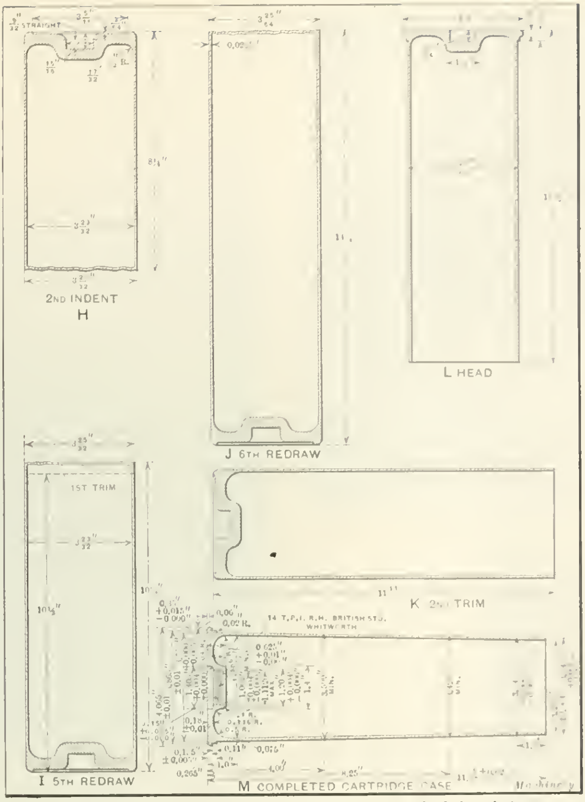


Fig. 144. Sequence of Operations on British 18-pound High-explosive Shell Cartridge Case—Continued (Thickness of Walls Slightly Exaggerated)

redrawing operation is now performed on a Toledo No. 856 press. The case, at this operation, is quite long and the production, of course, is somewhat reduced, being 120 per hour, with two operators. In the sixth redrawing operation the important dimension to retain is the thickness of the wall at the mouth; this should be 0.0285 inch. Following the sixth redrawing operation, the case is given a second trimming, as shown in Figs. 149 and 151. The production on the trimming machine is 350 cases per hour.

Heading

After the sixth redrawing and trimming operations the cartridge case is not annealed, but is taken directly to the Toledo heading press shown in Fig. 155. The operation of this press is quite interesting and is as follows: An indexing fixture fastened to the ram of the press carries two heading punches, one being used for forming the primer pocket and the other for flattening out the head. The heading die-holder retained on the bed of the press is also of the indexing type. By referring to Fig. 155, it will be noticed that die-holder C carries two different shaped heading dies A and D, each of which carries a bottom plug or support for the cartridge case. The method of operating is as follows: assuming that both dies A and D are empty, first place the cartridge case over the plug in the die, then index the turret die-holder C, bringing the loaded die in line with the punches. Next, index punch B in line with the cartridge case; after this, the press is operated and the first blow delivered. The die-holder now remains stationary and the punch-holder is indexed to bring the flattening punch in line, after which the press is again operated and the second blow delivered. An unheaded case is now loaded in the empty die, and the die turret indexed; this brings the unheaded case in line with the ram, and the headed case in line with the pick-up E. The punch-holder is now indexed to again bring punch B in line, and the press operated. While the blow is being delivered to the second case, the headed case is removed from the die turret by pick-up E. The production is 150 cases per hour. Following heading, the mouth of the shell is annealed previous to the tapering operations which follow. The annealing is accomplished in an interesting manner as shown in Fig. 154. The machine comprises a rotating table carrying twelve plates, which are also rotated, upon which the cartridge cases are placed. Twenty burners fed by natural gas are provided. The large dial makes two R. P. M., and in the meantime the cartridge cases are rotated continuously and at a much higher speed. This is accomplished by a simple, ingenious method. The main rotating fixture carries a large spur gear which meshes with small pinions fastened to the spindles of the plates that carry the cases; hence as the large fixture rotates the plates carrying

Fig. 145. Recording Instruments used in checking up Temperature of Annealing Furnaces

Fig. 146. First Redrawing Operation performed on a Toledo No. 59 Press

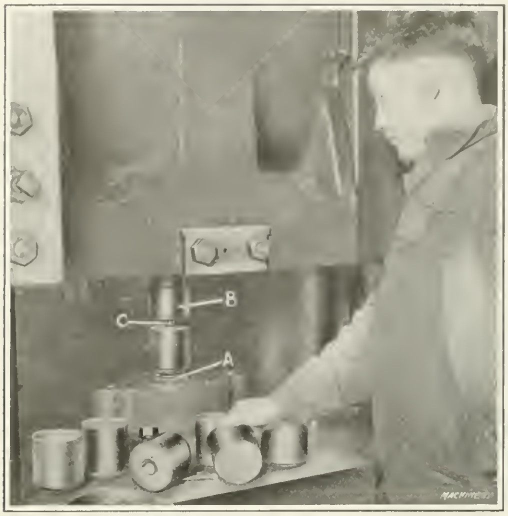


Fig. 147. First Indent on a Toledo Press

Fig. 148. Third Redrawing Operation on a Toledo No. 57 Press

the cases are also rotated. It requires two revolutions of the large table, or one minute, to anneal the mouth of the case sufficiently for tapering. The annealing temperature attained at this time is about 800 degrees F., which is sufficient to heat the cartridge cases to a cherry-red color.

Tapering

Following the annealing of the mouth of the case, two tapering operations are performed, bringing the case to the final shape shown at *M* in Fig. 144. These operations are performed in Toledo special tapering presses which are shown in Fig. 152. These machines differ from the ordinary punch press in that the stroke of the press is controlled by an eccentric and link motion instead of by a combined crank and toggle action. This mechanism is used owing to the length of stroke necessary and because of the fact that a press used for tapering does not need anywhere nearly the same amount of strength and power as one, for example, that would be used for heavy redrawing, embossing or forming operations.

Fig. 150. Second Indenting Operation on a Toledo Press

In the first tapering operations, the mouth of the case is reduced to 3⅜ inches diameter and tapered for a distance of 6 inches, the diameter at the termination of the taper being 3⅝ inches. Two men are employed for this operation and the production is 250 per hour. In the second tapering, the mouth of the shell is made straight for a distance of one inch and then tapered from there to the rim on the head at the rate of 0.04066 inch on the diameter for every inch in length. Two men can produce 250 cases per hour on this operation.

Fig. 151. Trimming Mouth End of Case on a Toledo Cartridge Case Trimming Machine

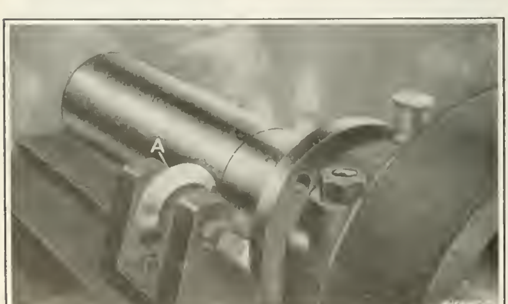


Fig. 149. Close View of Cartridge Case Trimming Machine shown in Fig. 151

Machining Cartridge Cases

The cartridge case is not finished complete in the punch press, but after tapering, several operations are performed on the head and mouth, and these are handled on the Bullard cartridge case trimming, chamfering and facing machine

Fig. 152. First and Second Tapering Operations on Special "Toledo" Cartridge Case Tapering Machines

shown in Fig. 153. A description of this machine appeared in the April number of MACHINERY.

The operations are: first, rough-bore primer pocket;

Fig. 153. Machining Head and Mouth Ends of Case on a Bullard Cartridge Case Trimming, Facing and Chamfering Machine

second, face head with facing tool; third, form with tool on rear of carriage; fourth, recess at bottom of primer pocket;

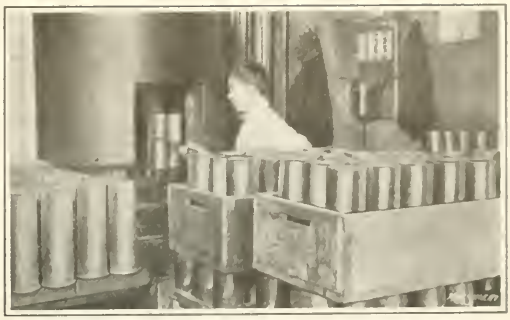


Fig. 154. Annealing Mouth in a Special Furnace previous to tapering

fifth, tap with Murchey tap—four threads per inch; sixth, ream with a combination reamer; seventh, turn and trim open end.

Inspecting and Testing

The cartridge case is now turned over to the inspectors, when the following gaging tests are made: First, gage for thickness of head; second, for tapers; third, over-all length; fourth, thickness through primer hole; fifth, primer hole diameter; sixth, root of thread; seventh, lower rim; eighth, thickness of head; ninth, thickness of head flange; tenth, diameter of counterbore at extreme head of case; eleventh, recess in pocket; twelfth, threads; and thirteenth, gun barrel test.

The manner in which these inspection operations are handled is shown diagrammatically in Figs. 142 and 162 and in Figs. 156 to 161, inclusive. The first test that is made is for the thickness

Fig. 155. Heading Cartridge Cases on a Toledo Press

Fig. 156. Gaging Thickness of Head of Cartridge Case

of head, measuring from the inside. This is accomplished as shown in Fig. 156 and diagrammatically at *A* in Fig. 142. The cartridge case is held on a post *a*, and the swinging arm *b* that rests on the shoulder of another post *c* carries two gag-

Fig. 157. Testing Taper of Cartridge Case with Horseshoe Gages

ing points *d* and *e*, one being set for the maximum and the other for the minimum dimensions. A limit of 0.002 inch is allowed.

The next inspection is gaging for taper. This is accom-

Fig. 158. Gaging Over-all Length of Case

plished by means of horseshoe gages, as shown in Fig. 157 and diagrammatically at *B* in Fig. 142. The upper gage *i* measures at a point 8.25 plus 0.000, minus 0.005 inch from the head and the lower gage *j* at a point 3.428 plus 0.000,

Fig. 159. Gaging Thickness of Head and Thickness through Primer Hole

Fig. 160. Gaging Diameter of Head and Depth of Counterbore

minus 0.002 inch from the head. The limit as shown at *B* is 0.002 inch for the smaller diameter, whereas the larger diam-

Fig. 161. Making Gun Barrel Test

eter has a limit of 0.005 inch. The third test is for over-all length as shown in Fig. 158 and at *C* in Fig. 142. Here the

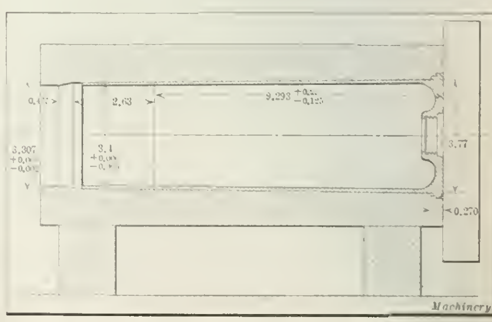


Fig. 162. Diagram showing Gage used for Gun Barrel Test

case is held on base-plate *f* and the gaging bar *g* is held on a standard *h*, a limit of 0.040 inch being allowed on the length.

The next test is shown in Fig. 159 and at *D* in Fig. 142.

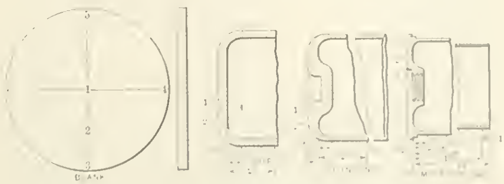
It consists in gaging the thickness from the head of the case to the inner face of the pocket. The allowable limit here is 0.010 inch. The hole for the primer is gaged as shown at *E* and *F* in Fig. 142. First, the clearance hole in the primer pocket is gaged as shown at *E*, afterward the root diameter of the threaded hole is tested as shown at *F*. Following this, the diameter of the head of the case is tested as shown to the right in Fig. 160 and at *G* in Fig. 142. Here the head is gaged at three different points as illustrated, the limits being as shown at *G* in Fig. 142.

The final gaging operations are shown at *H*, *I*, and *J* in Fig. 142, and in Figs. 161 and 162. The thickness of the head is gaged as shown at *H* and *I* in Fig. 142 and also to the right in Fig. 159. The gage used, shown at *H* and *I*, is of the double-ended type, so that the two thicknesses can be measured with one gage. The next test is to gage the diameter of the counterbore in the head of the cartridge case as shown at *J* in Fig. 142. Following this, the last and final test is made. This is the gun barrel test shown in Figs. 161 and 162. This gage comprises a cylindrical cast-iron tube, which is machined inside to the same dimensions as the bore of the barrel, as shown in Fig. 162, and two supporting stands. The cartridge case is pushed into this gage, and by laying a scale across the gage, the head of the cartridge case must come slightly below flush. The case should be easily inserted and extracted from this gage. This finishes the gaging operations.

Testing Cartridge Cases for Hardness

In order that the final product be according to specifications, it is imperative that each drawing and annealing operation be carefully followed. The method generally adopted by various manufacturers engaged in this work is to use the scleroscope and test the hardness of the case before and after each redrawing or annealing operation. Table VII gives the readings taken on the cartridge case after each operation, and the diagram with this table shows the points at which the readings are taken. It is the practice of this plant to "scleroscope" 1 per cent of its daily product; therefore, on a product of 4000 cartridge cases in ten hours, forty cases, after the completion of each operation, as shown in Fig. 163, are taken to the testing department where scleroscope readings are taken. These readings are then charted and compared with other tests.

TABLE VII. SCLEROSCOPE READINGS INDICATING HARDNESS OF METAL AFTER EACH ANNEALING AND REDRAWING OPERATION



Operation	Time of Test	Points at which Readings are Taken										
		1	2	3	4	5	6	7	8	9	10	11
Blanking	A*	15	14	14	14	15	14		..	.	.	.
Cupping	B	20	26	31	19	..	..	50	40	..	..	..
Annealed	A	12	12	12	11	..	..	13	12	..	..	.
First Redrawing	B	11	13	19	14	..	.	36	50	..	..	..
Annealed	A	12	12	12	11	..	..	12	11	..	..	.
Second Redrawing	B	12	10	12	..	..	..	36	50	50	..	
First Indenting	B	34	35	22	..	..	.	44	44	46	.	..
Annealed	A	11	11	11	..	..		15	14	14	.	.
Third Redrawing	B	11	12	12	..	..	..	36	41	48	..	..
Annealed	A	10	11	12	..	..		12	14	15	..	..
Fourth Redrawing	B	11	11	12	..	..	.	31	38	44	..	..
Second Indenting	B	12	26	34	..		..	34	51	51	.	.
Annealed	A	10	11	12	..	..	.	12	14	14	.	..
Fifth Redrawing	B	14	12	15	..		..	32	35	41	41	..
Annealed	A	11	13	14	..	..	.	15	11	14	15	.
Sixth Redrawing	B	13	20	15	..	..	..	22	30	31	41	42
Heading	..	16	38	47	..		.	28	32	33	44	45
Mouth Anneal	..	16	38	46	..	..	..	26	30	31	22	12
Second Taper	..	16	37	46	..	..	..	35	38	44	36	59

Machinery

* Note: "A" is scleroscope reading before, and "B" after annealing.

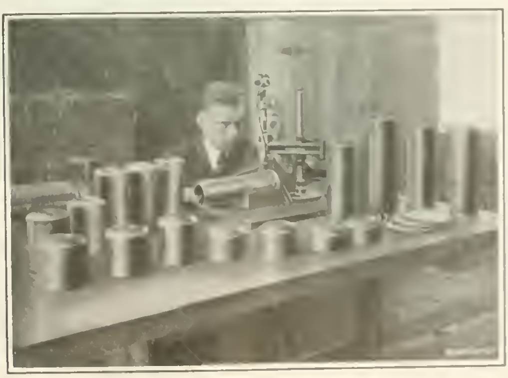


Fig. 163. Testing Hardness of Cartridge Case with Scleroscope

MAKING PRIMERS FOR CARTRIDGE CASES

The percussion primer, carried in the head end of the cartridge case and used for igniting the propelling charge, comprises six parts, as shown in Fig. 164. Of these six parts, the body shown at *A* is the most difficult to make. This is made from 1 7/16-inch round bar stock, either in a hand or automatic screw machine. In one plant turning these parts out in large quantities, a Gridley 1 3/4-inch multiple-spindle automatic screw machine as shown in Fig. 165, is used for performing the first series of operations. The order of operations is as follows: first, rough-counterbore and form; second, drill and countersink; third, thread external diameter; fourth, finish-ream, cut off and feed stock. The spindles of the machine are rotated so as to give a speed of 90 surface feet for the forming cut. The production is sixty per hour.

The second operation on the body consists in facing and shaving the head. This is done on a hand screw machine of the Pratt & Whitney type. The work is rotated to give a surface speed of 125 feet per minute, and the production is 120 per hour. The third operation is milling the key slots in the base in a Brown & Sharpe hand milling machine, using a simple indexing fixture. The end-mill which is used is operated at 200 feet surface speed, and one cut finishes each slot. The production is 140 per hour. The fourth operation is reaming the tap hole and the smaller hole in the base of the body. This is done in a Henry & Wright two-spindle drilling machine carrying a combination reamer. The work is held in a fixture which can be slid along the table, being controlled in its movement by guide strips fastened to the table. Two tools are used, one for roughing and the other for finishing, the surface speed being about 200 feet. The production on this operation is about 150 per hour.

The fifth operation is to tap the small hole in a tapping machine with a tap operating at a surface speed of 30 feet per minute. The work is held in a jig and the production is 120 per hour. The sixth operation is to finish-ream the percussion cap hole in a Henry & Wright drilling machine. This is a very difficult operation to accomplish because the accuracy required is ± 0.00[illegible] inch. The surface speed of the tool has to be cut down to 80 feet; and the production is 100 per hour. The seventh operation is to stamp the required letters on the base of the prim-

er with a hand stamp, three sets of stamps being required. The production is 150 per hour. The eighth is to lacquer the interior with a brush. The lacquer used consists of: seedlac, 10.53 per cent; turmeric, 5.26 per cent; spirits, methylated, 84.2 per cent. This is done at the rate of 200 per hour. The ninth operation is inspecting.

Making the Disk, Anvil and Plug

The closing disk *B*, Fig. 164, for the primer is made from 1-inch diameter brass rod in a 1¼-inch Gridley multiple-spindle automatic screw machine. The order of operations is as follows: first, form and cup; second, shave; third, finish cup; fourth, cut off and feed stock. The stock is operated at a surface speed of 110 feet, and the production is at the rate of 24 seconds a piece. The second operation is to remove the burrs on a small stand grinder. The third operation is to slit and straighten in a small Brown-Boggs punch press. The fourth is to inspect.

The anvil *C*, Fig. 164, is made on a No. 00 Brown & Sharpe automatic screw machine from ⅜-inch round bar stock. The order of operations is: feed stock to stop; form and bore; ream small hole; thread and cut off; burr in the burring attachment. The stock is rotated at 1800 R. P. M. for forming and at 900 R. P. M. for threading. The production is 300 per hour. The second operation is slotting, which is accomplished in a National-Acme screw slotting machine as shown in Fig. 167. The production is about 400 per hour. The third operation is drilling, which is accomplished in a Leland-Gifford high-speed drilling machine as shown in Fig. 166. The drill used is size No. 55 (0.052 inch) and is operated at 10,000 R. P. M. An indexing fixture is used, and it requires three indexes to complete the drilling. The production is 400 per hour. The fourth operation is inspecting.

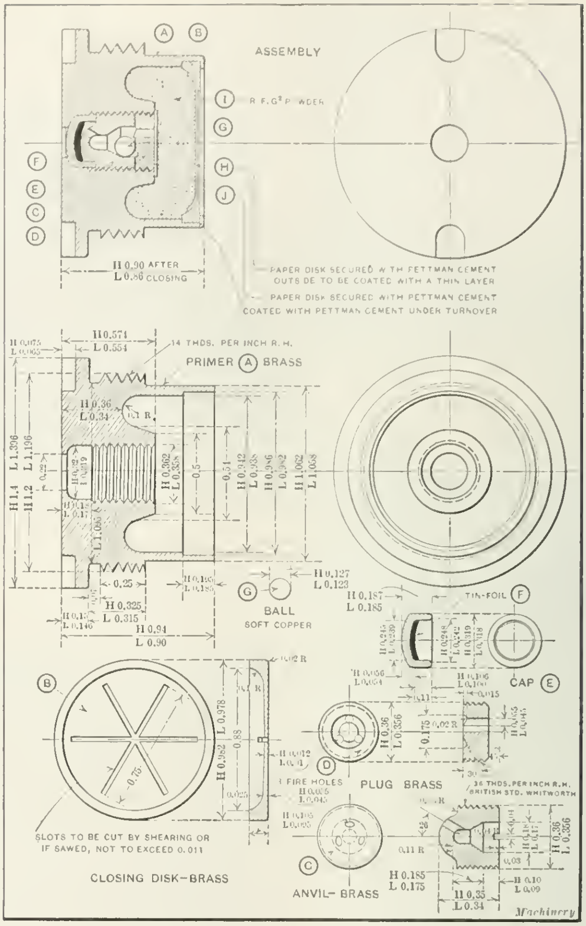


Fig. 164. Assembly View and Details of British Cartridge Case Primer

The plug *D*, Fig. 164, is also made on a No. 00 Brown & Sharpe automatic screw machine from ⅜-inch round bar stock. The order of operations is: feed stock to stop; form and groove; thread; cut off; burr with burring attachment. The spindle speed is 1800 R. P. M. The production is 450 per hour. The three fire holes are also drilled in the Leland & Gifford high-speed drilling machine shown in Fig. 166, using an indexing attachment. The drill is operated at 10,000 R. P. M., and 400 per hour are turned out. A different jig is used for drilling the plug from that used for the anvil. In the case of the plug the holes are drilled parallel with the axis, and in the anvil at an angle of 26 degrees with the axis. The percussion cap *E*, Fig. 164, is made in a small punch press in one operation, a combination blanking and cupping punch and die being used. The soft copper ball *G* is a standard product of the ball manufacturers.

Assembling and Loading

Up to the present time few of the manufacturers that have taken orders for primer parts are assembling and loading them. This delicate and somewhat dangerous operation is generally handled in the government arsenals or in cartridge factories regularly devoted to this work. Manufacturers that have taken orders for complete rounds of ammunition, however, may be called upon to handle this work in the future, so a brief review is given of the loading and assembling operations.

In the preceding description, the methods used in manufacturing the various parts of this primer have been described, but before any of the parts can be assembled the copper cap *E*, Fig. 164, must be charged. This cap, as previously mentioned, is made

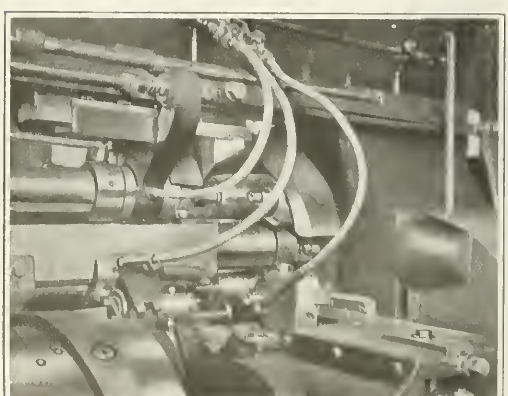


Fig. 165. Machining Cartridge Case Primer Body on a Gridley 1¾-inch Automatic


Fig. 166. Drilling Fire-holes in Anvil in a Leland-Gifford High-speed Drilling Machine

on a double-action punch press, and is blanked and cupped in one operation. After cupping, it is cleaned, dried and then varnished with a varnish containing the following constituents: finest orange shellac, 20 per cent; spirits (methylated), 80 per cent. The next operation is charging the cap with 1.2 grain of the following explosive composition:

Constituent	Parts (by weight)
Sulphide of Antimony	18
Chlorate of Potash	12
Glass (ground)	1
Powder (mealed)	1
Sulphur	1

For charging, the caps are held on one plate, and a second plate called a "charger," having the same number of holes as the cap plate, is located over the caps, and the explosive charge held in the plate is deposited in the cap. The cap plate is then taken to what is called a fulminate pressing press, where the charge in the cap is compressed by means of punches under a pressure of 800 pounds. The next step is to prepare sheets of tin foil which are lacquered on one side with the following composition: seedlac, 10.52 per cent; turmeric, 5.26 per cent; spirits, methylated, 84.22 per cent. Disks are then cut out from this tin foil and pressed into the cup under 400 pounds pressure, the lacquered side outward. The primer cup is then varnished with the same varnish as that used on the cap previous to charging. The cap is now coated externally with Pettman's cement which is composed of the following ingredients:

Ingredient	Per Cent
Gum Shellac	18.18
Spirits, methylated	19.39
Tar, Stockholm	12.12
Red, Venetian	50.31

The primer is now ready for loading, and the first part to be assembled is the cap *E*. Before this is placed in body *A*, however, the pocket in the latter is coated with Pettman's cement. The parts are then put in, in the following order (see Fig. 164): cap *E*, anvil *C*, soft copper ball *G*, and brass plug *D*. Plug *D* is locked in place by three small punch blows, after which the fire holes are covered with a paper disk *J* that is secured with Pettman's cement. The primer cavity is now filled with R. F. G[2] powder, and brass closing disk *B*, with paper disk *H* attached to the inner surface by Pettman's cement, is then put in place. This is finally held in place by spinning over the edge of the primer body, as shown in Fig. 164. The last operation is to coat the outer surface of disk *B* with Pettman's cement, after which the primers can be turned over to the inspectors.

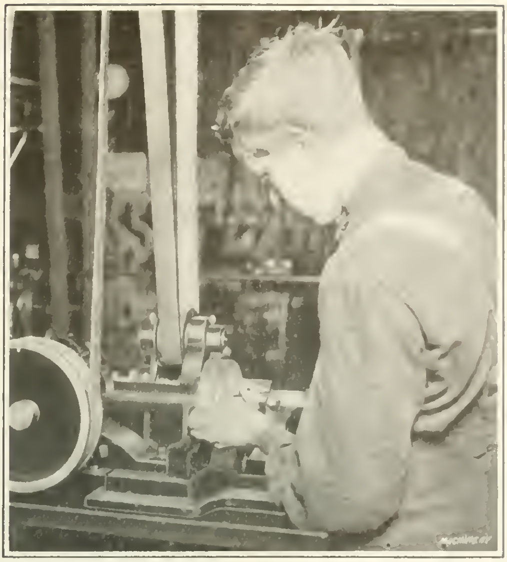


Fig. 167. Slotting Anvils in a National-Acme Screw Slotting Machine

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Fred E. Rogers, Editor
Erik Oberg, Franklin D. Jones, Douglas T. Hamilton,
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AS THE great European war drags on, the need of shells and still more shells, becomes more and more insistent. How many have been used is not known—we simply guess that the number is enormous. In August, 1914, the German army had six cannon for each thousand infantry and cavalry and 6000 shells for each gun. On the basis of 4,000,000 first and second line troops liable to call to the colors, this means over 140,000,000 shells ready for all classes of artillery when war was declared. But even the foresight of the German military experts who had devoted years to planning and preparation apparently had not provided adequately for millions of men fighting for months on battle lines extending hundreds of miles. An American army officer who has given the matter considerable thought, estimates that the consumption of shells by the German army has been three times the number on hand at the outbreak of the war. The Allies have had to meet this condition of preparedness as best they could by utilizing the resources of private manufacturers, with the result that the metal manufacturing world, other than the Teutonic nations, is largely engaged in the business of shell making, or manufacturing machinery for the purpose.

The design and construction of high-explosive shells used by the different nations differ in details and explosives used; but the primary object is the same for all—to demolish trenches, earthworks, and fortifications. While shrapnel is fired with awful destructive effect upon troops in open formation, it is of little use when the enemy is concealed behind earthworks or in trenches. Then the shell that bursts on impact and blows the defenses into fragments is needed.

Because of the enormous number of shells being made in the United States and Canada, the structure and manufacture of these deadly missiles have become legitimate engineering subjects, and this number of MACHINERY is partly given up to a treatise on the manufacture as studied in many Canadian and American plants. Modern war is replete with engineering problems, and not the least is the manufacture of ammunition. The grim events of the past year in the theater of war have given many serious concern as to what would be the fate of this nation, unprepared as it is, if suddenly attacked by a powerful and unscrupulous foe. The response of private plants in this crisis of the Allies has shown that in them our government has resources not realized by the champions of national defense. In presenting these articles we have helped, we hope, to make that private arm still more effective for preserving national peace.

* * *

AS EVERY one knows, the demand for machine tools and other metal-working machinery used in the making of munitions has never been so great as now, because the prosecution of modern war depends as much on the making of guns and ammunition as on the movement of armies and navies. Few, in America at least, anticipated that a great war would resolve into such a gigantic engineering enterprise, and that the machinery of shops, mills and factories would be so vitally necessary to its successful prosecution. But the fact is keenly appreciated now, and while the battle rages in Europe the shops in America hum with the sound of making shrapnel, shells, guns, powder and cartridges. The whole manufacturing world is the workshop for the armies of Europe, and the output has not yet equalled the demand.

With this enormous demand for American machinery has come the temptation to scamp work and charge high prices. Lathes used only for turning shrapnel or high-explosive shells need not be necessarily as perfect in alignment as when made for general purposes; and when munition plants in America and Europe are clamoring for machinery, the inspectors must be less rigid in testing them. If under these conditions any of our manufacturers fill their orders with an inferior product for which they charge fifty or seventy-five per cent more than good machines were sold for before the war, such a policy will react against them when normal conditions again prevail. Would it not be wiser to build "turning machines," with no pretensions of possessing high-grade qualities and sell them as such, than to work them off as the regular high-grade product that has won recognition the world over for excellence? The war will not last forever; normal conditions will surely return, and when they do return manufacturers who have filled their war orders with machines up to the high standard of reputable American machine tool builders will have no regrets—no shameful records that they will wish obliterated. Most of our manufacturers belong in this class; but those who have been less scrupulous will suffer in reputation and pocket, and with them will suffer the reputation of our machine tool industry as a whole.

* * *

A FEW builders of motor trucks have provided covers to protect the driving chain and sprockets with the idea of lengthening the life of these vital members of the drive. The importance of protecting chain drives has been referred to in these columns before, but in previous articles the principal reason advanced for protecting the sprockets and chain was to increase mechanical efficiency. Recent accidents in New York and other cities have shown that there is a great need of chain-cases for the protection of pedestrians. Several deaths have occurred within the past year as the result of persons stumbling and falling into the driving chains of motor trucks and being mangled.

The possibility of such terrible accidents is obvious when once pointed out, although we seldom consider the unprotected parts of moving vehicles dangerous to pedestrians. In crowded cities, conditions differ essentially from those in the country, and the possibility of having one's garments drawn into the chain-drives of a passing vehicle is apparent.

The probability is that state laws will have to be passed requiring users of motor trucks having chain-drives to protect them, to insure the safety of pedestrians. Such legislation will necessitate the employment of designers to solve the problem which has been brought to their attention many times in the past. The problem of protecting the chain-drive of a motor truck is a peculiarly awkward one because of the shape, size and arrangement of its members, and the necessity, oftentimes, of quickly getting at the working parts. It cannot be solved in any makeshift manner. The parts must be properly designed for strength, lightness and durability. When treated as an engineering problem, the difficulties will disappear; but they will not disappear until designers of ability have turned their attention to it.

LETTERS ON PRACTICAL SUBJECTS

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TURNING SINGLE-THROW CRANKS

The difficulty experienced by school boys in making and using the ordinary style of dogs for turning single-throw crankshafts for gasoline motors led the writer to devise the method illustrated and described herewith. The style of dog shown in MACHINERY'S Operation Sheet No. 56 was first tried, but it soon became evident that this plan presented too great difficulties for the use of second-year boys in our day school. This applied both to the making of the dogs and to the setting up of the work, and even when adjusted with the aid of a surface gage an accidental dig of the tool would undo all the setting. The following method was finally devised and gave very satisfactory results.

Two blocks of mild steel were planed all over to a suitable size and centers were located representing the throw of the crank. Holes were then rough-drilled on these centers to somewhat less than the required size. The blocks were next clamped together and set up on a lathe to have the holes finished. The next step was to turn up a pair of parallel steel studs to fit the holes in the blocks, after which the blocks were mounted on the table of a milling machine with the studs resting on a pair of parallels as shown in Fig. 1.

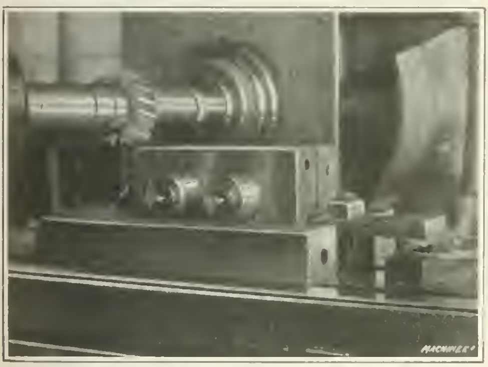


Fig. 1. Milling Blocks to bring Sides Parallel and Holes Central

Pieces of paper were put under the studs to make sure that the blocks were not tilted while the clamps were being tightened. After the work had been set up in this way, a cut was taken over the top surface of the blocks and then, without altering the vertical adjustment of the table, the blocks were turned over and reclamped so that the opposite sides could be milled. This insured having the sides of the blocks parallel and the holes centrally located.

Short steel plugs centered on one end were now fitted tightly into one hole in each block and pinned in position. These plugs provided for mounting the work on centers for turning the crankpin, and if a number of crankshafts had to be turned it would be desirable to make the plugs of tool steel so that they could be hardened. Set-screws were then fitted into the blocks for use in holding the crankshafts securely in place. Fig. 2 illustrates the method of setting the dogs on the crankshafts ready for performing the turning

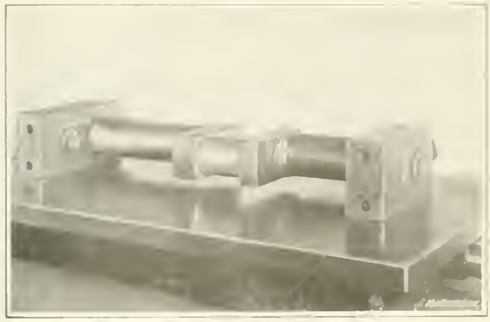


Fig. 2. Setting Dogs on Crankshaft ready for Turning Operation

operation, or for testing to make sure that the setting had not been disturbed during the machining operation. It will be seen that the crankshaft is laid on a surface plate with the dogs in position so that the slightest alteration in the setting can easily be determined. While this method of mounting the work for the turning operation involves some unnecessary labor in making the dogs, it was easily carried out and the risk of producing defective work was greatly diminished.

Christchurch, New Zealand. JOHN PEDDIE

MACHINING THE BAND GROOVES IN SHRAPNEL SHELLS

The fixture described in this article is attached to an ordinary engine lathe as shown in Fig. 1, and provides for machining the "waves" in the band groove of shrapnel shells. The chuck is made large enough to take shells up to 6 inches in diameter. A 60-tooth bevel gear is secured to the chuck and the number of "waves" is easily varied by changing the ratio of the bevel gear drive between the chuck and the carriage. A casting is fitted over the vees of the lathe bed at the front of the headstock, and this casting has a boss in the center which carries the eccentric shaft to which the bevel pinion is keyed. This shaft transmits motion to the saddle by means of a connecting-rod which runs down the center of the lathe bed below the stay and is bolted to a cross-plate on the front of the saddle.

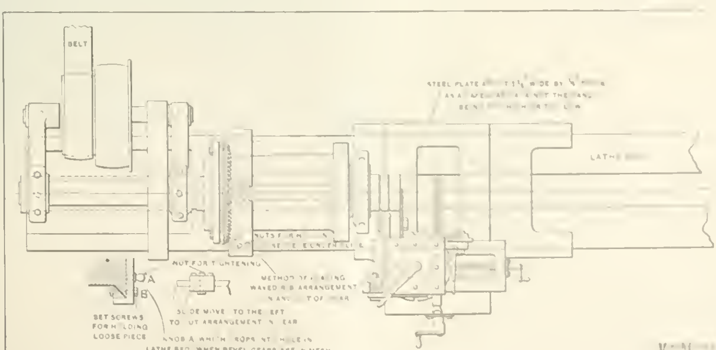


Fig. 1. Lathe equipped with Attachment for machining "Waves" in Band Grooves of Shrapnel Shells

A toolpost which carries four tools made of high-speed steel is mounted on the cross-slide. The cycle of operations, shown in Fig. 2, is as follows: First, chuck the shell and bring

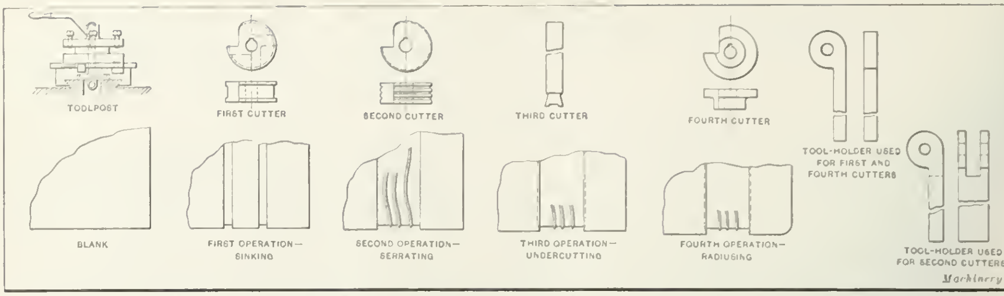


Fig. 2. Cycle of Operations performed in machining Band Groove, and Tools used for Successive Operations

cutter No. 1 into position ready for sinking the groove to the required depth for the serrations. Two grooves are cut with the required amount of metal left between them for the serrations. A stop used in connection with this cutter provides for obtaining exactly the required depth for the groove. Second, bring cutter No. 2 into position and move the saddle forward to engage the special geared drive. Then enter the locating pin *A* into its hole and at the same time screw up the clamp nut *B* to give the required "wave motion" to the saddle and leave the compound rest free.

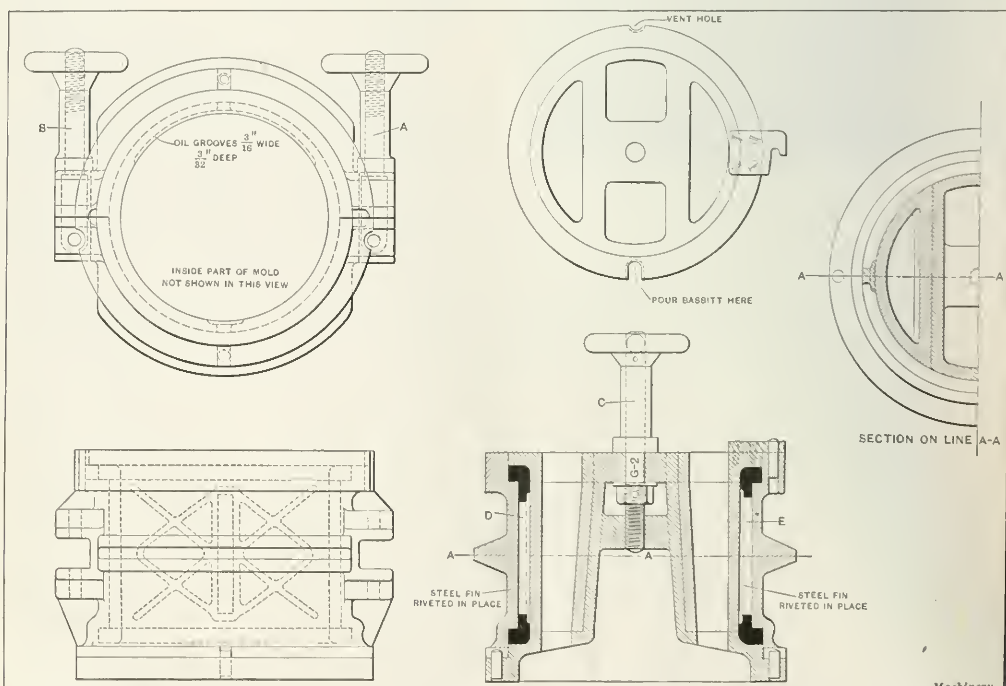
After the waving tool has been fed in to the depth reached by the tool for the first operation, the locating pin *A* is withdrawn and the saddle moved back sufficiently to disengage the gears. Third, bring around the third cutter and make the required under-cut at each side of the groove. Fourth, bring the last tool into the working position and round off the end of the shell. We have been using this device exclusively in the manufacture of different sizes of shrapnel shells, and found that it was possible to finish 100 shells a day on each machine. A feature of the attachment is that it enables the entire job to be finished at a single setting.

Sheffield, England. J. W. GEARY

MOLD FOR BABBITTING CONNECTING-ROD BEARINGS

It is the purpose of this article to describe a babbitt bearing mold which was designed for use in making connecting-rod bearings. The accompanying illustration shows the mold in plan and elevation, together with a vertical cross-sectional view, a horizontal cross-section of half the mold, and a plan view of the cover plate. It will be seen that the body of the mold consists of two parts which are clamped together by the bolts *A* and *B* and tightened by means of star-wheels; and that the cover plate is held down by a third bolt *C*. The arrangement is such that the mold can be operated very rapidly, and as the castings are cored out to provide the maximum radiating surface, the babbitt cools in a short time after it has been poured. Lack of adequate radiating surface is often a serious fault of babbitting fixtures.

The babbitt bearing is cast complete so that it is ready to be machined; and the oil grooves are formed in the mold so that scraping is the only operation necessary on the inside. Steel fins shown at *D* and *E* are mounted in the mold to divide the bearing into halves, but these fins leave sufficient babbitt at each end to form a connection which



Bearing Mold in which the Babbitt Liner is cast in One Piece for Convenience in machining, and then split ready for Use

holds the two parts together, so that the bearing can be mounted on a mandrel while the outside is being machined. The fins are riveted to two castings which fit against the taper shells, as shown in the cross-sectional view. Thus it is possible to lift them out with the bearing, so that the steel fins can be easily removed. M. W. W.

BORING MILL KINKS

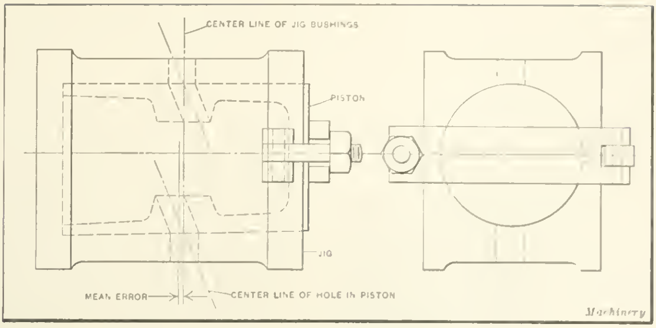
To bore a long straight hole on a boring mill is about as ticklish a job as a machinist can find, especially where the mill is used for all sorts of work and the rams are changed from day to day. I have had to bore holes from two to four feet long with only 0.002 inch variation. The quickest way to bore a hole like this is to set the ram over as close as possible, which will be a few thousandths inch off one way or the other. Then, instead of losing time and patience trying to set the ram exact, just put a shim under the saddle on the cross-rail and you will get the proper variation one way or the other. This "stunt" is so useful that if I had a shop of my own with a boring mill, I would put one set-screw on each side of the saddle, coming in touch with the gibs, so I could raise either side without using shims. This same method could be used for turning a job on the mill or planing down the side with the top head of the planer.

Wausaukee, Wis. W. E. Butler

AN ACCURATE JIG THAT PRODUCED INACCURATE WORK

If the work produced with a jig is inaccurate, the chances are that the jig is to blame, but this is not necessarily the case. A strange instance of this kind came to my attention some years ago in which a carefully made jig for use in drilling the trunnion holes in pistons was returned to the toolmaker for the purpose of having errors corrected which were supposed to exist in the tool. A careful inspection failed to disclose anything more than minute inaccuracies and the jig was sent back to the machine shop with a report that it was O. K. But pistons drilled in the jig failed to pass inspection and the tool was finally sent back with orders to remake it. Acting upon these instructions, the holes were rebored and new bushings and clamps were provided, after which the jig was again sent to the manufacturing department. After doing all this work, however, there was no improvement in the accuracy of the pistons.

Different machinists were assigned for this operation and the jig was used on different machines, but the result was always the same—the pistons produced in the jig ultimately found their way to the scrap pile. After several conferences had been held and a lot of time lost, someone tried drilling the trunnion holes at a lower speed and finer feed, with the result that all the pistons drilled under these conditions were found to be quite accurate. This showed that the cause of the trouble lay in the operation card which specified the speed and feed at which the work was to be done, and not in the jig, on which much of the blame had been laid.



The Way in which Trunnion Holes in Pistons were out of Alignment when drilled in an Accurate Jig

The explanation of the way in which the error was produced in the work lay in the fact that under the excessive speed and feed which had originally been specified, there was a tendency for the drilling to "run out." This effect was further increased by the springing of the work under the heavy feed pressures. The maximum error in the jig was not over 0.001 inch, but owing to the inaccuracy resulting from the excessive speed and feed, the error in the work averaged 0.006 inch. The accompanying illustration exaggerates the manner in which the error occurred; the location of the holes at the surface was correct, but the holes were out of line. Line-reaming the piston after removal from the jig brought the holes into alignment, but the line of the holes was not perpendicular to the axis of the piston.

Brooklyn, N. Y. F. J. Badge

TOOL FOR CUTTING TEST BARS

The cutting of test bars from solid steel stock is a difficult operation, but the greatest trouble is likely to be experienced in cutting off the bar at the bottom after the trepanning operation has been completed. The accompanying illustration shows a tool for cutting test bars which has given very satisfactory results. The body of this tool has a hole *A* running through it of the diameter of the test bar which is to be cut, and a second hole *B* of suitable size to receive the tool-bar *C*. This bar is slotted to receive the cutter *D* which is held in place by a set-screw. The feed lever *E* is secured to the opposite end of the tool-bar by means of a pin or set-screw, and the feed-screw *F* is carried by a lug on the body of the tool. Tightening up the screw *F* results in rotating the feed-bar by the engagement of this screw with lever *E*, the coil spring *G* is provided to eliminate backlash. It will be evident that the tool itself is turned by means of the crank handle *H*. After the trepanning operation has been completed, the cutter *D* is fed in to a depth of 3/16 inch in the case of a test bar 13/16 inch in diameter, and after the tool has cut to

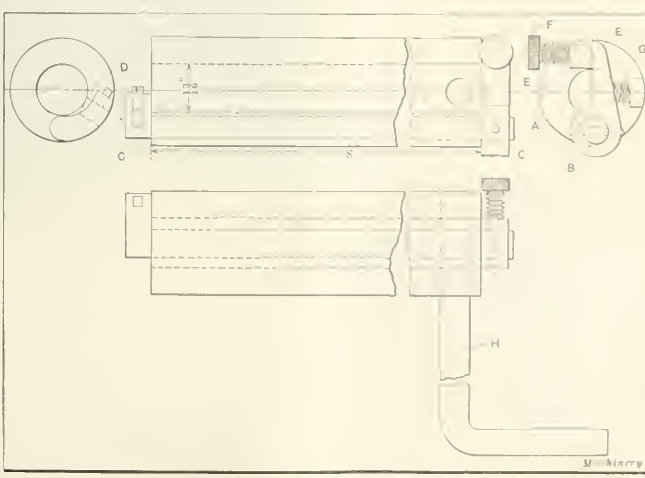
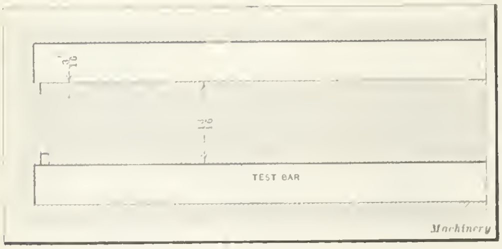


Fig. 1. Type of Trepanning Tool used for cutting out Test Bars from Solid Stock

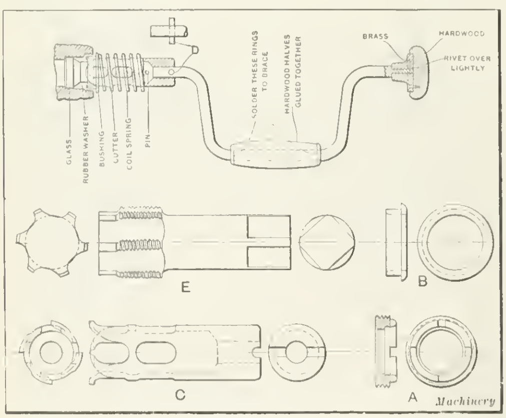


this depth the bar can be easily broken off. To withdraw the tool from the work, it is merely necessary to release the feed-screw *F* until the feed-lever comes to the starting position, which is determined by a stop carried on the body of the tool. In case the feed-lever fails to come into contact with this stop, the whole tool is turned backward to remove the chip or other obstruction which is holding the tool.

Milwaukee, Wis. GUS LUCK

REMOVING RUBBER GASKETS FROM LUBRICATORS

The accompanying illustration shows a tool for use in removing rubber gaskets from sight-feed lubricators on locomotives. A cross-sectional view of the lubricator is shown at the top of the illustration with the tool in the operating position. Trouble is sometimes experienced in removing the old gasket when it is necessary to substitute a new one, but by using the tool which the writer developed for this purpose, the work can be done quite easily. The method of procedure is as follows: After the jam-nut *A* has been removed, the casehardened bushing *B* is substituted to prevent injuring the threads in the lubricator. The spring provided on the tool serves to hold the bushing in place. The cutting edges of the tool *C* are of a larger diameter than the bore in the bushing, so that it is necessary for the bushing to be slipped over the cutter from the back before the tool is assembled ready for use.



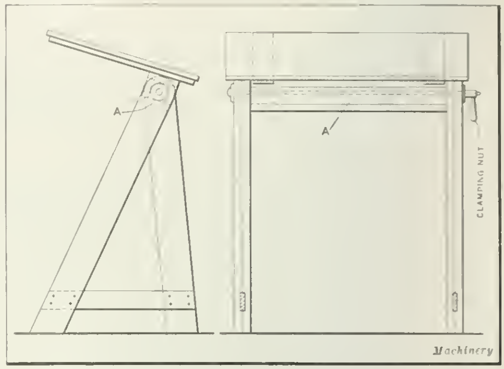
Special Brace and Tools used for removing Rubber Gaskets from Sight-feed Lubricators

It will be seen that the cutter is driven by a pin *D*, which is 3/16 inch in diameter; this pin is fitted into the end of the brace and enters the groove in the end of the tool *C*. The tap *E* is provided for tapping the threads in the lubricator when it is necessary to refinish them. A special brace is designed for this work as shown in the illustration.

L. K.

ADJUSTABLE DRAWING TABLE

The accompanying illustration shows an adjustable drawing table which the writer made for his own use some time ago. As this table has been found very satisfactory, and as it is inexpensive to make, it may prove of interest to some readers of MACHINERY. It will be evident from the illustration that the drawing board may be readily set to any required angle, as the uprights have no fixed tie between them except the cross-rail *A*, so that adjustment is provided to enable the feet to find a bearing on uneven floors. The cross-rail is probably the only part which may not be clearly understood after looking at the two views of the table. It is made of 1-inch pine, the four sides of the box section being firmly screwed together; the cross-rail is also screwed to the battens on the back of the drawing board. The ends of the cross-rail are carefully squared up to provide a good bearing surface for the faces of the uprights, and the ends



Drawing Table with Adjustment to find a Good Bearing for Legs

of the rail are provided with wooden plugs to retain the clamping bolt in position. Iron washers 2 inches in diameter are placed under the nut and under the head of the bolt to distribute the pressure.

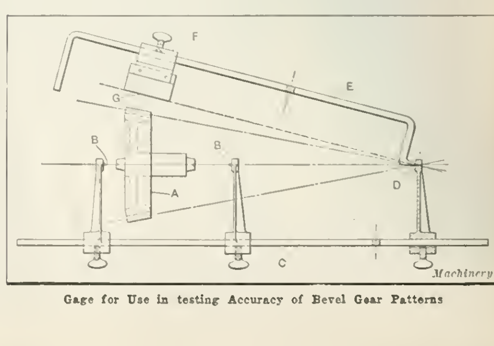
Christchurch, New Zealand. JOHN PEDDIE

BEVEL GEAR PATTERN GAGE

When a patternmaker has to make the patterns for a pair of bevel gears, he turns up the blanks to the required size, using a square and protractor to test the work with from time to time. This method is not particularly satisfactory, as the slight errors in the pattern are likely to result in the production of a very noisy pair of gears.

The illustration presented in this connection shows an improved form of bevel gear pattern gage which I developed to overcome the difficulties resulting from the use of the square and protractor. It will be seen that the gear pattern *A* is supported on centers *B* which are carried on a square rod *C*. A third center *D*, which is in line with the centers *B*, is carried by the same rod. The square rod *E* has a point which is supported by center *D* and this rod carries a support *F* which holds the straightedge *G*.

It will be seen that the centers *B* and *D* and the support *F* are held by wing-nuts so that they may be adjusted to any desired position on their respective bars. In using the gage the bevel gear is set up between centers so that it may be rotated, and the center *D* is located at the required position on bar *C* so that it is at the apex of the cone. Support *F* is then adjusted on bar *E* so that the straightedge engages the



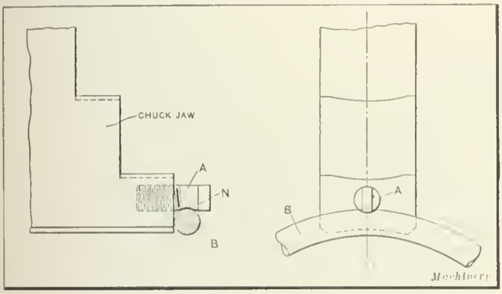
Gage for Use in testing Accuracy of Bevel Gear Patterns

bevel gear as shown, and the straightedge G may then be used to test the accuracy of the bevel gear pattern.

Minneapolis, Minn. GLENWOOD MACOMBER

TRUING UP CHUCK JAWS

In the June number of MACHINERY a description was published of a method of truing lathe chuck jaws which would doubtless give very satisfactory results. For some time I have been using a similar method which possesses the advantage of enabling the entire finishing cut to be performed at a single operation. The method is described with the hope that it may prove of value to some readers of MACHINERY. A hole is drilled and tapped in each of the chuck jaws to receive the pins A which have a notch cut in them to afford



Improved Method of truing up Chuck Jaws

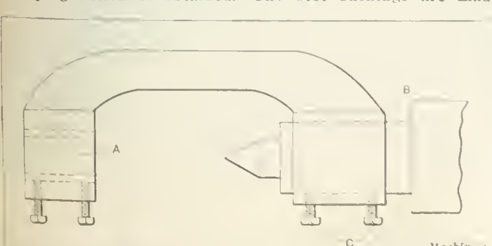
a firm bearing for the centering ring B. The pins are flattened in order that they may be turned with a wrench.

In using this method the jaws are tightened against the ring as in the manner described in the June number, but by having the ring engaged by pins instead of by the chuck jaws, it is possible to take the entire refinishing cut at one time, thus enabling the work to be done more rapidly and avoiding the chance of slight errors which may be introduced in starting to take the second cut. It will of course be obvious that hardened chuck jaws will have to be annealed before the holes can be drilled and tapped to receive the pins A, but in the case of hardened jaws already provided with holes, it ought to be possible to perform the truing operation with a grinding wheel without the necessity of annealing the jaws to enable them to be trued up with a turning tool.

Chicago, Ill. W. G. DRUMMOND

A TAILSTOCK DRILL-HOLDER

The fixture described in the following was designed for holding straight-shank drills in a lathe without requiring the use of a dog. It consists of a casting with the two holes A and B bored parallel with each other on the same center line. Hole B is made a close fit for the tailstock spindle on which the fixture is held fast by means of two cap-screws C, a piece of soft metal being placed under these screws to prevent them from marring the spindle. Hole A is bored to a diameter 1/4 inch greater than the largest drill which the fixture is required to hold, and bushings of suitable size for the different drills used in the holder are made to fit hole A. These bushings should be split and opened slightly so that a good spring clamping action is obtained. The best bushings are made



Drill-holder for Use on the Lathe

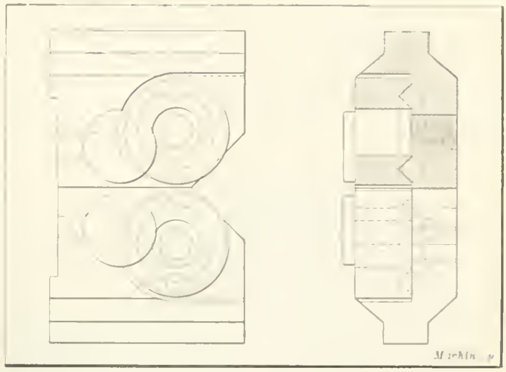


Fig. 1. One of Three Styles of Roller Follow-rests for Use on J. & L. Turret Lathes

from steel and left soft. The rib that connects the two ends of the fixture should be made fairly heavy so that the twisting force exerted by the drill will not throw the two holes out of line with each other. To compensate for variations in the length of different sizes of drills, the end B of the fixture is set in different positions on the tailstock spindle according to the size of drill that is to be used. This holder is adapted for use in drilling holes not over 2 inches in depth.

Worcester, Mass. C. H. ANDERSON

ROLLER FOLLOW-RESTS WITH BALL THRUST BEARINGS

To avoid trouble experienced from the V-block follow-rests used on Jones & Lamson turret lathes damaging the turned

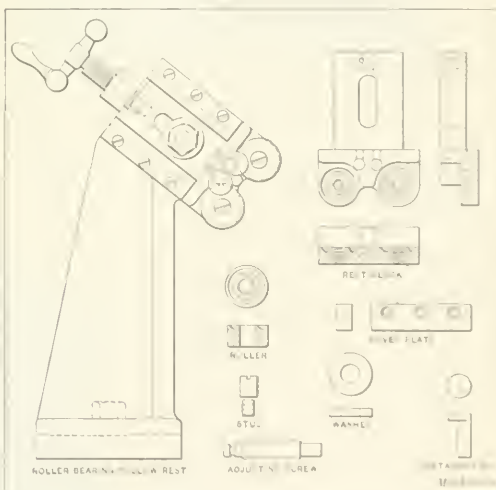


Fig. 2. Roller Follow-rests for Use on Engine Lathes

stock, we designed three styles of roller follow-rests equipped with ball thrust bearings. One of these rests is shown in Fig. 1. The three rests referred to were for turning stock of small and large diameters, and for handling shoulder work. The body of these rests was made similar to that of the V-block follow-rests furnished with the machine, and ball races for thrust bearings were formed concentric with the studs on which the rollers are carried. The rollers are held in place on the studs by eccentric headed pins. The use of these follow-rests has done away with the trouble experienced from the marring of turned surfaces.

Fig. 2 shows a roller follow-rest of similar design which is made for use on engine lathes. It consists of a standard on which there is a planed slide which carries an adjustable block. The two rollers, which are provided with ball thrust-

bearings, are carried by hardened steel shoulder studs mounted in the adjustable block. As in the preceding case, the rollers are held in place by eccentric headed pins. The general construction is the same as that of the follow-rest for the Jones & Lamson turret lathes, and the results obtained in both cases have been equally satisfactory.

Rockford, Ill. E. K. Morgan

OXY-ACETYLENE WELDING AND CUTTING EQUIPMENT

I have read, with a great deal of interest, Mr. Miller's articles in the October number of Machinery. His descriptions and photographs of actual welding work and his methods of preparation, overcoming contraction strains, etc., undoubtedly will be a great help to users of the oxy-acetylene process. The experiences of practical men, clearly expressed, should be of decided benefit, and Mr. Miller's long experience in the repair business peculiarly qualifies him as an expert in this line; users of the system will profit by his knowledge.

In justice to the process of oxy-acetylene welding and cutting and to many manufacturers of high-class apparatus, however, it seems to me that that portion of Mr. Miller's articles entitled "Oxy-Acetylene Welding and Cutting Equipment" needs further discussion. Mr. Miller describes on page 86 the methods pursued to overcome the tendency of acetylene to burn backward, and states that unless the tube used is a very small one, this danger is great. He may have had such an experience, but I can find no authority for any such statement; in hundreds of experiments I have never been able to make acetylene burn against the flow and I know of no one who has been able to do this. If this were true, every acetylene house lighting equipment would be a menace, for in this case the flow of gas is at a very low speed and through a fairly large pipe. Acetylene (or any other combustible gas) will not burn unmixed with air or oxygen, and if Mr. Miller will try the experiment for himself I think he will agree. If, however, acetylene is heated to a sufficiently high degree (authorities place this point at about 800 degrees F.) it will explode without air mixture; but this condition cannot very well be obtained in a welding torch.

The danger which Mr. Miller describes, then, is not in the acetylene but in the mixed gases, and any well constructed torch must be provided with such devices as are thought to prevent the propagation of the flame beyond the torch. Whether this can be accomplished by means of small holes or by packing in the handle is a question still open to considerable discussion. It has by no means been proved that either will prevent it under some conditions well known to manufacturers of welding apparatus. The point I wish to bring out clearly is that acetylene properly handled is not a dangerous gas to use. It has been misunderstood more than any other gas, and wrong impressions have been created regarding it. It should be clearly understood that with the proper air mixtures it will burn against the flow, but without such mixtures it cannot do so.

Further on, Mr. Miller states that the welding torches in use may be divided into two classes: low-pressure and medium-pressure; he defines the low-pressure torch as one using acetylene under a few ounces pressure, and the medium-pressure as one using acetylene under a pressure as great as six pounds. In justice to the conscientious manufacturers of the equal-pressure type, a descriptive article of welding apparatus is not complete without an explanation of this type of torch. In this country, the divisions should properly include three classes: Low-pressure (or injector) torches, where the acetylene is under a very low pressure and the oxygen under a comparatively high pressure; medium-pressure torches, where the acetylene may be used under a pressure of somewhat less than fifteen pounds and the oxygen under a pressure averaging about twice the acetylene pressure; and equal-pressure torches, where both gases move at about the same speed. The "Oxweld," "Delcampe" and "Messer" are examples of the first class; Davis-Bournonville, "Vulcan," Henderson-Willis "Searchlight," Milburn, "Economy," "Meco" and Metals Welding of the second; and "Prestolite," Waterhouse, Dyer, "Imperial," and Tolman of the third. Which particular type is the best one to use cannot be said in a fair article; but the very fact that the equal-pressure torch lowers the velocity of the oxygen—and this has been sought for in all types of torches—demands its consideration in any discussion of welding apparatus. The particular apparatus which Mr. Miller describes at length is unquestionably a high-class one and the manufacturers of it have the admiration of everyone connected with the industry, but it is by no means the only good apparatus; nor the only economical one. It is simply in a spirit of fair play to the manufacturers of other types that I call attention to this oversight.

On page 92 is this statement: "Acetylene has the property of having more heat units per cubic foot than any other gas. . . . Consequently, if it were completely burned, it would produce the maximum temperature possible in a gas flame." "Blaugas," "Wolf Gas," "Gasol," "Thermalene," and two or three others, have more heat units than acetylene and any one of these gases will produce more heat than acetylene. None of them, however, will give the flame temperature of oxygen and acetylene, for reasons which have previously been explained in Machinery. The danger of a statement of this kind lies in the fact that it may be quoted (as similar statements have been) by manufacturers of gases having more heat units than acetylene, and the natural inference of the reader would be that if acetylene with 1600 heat units gives a flame of 6300, then this other gas with 2200 heat units undoubtedly would give 8000 or more; when as a matter of fact the combination of oxygen and acetylene gives a much hotter flame than any other combination.

"It is perfectly safe to compress acetylene into such tanks" on page 92 is a misleading statement. Somebody is going to take this literally and proceed to pump acetylene into the well-known safety storage cylinder (as embryonic gas manufacturers have attempted to do in the past, usually with disastrous results) unless it is shown that the act of compressing acetylene is attended with considerable danger. Any one of the three large manufacturers of dissolved acetylene can probably testify to the truthfulness of this statement, and they have learned it at the cost of wrecked plants. After the gas is in a properly constructed tank, it may be considered safe, but certainly it is quite unsafe to compress it.

The development of the oxy-acetylene process of welding and cutting is largely dependent upon the purity, convenience and price of the oxygen; and the Linde Air Products Co., as the largest producer in this country, is certainly a big factor, but in my opinion the oxy-acetylene industry should also give thanks to the Superior Oxygen Co., the Burdett Mfg. Co., the International Oxygen Co. and to numberless smaller companies who have done much to widen its scope.

On page 88, Mr. Miller states that "nitrogen . . . even when small, has an adverse effect on a weld," and later on that "hydrogen, which does not injure the weld." On page 90 he corrects the first statement by saying, "is nitrogen, which is chemically inert, so that it has little detrimental effect upon the steel or other metal which is being welded." Undoubtedly nitrogen is inert and practically the only effect it has is to somewhat reduce the flame temperature, and it is present in liquid air oxygen to such a slight extent that it could not be noticed in a welding flame by even the most expert operator. If hydrogen were present to any large extent in electrolytic oxygen, it would manifest itself in the character of the welding flame and the water vapor created by the combustion of oxygen, and this gas would be a serious detriment to a successful steel weld. Fortunately neither foreign element, nitrogen nor hydrogen, is present in oxygen manufactured by the two systems in sufficient quantities to materially affect the flame temperature, on the one hand, or the character of the weld on the other.

Mr. Miller's articles are going to be too valuable to the oxy-acetylene industry to allow misunderstandings or misstatements to become known as facts, and without a spirit of criticism, but wholly with the feeling of fair play toward each contributor to the success of welding and cutting apparatus, this article is written.

New York City. M. Keith Dunham

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

LEES-BRADNER SHELL THREAD MILLING MACHINE

This machine employs a special form of multiple cutter which is similar to a hob used for generating gear teeth. The cutter is the length of the thread which it is required to mill, and as a result it is merely necessary to rotate the work through one complete revolution plus a slight overtravel. The use of this principle makes it possible to mill threads on this machine with a very satisfactory rate of production. An idea of just what the productive capacity amounts to may be gathered from the figures presented in the article, which give the rates of output for different thread milling operations on shells and fuse parts.

For the performing of internal and external threading operations, the Lees-Bradner Co., Cleveland, Ohio, has developed a milling machine, front and end views of which are shown in the accompanying illustrations. A positive opening and closing collet is provided for holding the work, this collet being located on the inside of the work-spindle and controlled by a handwheel at the rear end of the spindle. The threading is done by a multiple type of cutter which makes it necessary for the work to revolve only a little more than one revolution in order to finish the cut. The machines are built in four different sizes which have capacities for holding work from 3¼ to 9½ inches in diameter.

These threading machines are particularly adapted for use in machining shrapnel and high-explosive shells, and some of the rates of production obtained should prove of interest. In threading 18-pound high-explosive shells, the rate of production obtained is forty per hour. In threading nose pieces for 4½-inch high-explosive shells, 400 pieces were threaded in 9¾ hours. In the two cases just referred to the threaded hole is 2 inches in diameter by 1.2 inch in length and has 14 Whitworth threads per inch. In threading standard bronze fuse pieces on which the threaded portion is 1.2 inch in diameter, 1100 pieces were produced in a ten-hour day.

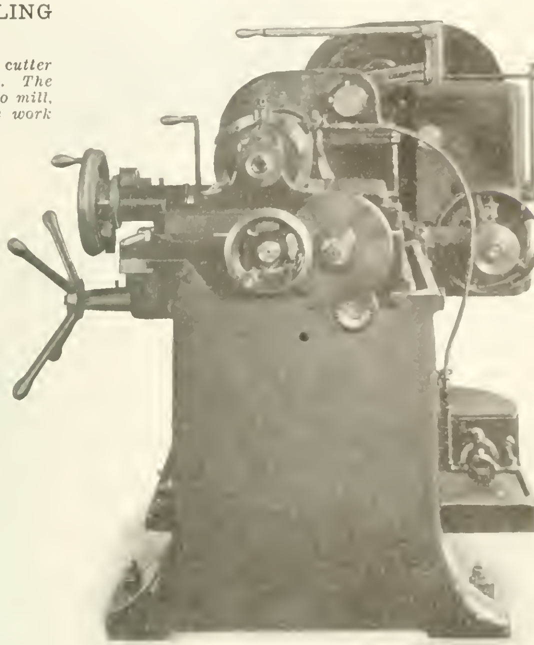


Fig. 2. End View of Lees-Bradner Thread Milling Machine shown in Fig. 1

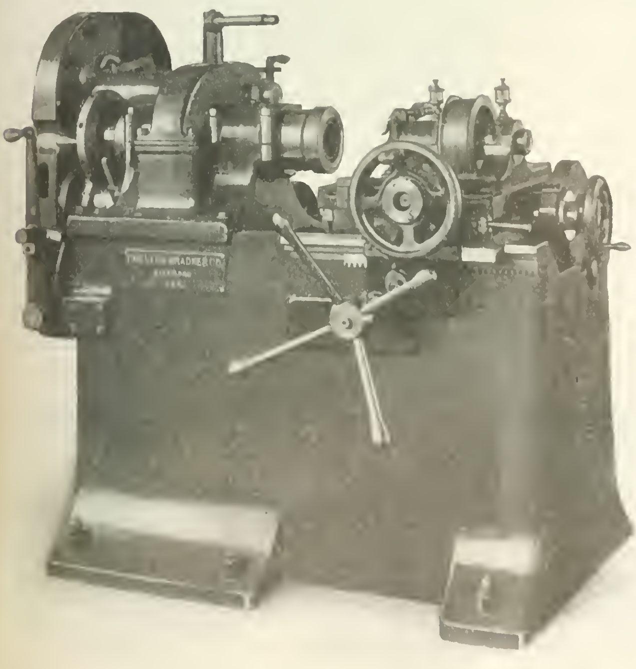


Fig. 1. Lees-Bradner Thread Milling Machine for Internal and External Threading Operations

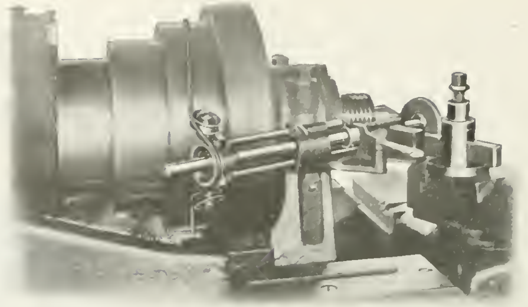
On machines which have a chucking capacity for work up to 6 inches in diameter, the cutter-spindle is driven direct; and on machines with a capacity for work ranging from 8 to 9½ inches in diameter, a back-geared drive is employed, which provides sufficient power to enable the machine to mill threads 3½ inches in length in a single cut, i. e., at one revolution of the work with a small overtravel. The machines for work from 3 to 6 inches in diameter are usually belt-driven, while the machines for work from 8 to 9½ inches in diameter may be either driven by a belt or by individual electric motor. When the motor drive is employed, it allows a crane to be used over the machine.

LEADER CENTER GRINDER

The center grinder which forms the subject of the following description was designed by C. M. Stretcher and is made by the Leader Mfg. Co., Springfield, Ohio. The most important feature of the tool is that it is driven from the lathe cone pulley by means of a round belt, so that no special provision need

be made for driving. Another noteworthy feature is that it can be used on any lathe regardless of whether the machine is provided with a compound rest or not.

It will be evident from the illustration that the tool is provided with a shank to fit in the toolpost, and the method by which it is driven from the cone pulley on the machine is also clearly shown. It will be seen that a short lever is provided which enables the spindle that carries the grinding wheel to be traversed back and forth for the purpose of feeding the wheel across the center to grind it accurately to shape. With one of these tools in a shop, there is no excuse for not having the lathe centers kept perfectly accurate. The weight of the tool is 6½ pounds and the simplicity of the design makes it an easy matter for the tool to be set up and used by any workman of average intelligence.



Stretcher Center Grinder made by the Leader Mfg. Co.

ILLINOIS DIE FILING MACHINE

In designing this machine, provision has been made for tilting the entire mechanism over in such a way that the operator may obtain a clear view of his work when using the off side of the file. It will be seen that both the motor and the driving mechanism are completely enclosed, providing adequate protection against filings and dust. A system of forced lubrication is employed, which insures smoothness of operation, durability of working parts, and the elimination of noise and vibration.

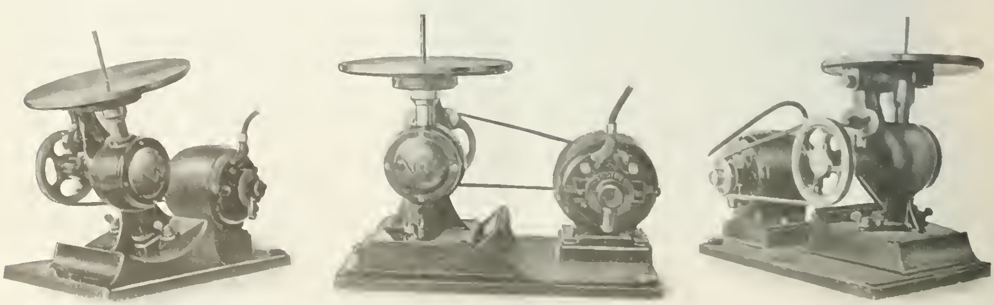
The Illinois Tool Works, 154-166 E. Erie St., Chicago, Ill., does an extensive business in the making of dies, and for use on this work the die filing machine which is shown in the accompanying illustrations was developed. The original idea was to produce a machine for use in the shops of the Illinois Tool Works, but the results obtained have been so satisfactory that it has been decided to build it for the market. The most noteworthy features of the design are the arrangement for tilting the entire mechanism of the machine so that the operator may use the off side of the file and still obtain a clear view of his work without leaning over the spindle or getting in his own light, the provision of a system of forced lubrication for the driving mechanism, and the protection of all working parts from filings and dust. These features will be described in detail in subsequent paragraphs.

It will be seen that the machine is provided with individual electric motor drive, the motor used for this purpose being a 1/10 horsepower unit built by the Bodine Electric Co., Chicago, Ill. The motor may be supplied for use in connection with a circuit of any current and voltage; it runs at 1600 revolutions per minute and the filing machine makes 720 strokes per minute, the length of stroke being 1 inch. The table of the machine is mounted on a pivoted support which provides for setting it at any required angle with the spindle to obtain the desired clearance in the die which is being filed; and a graduated scale is secured to the frame of the machine to provide for setting the table at the required angle with the spindle. It has been mentioned that the machine is mounted on a pivoted support so that the entire mechanism may be swiveled to enable the operator to have a clear view of his work. In filing a die, it is frequently most convenient to have the file working on the side of the hole farthest away from the operator and when working in this way the machine is tilted toward the operator so that the file does not obstruct his view of the outline to be followed.

It will be noticed that the entire driving mechanism is enclosed in a dust-proof case. This is very important in the case of a filing machine as there would otherwise be a tendency for filings to find their way into the mechanism and cause an undue amount of wear. This form of enclosed construction also makes it possible to employ the system of forced lubrication referred to in the opening paragraph. In setting up the machine it is merely necessary for the operator to fill the case with oil to the level indicated in Fig. 4, after which no attention is required to see that proper lubrication is obtained. The mechanism which provides forced lubrication is clearly shown in this illustration and the method of operation is as follows:

Frame *A* which encloses the mechanism is filled with oil to the highest level provided for by barrier *B*. On its upward stroke pitman *C*, which drives the spindle, creates a partial vacuum in channels *D* and *E* and well *F*, with the result that oil flows in from the supply carried in the frame of the machine. On the downward stroke pitman *C* descends and covers opening *G*, thus preventing the escape of oil through passage *E*. As a result, the only path of escape for the oil as pressure is developed by the continued downward movement of the pitman is through passage *D*, which leads to oil tube *H* that throws oil over the entire surface of pitman *C*, cross-head *I* and crank disk *J*. In this way, the oil finds its way into all crevices around the slide *K*, and the crank-pin is thoroughly lubricated by oil creeping into the slide space of the cross-head *I*.

In addition, the edge of crank disk *J* dips into the oil carried in the reservoir in the frame of the machine, and in revolving carries up a supply of oil on its rim, which flows into notch *L* and thence through channel *M* to provide for lubrication of the crankshaft bearing. The oil thrown onto pitman *C* is carried to the upper bushing *N* on the upward stroke; and the lower bushing *O* is well lubricated by oil which is carried into the bearing space on the downward stroke of the pitman. The oil carried in the well *F* serves the further purpose of



Figs. 1 to 3. Three Views of Illinois Die Filing Machine showing Different Settings that may be obtained

taking up the impact of the pitman and eliminating vibration, so that the operation of the machine is extremely smooth. As a result, the work done on the machine is accurate and the finish produced is extremely satisfactory.

The machine uses standard files of the form made for use on die filing machines, and the chuck is designed to give a three-point contact on the round shank of the file. A supply of ten assorted files is furnished as part of the equipment. The machine illustrated in connection with this description is arranged for electric motor drive, but if so desired this filing machine can also be provided for belt drive from a countershaft.

The principal dimensions are as follows: diameter of table, 9 inches; height of machine, 12 inches; bench space occupied, 16 by 10 inches; and weight of machine, 54 pounds.

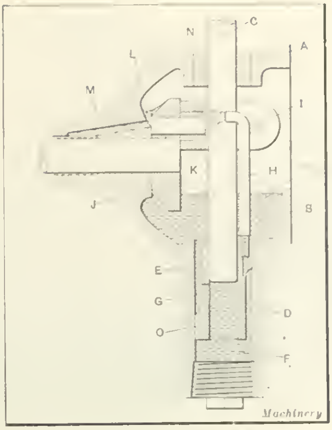
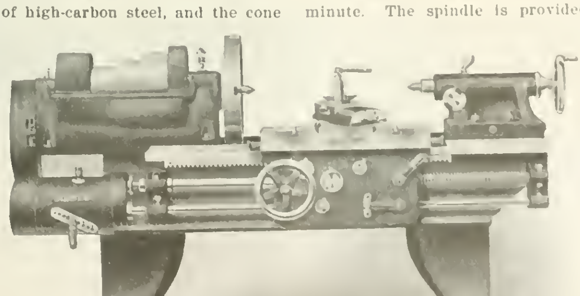


Fig. 4. Cross-sectional View through Driving Mechanism, showing Forced Lubricating System

SIDNEY ENGINE LATHE

The general features of design of the 17- and 19-inch double back-geared engine lathes which have recently been placed on the market by the Sidney Tool Co., Sidney, Ohio, will be apparent from the illustration presented in connection with the following description. Among the more important structural features of the machine, the following are worthy of mention. The bed is made with heavy double-wall girths placed at intervals of two feet, which provide an exceptionally rigid construction. There is a large bearing at the front of the bed and a standard sized bearing at the back; the bearings are carefully chilled to produce a hard close-grained metal. The carriage V-bearing is 2½ inches in width and the bridge is liberally proportioned. The carriage is drilled to receive a taper attachment so that the machine may be easily equipped for taper turning after it has been installed. The compound rest is rigidly designed and the swivel is made completely circular and graduated in degrees. Full length tapered gibs with end screw adjustment are provided on both the cross- and compound-rest slides.

The headstock is of the closed type and is offset one inch, making it better adapted for high-duty work. The headstock spindle is made of 50 point carbon steel and runs in phosphor-bronze boxes. The tailstock spindle is clamped in position by means of a double binder which is constructed in such a way as to clamp the spindle in any position without affecting its alignment. The apron is a one-piece casting in which all bearings are integral with the apron. All gears are provided with bearings at both ends and the feed-rod is also supported at both ends. The lead-screw is made of 40 point carbon steel and is 1 7/16 inch in diameter. All gears in the quick-change gear mechanism are made of high-carbon steel, and the cone gears employed in the quick-change mechanism are cut with an improved type of 22½-degree cutters, which form a pointed tooth that is slightly rounded at the top. This permits instantaneous engagement of the gears without interference. The quick-change mechanism forms a complete unit and is mounted on the machine by means of a tongue and groove joint which insures accurate alignment. It provides changes for a wide range of feeds and thread cutting operations which are listed on a direct-reading index-plate located above the tumbler lever.



Double Back-geared Engine Lathe made in 17- and 19-inch Sizes by the Sidney Tool Co.

As previously mentioned, the machines are made in nominal sizes of 17 and 19 inches, and both sizes are built with 6-, 8-, 10-, and 12-foot beds. The principal dimensions of the 17-inch lathe are as follows: swing over ways, 19 inches; swing over carriage, 11¼ inches; travel of tail-spindle, 8 inches; size of hole through head-spindle, 1 9/16 inch; width of driving belt, 3½ inches; ratio of back-gears, 3.55 to 1 and 10 to 1; number of changes of feed, 32; range of threads, 3 to 46 per inch; available spindle speeds, 13 to 360 R. P. M.; and weight of machine, approximately 3100 pounds.

The principal dimensions of the 19-inch machine are: swing over ways, 21 inches; swing over carriage, 13¼ inches; travel of tail-spindle, 8 inches; diameter of hole through head-spindle, 1 9/16 inch; width of driving belt, 4 inches; ratio of back-gears, 3.25 to 1 and 10 to 1; number of quick-change feeds, 32; range of threads, 3 to 46 per inch; available spindle speeds, 13 to 360 R. P. M.; and weight of machine, approximately 3300 pounds.

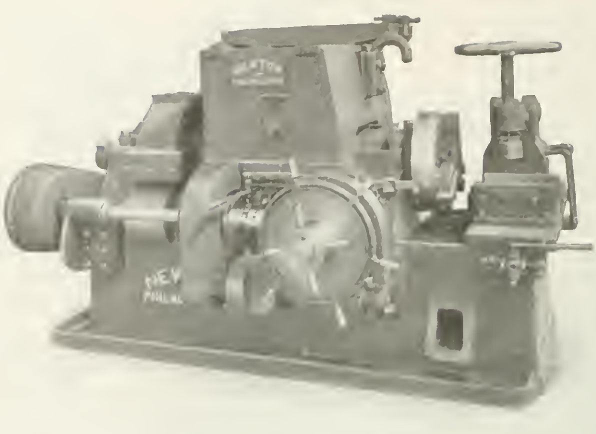
NEWTON RAIL ENDING MACHINE

The rail ending machine shown in the accompanying illustration has been developed by the Newton Machine Tool Works, Inc., Philadelphia, Pa., to meet the requirements of a machine for operating on high-carbon, high-manganese, open-hearth steel rails of the kind which are now in general use. The general design of the machine follows that of preceding types of rail ending machines built by this company, but has been modified to meet the severe service incident to working on rails rolled from the material referred to. The driving motor is mounted at the top of the machine and drives through a 10-inch belt which transmits the power to the spindle through a phosphor-bronze worm-wheel and hardened steel worm of steep lead. The worm-wheel is double keyed to the spindle, and the statement that the spindle is one-half the diameter of the cutter-head will give a better idea of the way in which these parts are proportioned than by quoting actual dimensions. The bearings are capped and bronze-bushed, so that compensation for wear is provided.

The feed is provided by a stationary screw and revolving nut, and the thrust is taken by enclosed ball bearings. The spindle has a movement of 2¾ inches and hand adjustment of the spindle is provided; there are four changes of feed of 1/64, 1/32, 3/64 and 1/16 inch per revolution, the speed of the cutter-head covering a range of from 5 to 15 revolutions per minute. The spindle is provided with an adjustable automatic stop and safety limits so that the spindle cannot jam at either end; and it is furnished with a power quick-return motion. All gears are fully enclosed, and the principal driving and feed gears run in oil. The base of the machine is surrounded by a pan, and the machine is fitted with a pump and distributing system for supplying cutting compound to the tools. Cored openings are provided in the base to facilitate the removal of chips; and lift-

ing hooks are furnished on the machine to enable it to be readily transferred from one fixed position to another to take care of handling the different lengths of rails produced in the mill. The cutter-head is of the three-tool type and uses either solid cutters or tool-holders.

The rail to be finished on the machine is held by a chuck which is fitted with hardened serrated clamping plates, and the mouth of the chuck is beveled in all directions to facilitate introducing the rail. The clamping mechanism is of the patented clearance, air-operated type developed by the Newton Machine Tool Works, and provides a clamping pressure of 32 tons. The clamp is operated by the valve shown at the front of the machine, and the adjusting screw on the air clamp is provided with a handwheel to take care of various sections of rails produced in the mill. These rail ending machines are used in conjunction with machines for drilling the splice bar holes, and in designing them the aim has been to produce an equipment with a productive capacity on T-head rails which exceeds the capacity of the drilling machines.



Rail Ending Machine built by the Newton Machine Tool Works

DEVELOPMENT IN STEAM POWER AIR COMPRESSORS

Present-day steam engineering practice is marked by the wide use of high-pressure and superheated steam. This condition has made the use of the slide valve gear, even of the adjustable cut-off type, obsolete practice on steam-driven air compressors. The slide steam valve in various forms has been generally used on air compressing units below the sizes (about 25-inch stroke) where the use of the Corliss valve gear becomes commercially practicable. At high temperatures the slide valve is very unsatisfactory due to its tendency to warp, with consequent leakage; and under these conditions there is also an increasing difficulty with lubrication, which results in excessive wear and a greater force required to drive the valve. To provide a steam-driven air compressor which will operate satisfactorily with high pressure and superheat, as well as at moderate pressures, the Ingersoll-Rand Co., 11 Broadway, New York City, has developed a balanced piston steam valve gear. This has been incorporated in the design of the standard "Imperial" duplex air compressors.

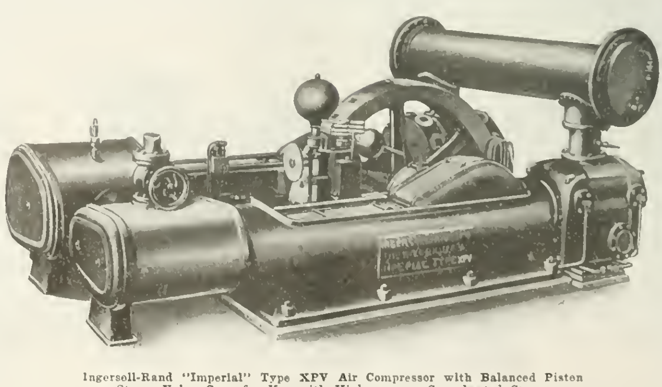
The use of a balanced valve makes it possible to control the machine in the only really economical manner, *i. e.*, by automatically varying the point of cut-off in the steam cylinders. This method of regulation maintains constant speed for changing steam pressures and at the same time varies the speed of operation according to the demand for air. Steam is always admitted to the steam cylinder at full boiler pressure and without the wire drawing of a governor of the throttling type, which means, in short, that the machine automatically operates at its highest efficiency. It is pointed out that the higher the steam pressure the greater the relative increase in efficiency. With the hand adjusted cut-off valves, which are usually set at ⅝ or ¾ of the stroke, the steam economy is admittedly poor; while with an automatic cut-off regulation, the saving in actual steam consumption is the point most emphasized by the manufacturer.

This piston valve is a perfectly balanced valve of the telescopic type; and the cut-off valves are right- and left-hand threaded to a cut-off valve stem. Steam admission is through the center of the valve, the steam then passing through the valve ports to the cylinder, from which it is exhausted by the ends of the valve. It is to be noted that this construction exposes the valve chest covers and steam packings to exhaust pressure only, thus proportionately reducing the liability of leakage. The design and even distribution of metal in the "Imperial" piston valve are claimed to preclude any possibility of warping and to result in a valve which is so balanced that friction is minimized and lubrication facilitated.

The steam ports are large and unusually direct, and a special effort has been made by the manufacturer to reduce the condensation surfaces in the cylinders. Exceptionally complete insulation, the separation of live and exhaust steam passages, and the fact that the steam chest partially encircles the cylinder contribute to the steam economy. The cylinder and receiver lagging are covered with a sheet iron casing and the cylinder heads with cast covers.

The steam receiver is a direct connection between the high- and low-pressure steam chests. The low-pressure chest is proportioned to furnish additional capacity, and is so located that the heat ordinarily lost by radiation is used in heating the cylinder and valve. A special expansion joint prevents any possibility of the cylinder alignment being destroyed. The governor is a speed and pressure regulator which varies the cut-off by automatically rotating the cut-off valve stem and changing the relative position of the cut-off valves. It is essentially a chain driven rotary oil pump which acts against a weighted plunger. The variation in oil pressure due to the changing speed of the compressor, or the varying air pressure through the movement of the plunger, changes the cut-off point in the steam cylinders.

This governor is claimed to be entirely automatic in operation and capable of maintaining exceptionally reliable as well as close regulation. Lubrication of both air and steam cylinders and valves is provided for by forced-feed oilers. The other features of this compressor, which is called the



Ingersoll-Rand "Imperial" Type XPV Air Compressor with Balanced Piston Steam Valve Gear for Use with High-pressure Superheated Steam

"Imperial" Type XPV, are those of the "Imperials" now in service; wholly enclosed main frames containing the reciprocating parts, automatic lubrication by the bath system and the standard completely water jacketed air compressing cylinders. This "Imperial" Type "XPV" compressor is built in capacities from 608 to 3620 cubic feet per minute and for discharge air pressures from 10 to 110 pounds per square inch.

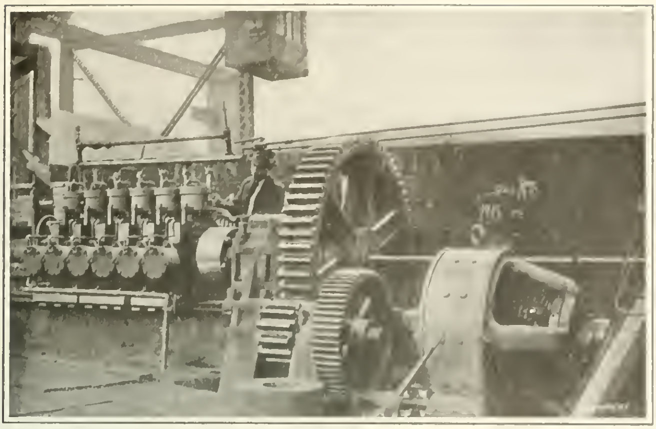


Fig. 1. Southwark Cutting-off Machine cutting Six Blanks at a Time from a Bar 5½ inches in Diameter

SOUTHWARK CUTTING-OFF MACHINES

The McMeans-Bosler cutting-off machines which are illustrated and described herewith are a recent product of the Southwark Foundry & Machine Co., 430 Washington Ave., Philadelphia, Pa. The cutting is done by three air-operated cutting-off tools which are mounted in a common head, all three tools cutting in the same kerf. The tools are forced into the work by air pressure which is claimed to be an advantageous method in that the pressure on the tool remains constant and enables the depth of the cut to be automatically regulated according to the hardness of the metal. Furthermore, if the bar is out of round the tool backs away slightly at the high spots, thus maintaining a constant cutting depth. As a result, the machine may be operated at the maximum depth of cut which the tools will stand without danger of damage in case the tools encounter an exceptionally hard or high spot in the work. The machines are made in two types and in several sizes. The first type, which is shown in Figs. 1 and 2, is a multiple-head machine equipped with six three-tool air-operated heads mounted on a cast-iron or structural steel bed. There is a heavy driven headstock at one end of the bed, which carries the chuck; and the cut-off heads also serve as steady-rests. There is no tailstock on the machine, the bar being fed in from one end.

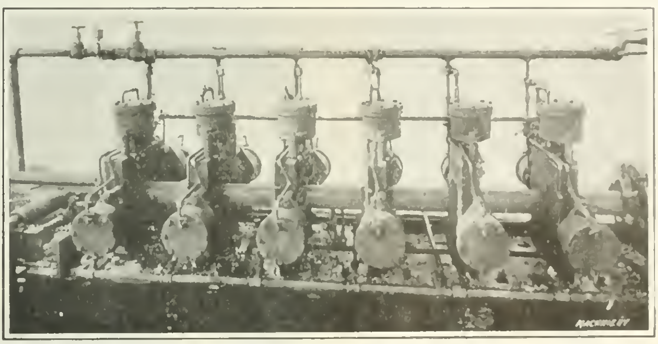


Fig. 2. Machine shown in Fig. 1 set up for cutting off Blanks 19¾ inches in Length

The second type referred to is a single-head machine which consists of a cutter-head with three air-operated cutting-off tools which operate in the same kerf, the design of the head being similar to that of the heads on the multiple machine. The single head is moved along the bed of the machine by means of an air cylinder. At the end of the bed there is a heavy headstock which is either belt-driven or geared to an individual motor.

These machines do not cut the bar entirely through but leave a neck at the center, of somewhat less than one-third the diameter of the original bar, as required by shell specifications. The blanks are separated by breaking the necks of metal left between, and the fractured ends disclose any pipes or flaws more plainly than if they were sawed clear through. In general, the time in seconds required to cut through a bar is three or four times the square of the diameter of the bar in inches. In many cases the time in seconds required to cut through a bar has been only twice the square of the diameter in inches, but this rate of cutting could not be maintained.

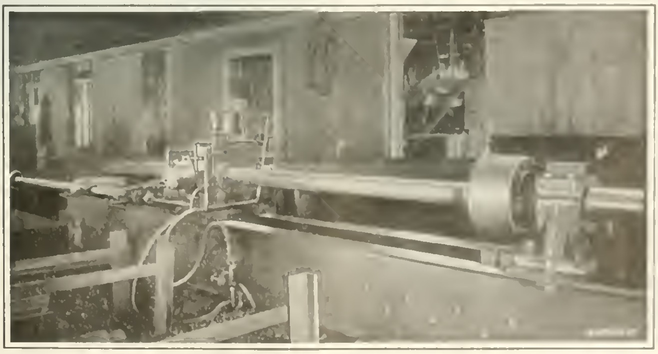


Fig. 3. Southwark Cutting-off Machine of the Single-head Type

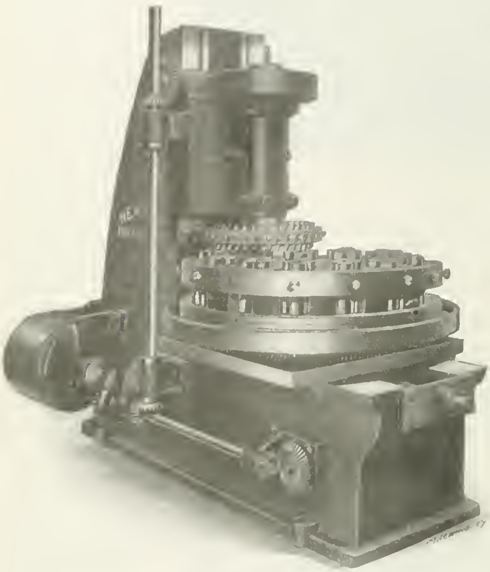
NEWTON VERTICAL MILLING MACHINE

The vertical milling machine illustrated and described herewith has recently been added to the line of the Newton Machine Tool Works, Inc., Philadelphia, Pa., and is intended for use in milling off the solid end of shrapnel and high-explosive shell blanks. The design of the machine is not a new development, but the adaptation of the special chuck or fixture for holding the work provides for continuous operation in milling shell blanks. The machine is equipped with a cutter 10 inches in diameter, and the finished work can be removed and fresh blanks substituted in the fixture without stopping the feed.

After the forgings have been rough-

turned, they are set up in the fixture which has a capacity for holding sixty pieces at a time. It will be seen that the fixture is sub-divided into pockets, each of which is now arranged to hold five blanks, although the illustration shows a fixture in which each pocket has a capacity for four blanks. All of the blanks in the pocket are secured by tightening a single screw.

The principal dimensions of the machine are as follows: diameter of spindle, 5 inches; outside diameter of table, 54 inches; in-and-out adjustment of table, 10 inches; diameter of driving worm-wheel of spindle, approximately 18¾ inches; and length of spindle bearing, 24 inches. The spindle bearing is capped and bronze-bushed, and the work table has three changes of circular feed with hand adjustment for both the circular and in-and-out movement.



Newton Vertical Milling Machine facing off Ends of Shell Blanks

CONSOLIDATED SHELL BAKING OVEN

For the purpose of reducing the time required to bake the copal varnish applied to the inside of high-explosive shells, the Consolidated Car Heating Co., 419-423 N. Pearl St., Albany, N. Y., has recently developed an electrically heated oven of compact design which is rigidly constructed to stand up under severe service conditions. It will be seen from Fig. 1 that the shells are carried on a channel iron base which is fitted with pins to locate them in the proper relation to the heating elements which are carried inside the hood. During the time that the shells are being baked, the hood is dropped to the position shown in Fig. 2; this hood is made of sheet metal and lined with asbestos to retain the heat.

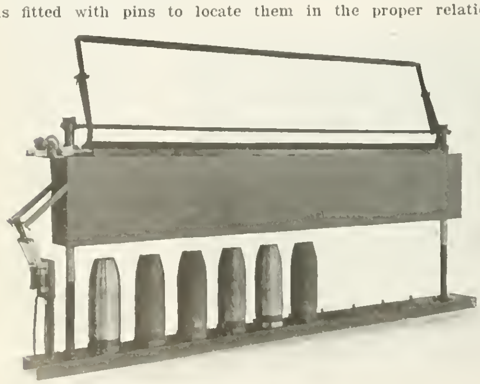


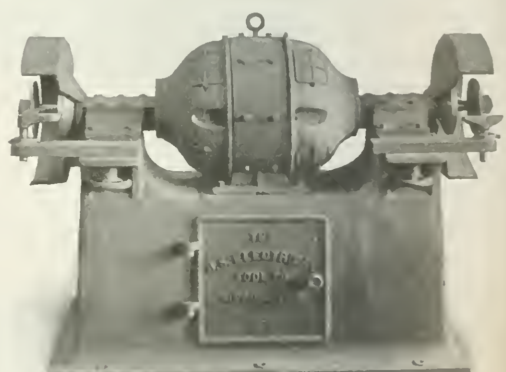
Fig. 1. Consolidated Baking Oven with Hood raised to show Method of locating Shells

Fig. 2. Shell Baking Oven with Hood lowered over Shells

When the hood is lowered the heating elements are in the correct position in the shells so that the heat is most effectively applied. As a result, an economy is effected in the amount of current required to operate the oven. The baking can be done in from one to one and one-half hour. Another feature of the oven is the automatic operation of the control switch which throws on the current when the hood is lowered over the shells, and cuts it off when the hood is raised. This oven can be built for baking any type of high-explosive shell and for operation on either alternating or direct circuits of any voltage up to 600 volts.

UNITED STATES ELECTRICAL GRINDER

The United States Electrical Tool Co., 6th Ave. and Mount Hope St., Cincinnati, Ohio, is now building the electrical grinder illustrated herewith, which has been especially designed to meet the requirements of heavy grinding operations in machine shops, railroad shops, and foundries. The spindle bearings are of the ring-oiling type and lined with babbitt; they are designed to be as nearly dust-proof as it is possible to make bearings of this type. The machine may be equipped with either a direct- or alternating-current motor. The direct-current motor furnished with the grinder is of the four-pole variable speed type; and the alternating-current motor is a single-speed unit made by the Westinghouse Electric & Mfg. Co.



United States Electrical Grinder built for Heavy Duty

The machines are made in two sizes driven by 5 and 7½ horsepower motors, respectively. The 5 horsepower machine is equipped with wheels 18 by 3 inches in size, the length of the wheel spindle is 62 inches, and the weight of the machine is 1600 pounds. The grinder driven by a 7½ horsepower motor carries wheels 24 by 4 inches in size, and the weight

of this machine is 1850 pounds. Both sizes of machines are manufactured for use on direct-current circuits of 110, 220 or 550 volts; or for use on alternating-current circuits of 220, 440 or 600 volts, of two or three phase.

NIAGARA FORMING PRESS

The Niagara Machine & Tool Works, Buffalo, N. Y., has recently developed a line of forming presses, one size of which is illustrated in Fig. 1. These machines are intended for use in forming and bending sheet metal up to No. 20 gage, and find

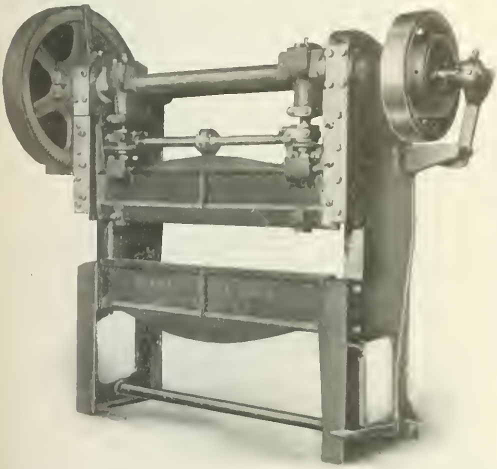


Fig. 1. Niagara Forming Press for Use in the Manufacture of Sheet Metal Furniture

application in the manufacture of metal furniture, lockers, window sash, shelving, filing cases, portable buildings, and a variety of other sheet metal products. Fig. 2 shows a set of three dies of the type used on these machines, and Fig. 3 illustrates examples of work produced with these three dies. The chief claim made for these Niagara forming presses is in regard to the rapidity with which the work can be done.

The bed and cross-head have machined recesses which are in perfect alignment with each other so that no time is lost in setting the dies sideways. The cross-head has a stroke of 3 inches so that dies of different heights can be used; and the housings have a gap 2½ inches deep to facilitate handling stock. The drive is arranged over head, making the dies accessible from the rear as well as from the front, and the motion

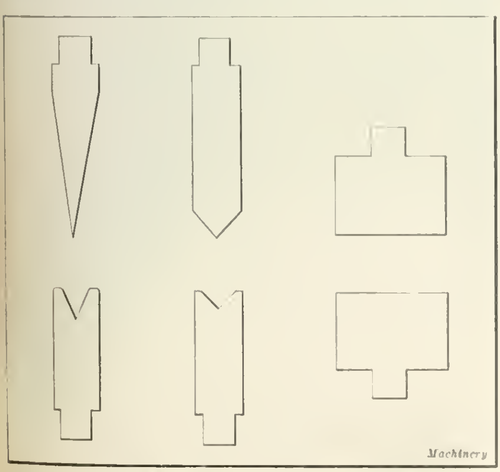


Fig. 2. Type of Dies used on Niagara Forming Press

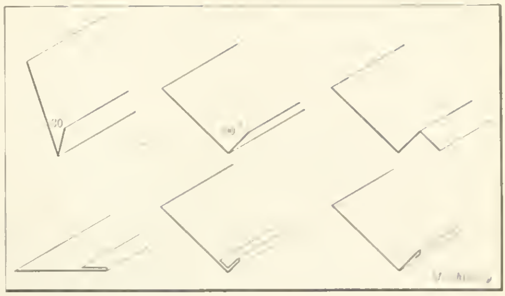
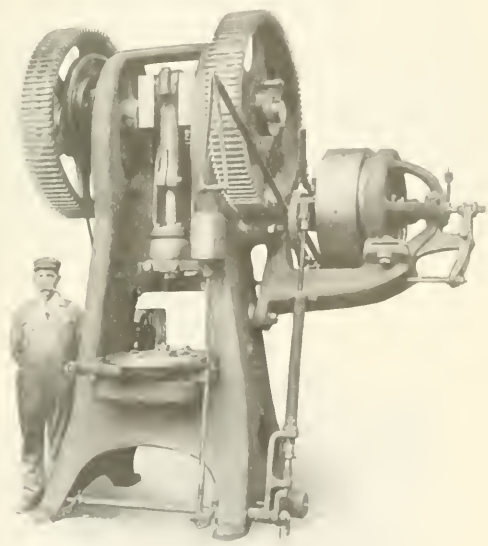


Fig. 3. Examples of Work produced by Dies shown in Fig. 2

of the machine is controlled by a friction clutch operated by a hand-lever or foot-treadle. The machine can be started or stopped at any point of the stroke. This line of forming presses comprises three different sizes with capacities of 37, 49, and 61 inches between the housings.

FERRACUTE DIAL FEED ATTACHMENT FOR CARTRIDGE CASES

The Ferracute Machine Co., Bridgeton, N. J., has recently perfected an automatic dial feed attachment for use in cupping and redrawing cartridge cases and other sheet metal shells, the attachment being used in connection with straight-sided presses developing pressures from 100 to 200 tons. The



Ferracute Automatic Dial Feed Attachment for Use in drawing Cartridge Cases

accompanying illustration shows a 100-ton Ferracute press equipped with one of these attachments; the dial has six recesses, and in designing the attachment it was necessary to make provision for aligning each successive recess with the ram to insure the entrance of the punch into the partially drawn shell. Pressure applied on the treadle caused the press to stop instantly in any position of its stroke.

The dial has an intermittent motion, being at rest while the press makes its stroke; and a cam on the main shaft imparts motion to the rack which revolves the dial yoke. A second cam on the main shaft operates the dial locking mechanism which consists of a lever with a wedge-shaped end that fits into one of six notches in the circumference of the dial. Connected to the locking mechanism there is an "interrupter" and when the locking plunger is in place in a notch in the dial, which insures the proper alignment of the ram and

recess in the dial, the interrupter prevents a weighted rod from descending; but if by any mischance the locking plunger fails to enter its notch, this interrupter changes its position and allows the weighted rod to descend and depress the treadle, thus instantly stopping the press and preventing damage to the tools. After the cause of trouble has been ascertained and corrected, the press may be made to complete its stroke by pulling down the handle strap; the rise of the ram elevates the weighted rod to its normal position and the treadle and treadle rod also return to their first position.

The press is equipped with a combination friction clutch and brake. Pulling down the hand-lever connects the power to the shaft and imparts motion to the press, while depressing the treadle releases the clutch and applies the brake. It will be evident from this description that the machine is under perfect control in any position of its stroke. There are several adjustments that give accuracy to the motion of the dial. For instance, the amount of rotation of the dial may be regulated by means of a roller at the top of the yoke, where set-screws are provided to obtain the exact adjustment that is required. The motion is also controlled by a brake which is automatically released at the time that the dial is locked. An eccentric adjustment provides for obtaining an accurate relation between the locking plunger and the successive notches in the dial. Although this press was primarily designed for continuous action, a press equipped with this dial feed attachment may be used intermittently, *i. e.*, it may be automatically stopped at the end of each stroke. When running continuously the production is twelve shells per minute.

VAN AUKEN DUPLEX HACKSAW

A departure from the usual practice in designing hacksaw machines has been made by the Clarence E. Van Auken Co., 216 N. Clinton St., Chicago, Ill., in its duplex high-speed hacksaw illustrated herewith. It will be evident that the machine is provided with two saw blades, and these move up and down together; one blade cuts on the down stroke and the other on the up stroke, making the operation continuous. The saws are fed alternately into the stock and released on the idle stroke.

Inside the frame of the machine there is a reservoir which is partially filled with cutting compound, and the saw frames are made of heavy seamless tubing. The frames are provided with ball check valves at their lower ends. As the saw frames work up and down, the cutting compound is forced up through the tubular frames and allowed to run down the blades, so that a copious flow is supplied at all times while the machine is in operation.

Fig. 1. The Van Auken Duplex Hacksaw Machine

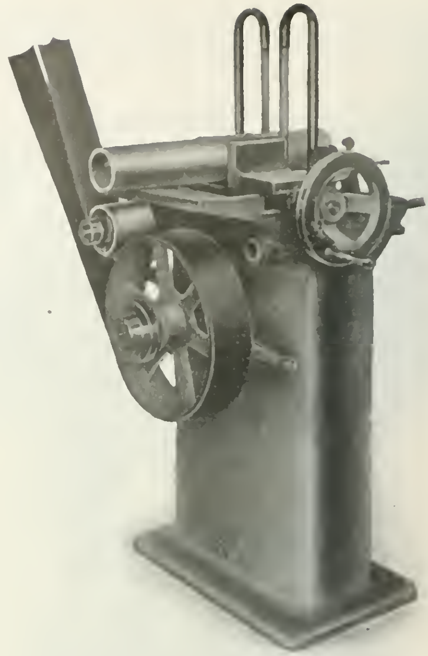


Fig. 2. Opposite Side of Van Auken Hacksaw shown in Fig. 1

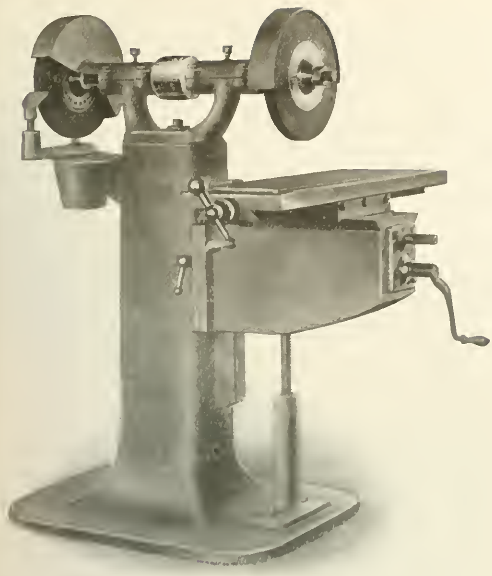
These saws can be operated at 270 strokes per minute, and it is claimed that they cut twice as fast as an ordinary hacksaw machine because there are two blades working simultaneously, and four times as fast as a machine on which no cutting compound is delivered to the work owing to the increased speed which is made possible by the manner in which the cutting compound is delivered to the saws.

The machine is driven through a positive clutch and is equipped with an automatic stop, adjustable feed and a stock gage. The screw which operates the vise jaws is threaded right- and left-hand so that both jaws move and hold the work in a central position. A top clamp is provided for holding short pieces, and the handle which operates the vise can be placed on either side of the machine. The saw frames are operated by the usual crank cross-head and guide, which are located in the reservoir inside the column of the machine so that they require no further provision for lubrication.

The machines are made in two sizes, known as Nos. 2 and 3. The No. 2 machine has a capacity for cutting work up to 4 by 4½ inches in size; the length of stroke is 6½ inches; the length of blades used, 12 inches; the floor space occupied, 10 by 16 inches; and the net weight of the machine, 145 pounds. The No. 3 machine has a capacity for cutting work up to 8 by 8 inches in size; the length of stroke is 7½ inches; and the length of saw blades used, 17 inches. These machines can be furnished with individual motor drive when so required.

LA SALLE PLAIN AND SURFACE GRINDER

The No. 3 plain and surface grinder recently developed by the La Salle Machine & Tool Co., La Salle, Ill., is intended for general shop and tool-room use and has been designed to meet the requirements of those users whose work calls for a larger and more rigid grinding machine than the tool of this type



Plain and Surface Grinder made by the La Salle Machine & Tool Co.

formerly manufactured by this company, which was illustrated and described in the February, 1912, number of MACHINERY. The spindle is made of steel and runs in babbitted bearings which are reamed in such a way that perfect alignment is assured. The vertical feed-screw is provided with a graduated dial which reads in thousandths of an inch, and smaller sub-divisions can be readily estimated when such a degree of accuracy is required. The transverse and longitudinal movements are obtained by a screw feed driven by liberally proportioned cranks which provide a smooth uniform motion. All bearing surfaces are carefully protected from dust and dirt, and the ways are hand-scraped to furnish a perfect bearing. The regular equipment of the machine includes two 12 by 1 by 1 inch grinding wheels, a countershaft, wheel guards, tool rest and a water pot.

The principal dimensions of the machines are as follows: Distance between grinding wheels, 25 inches; working surface of table, 10 by 28 inches; maximum longitudinal movement, 25 inches; maximum transverse movement, 8 inches; maximum vertical travel, 10 inches; spindle speed, 1400 R. P. M.; height to center of spindle, 42 inches; floor space occupied, 63 by 46 inches; and weight of machine with countershaft, 780 pounds.

OLIVER SAWING, FILING AND LAPPING MACHINE

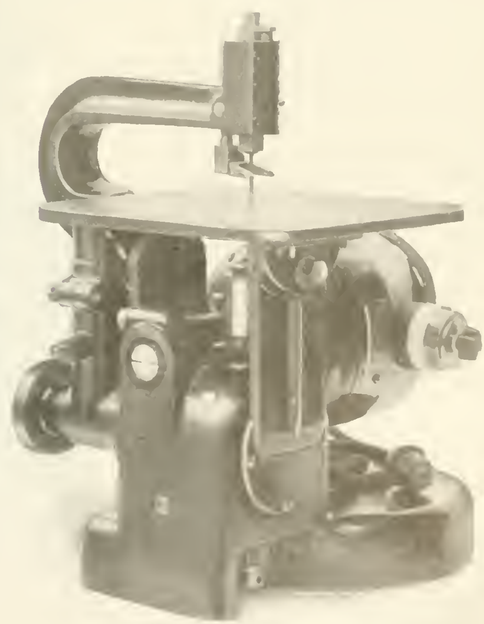
For use in shops engaged in the making of dies or instruments, or for shops where experimental work is being done, the Oliver Instrument Co., Detroit, Mich., has developed the sawing, filing and lapping machine which is illustrated and described herewith. It is particularly adapted for following irregular outlines; for instance, in making a blanking die the stock is removed by sawing out the material close to the outline, leaving an opening with the proper clearance and with a minimum amount of metal to be removed by filing. It will be evident from the illustration that the desired clearance is obtained by setting the table to the proper angle. An over-arm supports the saw or file at the upper end to prevent it from being deflected from the work.

Another typical application of the machine is in sawing out plain or irregular shapes from sheet metal or flat stock, and after the sawing operation has been completed such parts may be finished to exactly the required outline by filing. The correction of an inaccuracy in a hardened die or similar part may be mentioned as a typical example of the application of the machine for the performance of lapping or stoning operations. For this purpose, either a lap or a special oil-stone may be employed, which is so supported that the maintenance of the proper clearance angle and straightness of the work is assured.

The saw, file or lap used on the machine is clamped in a special collet carried by the lower ram, and the upper end is held and guided by a similar collet mounted in a slide that reciprocates in the over-arm. The over-arm does not reciprocate, and a coil spring acts on the slide to provide an initial tension on the saw blade. The tool may be quickly released from the slide and the over-arm swung to one side to provide for removing or replacing work on which it is necessary to operate in a hole in the center of the work. Special reinforced oil-stones have been developed for use on this machine, which are held and guided in the same way as the saws and other tools. When used as a filing machine, the over-arm may be used as an upper guide for thin files or where extreme accuracy is required; or it may be swung aside or entirely removed when the machine is handling rough work.

Either a direct- or alternating-current motor may be provided for driving the machine, and it is direct-connected and entirely enclosed to exclude filings, dust and other foreign material. The power is transmitted through steel spiral gears, and the crankshaft is supported by a ball bearing which takes the thrust of the ram. The reciprocating parts are carefully balanced. The ram guides are made of cast iron and the upper guide is a separate unit, made of close grained cast iron, so that it may be replaced if necessary.

The table is 9 inches square and may be tilted to any angle up to 10 degrees in either direction from the horizontal position; it is clamped in any position by means of two bolts. The angle to which the table has been set is clearly indicated by a large scale and pointer which are shown in the illustration. A locating pin is provided, which facilitates bringing the over-arm into alignment with the lower ram, in which position it is securely clamped by a bolt. All gears, shafts, bearings and other parts of the drive are enclosed and run in oil; and the construction is such that dust, chips or other foreign matter cannot find their way into the mechanism. The equipment of the machine includes two upper and two lower collets, three oil-stones, a set of files, and a wrench for making all adjustments.



Sawing, Filing and Lapping Machine made by the Oliver Instrument Co.

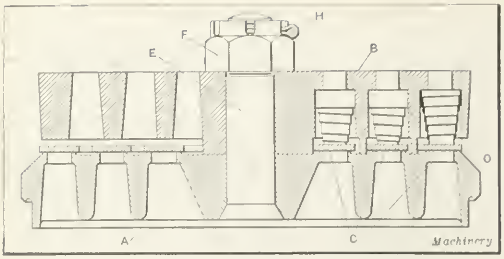


Fig. 1. "Simplate" Air Compressor Discharge Valve

"SIMPLATE" AIR COMPRESSOR VALVE

During the past decade a number of designs of flat plate compressor valves have been developed and subsequently discarded owing to their inefficiency or impracticability. These designs were all remarkably similar—varying only in minor details of construction—but the "Simplate" valve which has recently been brought out by the Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill., represents a departure from preceding efforts to produce a valve of this type. Its chief advantages are simplicity of construction, the fact that its plates are independent of each other in action, that each plate has its individual springs, that the tension of the springs on the inlet and discharge valves differs according to the density of the air handled, and that the valve is suitable for application in all positions and under all conditions of operation.

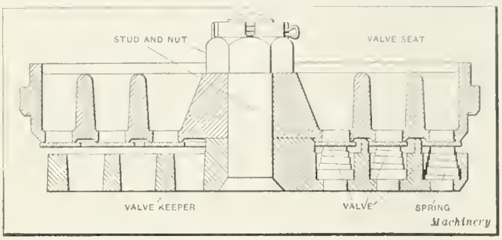


Fig. 2. "Simplate" Air Compressor Inlet Valve

Fig. 1 shows the discharge valve. The valve seat *A* is cast from a special alloy which possesses the properties of toughness and high tensile strength; it has circular ports as shown in this illustration. The valve seat is so machined that the raised portion, *i. e.*, the points on which the plates rest forming the joint, is very narrow so that the unbalanced area is reduced to a minimum. The keeper *B* is made of the same material and is provided with suitable ports for the free passage of air through it. The keeper also furnishes guides for the valve plates and pockets which carry the valve springs.

The valves *C* are simple concentric steel plates of uniform section, with a separate and independent plate over each port. Each plate is independently governed by its own spring so that the opening of each valve is entirely independent of the other. Should one of the plates open, the one next to it does not necessarily move; in fact, it will not move unless speed conditions demand it. This is the great advantage of having the plates independent of each other. The springs *D* are of the volute type and are made of special alloy steel, heat-treated and carefully tempered. They have the proper tension for the discharge and inlet valves, so as to effect the most perfect valve action. The parts making up a complete valve are assembled and held together by nickel steel stud *E* and castle nut *F*, and when this nut is securely tightened in place it is firmly held by cotter-pin *H*.

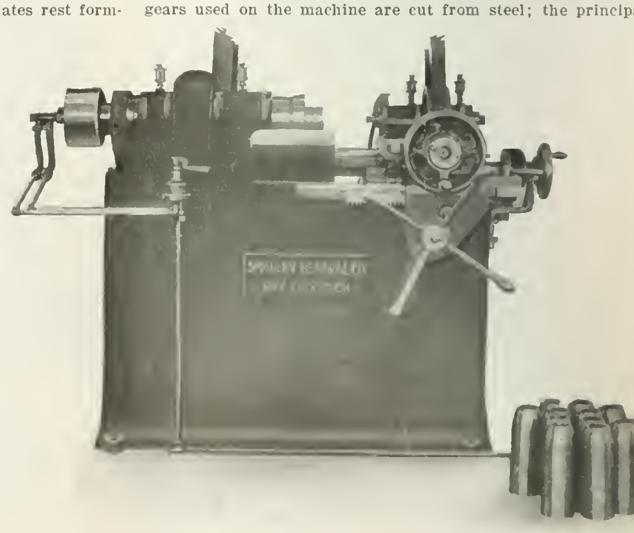
Fig. 2 shows the inlet valve, the construction of which is very similar to that of the discharge valve. It differs only in the following respects: The valve stud enters through the keeper instead of through the seat, as in the case of the discharge valve, and the keeper is of thinner construction, while the springs are also of lighter tension. On account of the difference in the thickness of these valves they cannot be reversed, *i. e.*, the inlet valve cannot be put in where the discharge valve should go, neither can the discharge valve be substituted for the inlet valve. The spring tension of the inlet valve is made very light in order to get the full benefit of the different plates when the piston speed is changed. For instance, with an inlet valve of the size shown the spring tension is so calibrated that the outer plate opens with a pressure of 1/4 ounce per square inch, and 1 ounce per square inch will open the intermediate plate, while it requires 2 1/2 ounces to open the inner plate. This illustrates the true meaning of the term "varied opening."

SMALLEY-GENERAL THREAD MILLING MACHINE

The thread milling machine which has recently been placed on the market by the Smalley-General Co., Bay City, Mich., is especially adapted for the performance of threading operations on shells. In working out the design particular attention has been paid to the development of a heavy accurate machine which is capable of standing up under the hard service conditions which are usually found in shops engaged in projectile manufacture. Although particularly developed for shell work, the machine is also adapted for threading operations on a variety of other classes of work.

The accompanying illustration shows one of the Smalley-General thread milling machines equipped for operation on 3.3-inch high-explosive shells. The shell to be threaded is held in an air-operated collet chuck, and this method of holding the work, together with the rapidity with which the machine operates, enables shells of this size to be threaded at an average rate of 1 minute and 10 seconds per shell. This rate of production applies to the average rate over a full working day. For threading larger sizes of shells a different type of chuck is used.

The head and bed of the machine are cast in a single piece which insures a rigid construction and maintenance of perfect alignment at all times; and the bed is cast with two longitudinal and two vertical cross-ties which add materially to its strength. All slides are liberally proportioned and the gears used on the machine are cut from steel; the principal



Smalley-General Thread Milling Machine for Use on Shell Work

gears run in oil and they are all guarded to provide for the safety of the operator. All bearings on the machine are bronze-bushed.

The oil supplied to the cutting tool is separated from the chips and passes through three settling tanks in the base of the machine before entering the rotary pump which carries it back to the work. Liberal sized sight-feed oil-cups are provided for lubricating all of the main bearings. The principal dimensions of the machine equipped for threading 8-inch and 9.2-inch high-explosive shells are as follows: Length of bed, 7 feet, 4 inches; width of bed, 29½ inches; width across ways, 28 inches; height from ways to center of spindle, 13½ inches; and size of main spindle bearings, 4 by 8⅜ inches. The operation of these machines is such that one man can easily attend to two machines; and as usual with thread milling machines, the thread is completed by a single revolution of the work.

"MECHANICS" UPRIGHT DRILLING MACHINE

In designing the upright drilling machine which forms the subject of this description, the aim of the Rockford Machine Tool Co., Rockford, Ill., has been to simplify the mechanism as far as possible and eliminate all parts that are likely to fail under severe service conditions. The illustrations show side views of the machine, from which a good idea of its design may be obtained. Power is supplied by a single clutch pulley 20 inches in diameter by 6 inches wide which is belted to the lineshaft; this pulley is located at the right-hand side of the machine and is shown in Fig. 1. A view of the machine from the opposite side is shown in Fig. 2, in which the cover has been removed from the change-gear box; this box is furnished with six change-gears and provides six spindle speeds ranging from 60 to 360 revolutions per minute. Fig. 3 shows a top view of the machine, together with a cross-sectional view through the feed works, and illustrates the manner in which the six available changes of feed are secured by means of six change-gears. These feeds range from 0.010 to 0.060 inch per revolution. All driving gears are of 4 pitch, and have a face width of 2½ inches. The feed gears are 6 pitch and have a face width of 1½ inch.

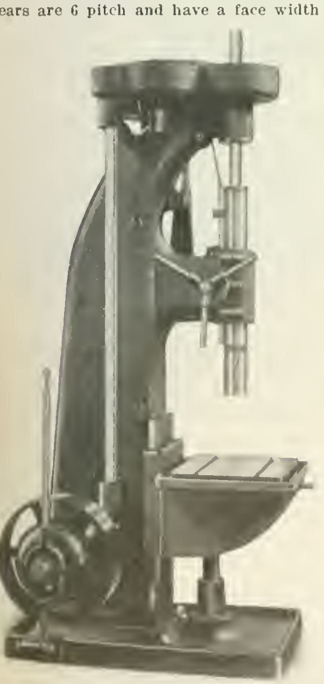


Fig. 1. Left-hand Side of Machine showing Single Pulley Drive

Fig. 2. Right-hand Side of Machine showing Change-gear Box with Cover removed

The principal dimensions of the machine are as follows: Distance from face of column to center of spindle, 12 inches; maximum distance from spindle to table, 28 inches; length of power feed, 14 inches; diameter of spindle in sleeve 2⅜ inches; diameter of spindle above sleeve, 2¼ inches; diameter of sleeve, 4 inches; diameter of base of spindle, 3⅞ inches; diameter of vertical driving shaft, 2¼ inches; working surface of table, 18 by 24 inches; width of steel rack on spindle sleeve, 1¾ inch; size of spindle driving gear, 12 inches in diameter by 2½ inches face width and 4 pitch; vertical adjustment of table, 16 inches; available feeds, 0.010, 0.015, 0.020, 0.030, 0.040, and 0.060 inch per revolution, available spindle speeds, 60, 120, 180, 240, 300 and 360 revolutions per minute; size of driving pulley, 20 inches in diameter by 6 inches face width; speed of driving pulley, 400 revolutions per minute; and approximate weight of machine, 3600 pounds.

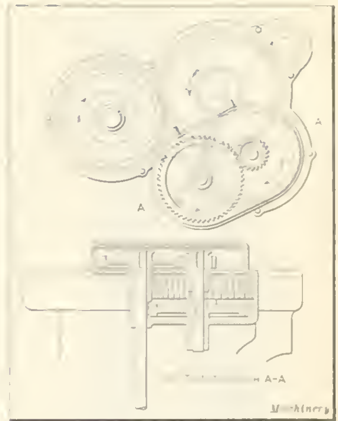


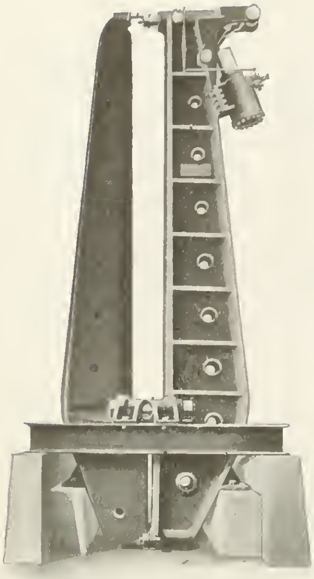
Fig. 3. Top View of Machine and Cross-section through Feed-box

VULCAN PNEUMATIC RIVETER

The pneumatic riveter illustrated and described herewith, has recently been placed on the market by the Hanna Engineering Works, and the Vulcan Engineering Sales Co., 2063 Elston Ave., Chicago, Ill., has the sales agency for the machine. The claim is made for this machine that it is the largest pneumatic riveter ever constructed; it has a reach of 21 feet and is capable of exerting a pressure of 100 tons on the rivet die when operated with air at a pressure of 100 pounds per square inch. An idea of the size of the machine will be appreciated from the fact that its weight is 40 tons.

In designing this machine, toggles, levers and guide links have been combined in a simple form to give a large opening of the toggle joint movement with gradually increasing pressure until the desired pressure has been obtained. After attaining the required pressure, there is a simple lever movement through a considerable space under approximately the maximum pressure. This space is sufficient to assure pressure being applied to the rivet, and after the machine has once been adjusted for a certain length of rivet and thickness of plate, it will require no further adjustment for ordinary variation in the length of the rivets, the size of the holes or the thickness of the plates. It is claimed that the results obtained with this pneumatic riveter are the equivalent of those produced with hydraulic machines.

The machine is adapted for the performance of riveting operations on boiler, tanks, and structural work. It is furnished with a cylinder in which the piston has a stroke of 22 inches to accomplish a travel of 5¾ inches of the riveting die. As in the smaller machines of this type, the toggle action is in operation during the first half of the piston travel, i. e., during the first

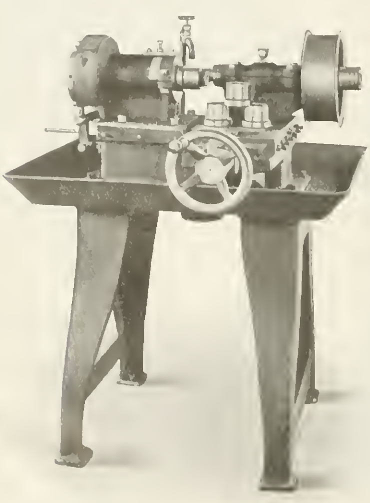


Large Pneumatic Riveter made by the Hanna Engineering Works

movement of 11 inches, which corresponds to approximately the first 4¾ inches of die travel. At this point the operation of the mechanism automatically changes to a simple lever action which holds the rated pressure capacity of the machine at the riveting die, which is practically uniform for the last 1 inch of die travel. By the use of a pressure regulating valve in the supply line which delivers air to the riveter, the pressure of the air at the cylinder may be quickly changed to vary the pressure developed by the riveting die, to produce any pressure which it may be deemed advisable to use on the work which is being handled.

HOLDEN-MORGAN SOCKET THREAD MILLER

The Holden-Morgan Co., Toronto, Canada, has recently added to its line a thread milling machine which is especially adapted for milling the outside thread on the fuse sockets of all types of high-explosive shells up to the 6-inch size. The socket to be threaded is placed on a special chucking device and the threading operation is then completed without requiring any further handling of the work. This machine produces a clean, accurate thread, and the operation is completed in from 1½ to 2 minutes, according to the size and type of shell for which the socket is intended. The machine is provided with stops so that it may be readily set for operation on any class of work; and the method of operation is so simple that unskilled labor may be utilized with satisfactory results. No countershaft is necessary as the machine may be belted direct to the lineshaft. It is customary to set the machines up in tandem, and a battery of machines may be tended by a single operator. The features are simplicity of design, rigidity of construction, and efficiency of operation when handled by unskilled labor. The A. R. Williams Machinery Co., Ltd., 64-66 Front St., W., Toronto, Ontario, Canada, has the selling agency for this machine.

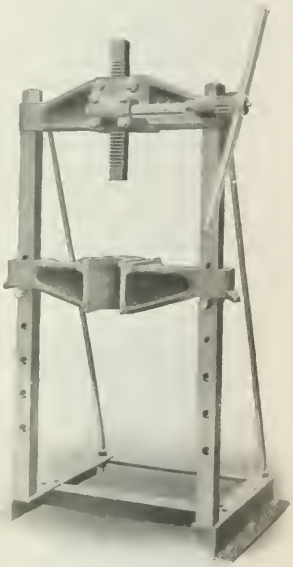


Holden-Morgan Socket Thread Miller sold by the A. R. Williams Machinery Co.

UNITED "LONG RANGE" ARBOR PRESS

The United Engine & Mfg. Co., Hanover, Pa., has developed what is styled a "long range" arbor press to meet the demand for a press with ample capacity for handling the great variety of work which comes to garages, general repair shops and machine shops in which arbor presses are used. The two most noteworthy features of this machine are as follows: First, one man can raise or lower the table to any desired position in less than a minute, which is a valuable feature on a machine adapted for work in which the size varies considerably; second, the sliding V-block on the table instantly adjusts itself to suit all different sizes of arbors and also gives ample support to the hub or bushing no matter how thin it may be.

The rack and pinion method is employed for operating the ram, which experience has shown to give very satisfactory results due to the efficiency, durability and speed of operation of this type of mechanism. The suitability of the term "long range" arbor press for this machine will be appreciated when it is known that the capacity is for work ranging from pieces of large diameter down to arbors or shafts of considerable length. The construction has been worked out in such a way that the press is quite rigid and strong enough to stand up under all classes of work for which it is adapted. It is a self-contained unit which is bolted to the floor and requires no further support.



"Long Range" Arbor Press made by the United Engine & Mfg. Co.

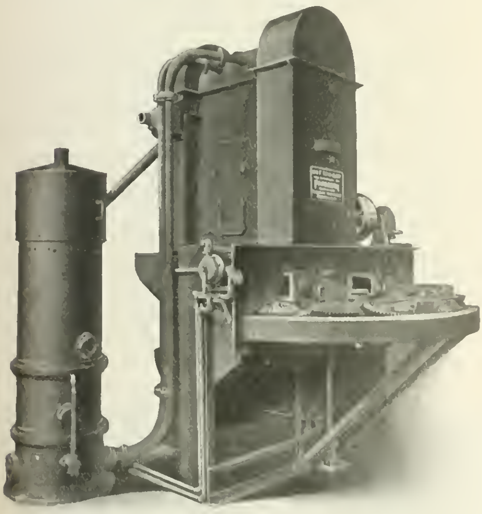
The principal dimensions are as follows: Height of center of operating lever from floor, 48 inches; capacity between standards, 21 inches; maximum capacity under ram, 40 inches; width of opening in table, 3¾ inches; travel of ram, 12 inches; floor space occupied, 24 by 22 inches; ratio of leverage, 100 to 1; pressure capacity, 10 tons; and weight of machine, 375 pounds.

PANGBORN ROTARY SANDBLAST MACHINE

The rotary table sandblasting machine which has recently been developed by the Pangborn Corporation, Hagerstown, Md., is primarily intended for cleaning medium and small sized castings which cannot be satisfactorily handled in the

barrel type of sandblast; and the machine also finds application in certain cases where it is not desirable to employ the hose type of sandblast. In using this machine, the castings are laid on the table which rotates in order to carry them under the blast, and with this method of handling there is practically no possibility of breaking the castings. The blasting compartment is located at the back of the machine and shielded by a series of rubber curtains which effectually prevent any sand or dust from escaping. The sand is delivered by rotating nozzles which are set at a slight angle and pass over the entire surface of the table. After striking the work, the sand falls through the grate bars of the table to a "boot" from which an elevator returns it to the sandblast. The refuse is thoroughly separated from the sand each time it is used, and the continuous operation of the elevator also provides for continuous operation of the machine.

All moving parts of the machine are enclosed to protect them from damage and to provide for the safety of the operator. The machine is designed along heavy lines and particular care has been taken in selecting the materials from which all parts are made, so that the required strength and durability are provided. The levers which control the machine are centrally located within easy reach of the operating position. It will of course be evident that in using this machine the operator merely loads the castings onto the rotating table which carries them under the blast, and removes the clean castings as the table carries them back past the operating position. In most cases the castings remain on the table while it makes two complete revolutions, and are turned



Pangborn Rotary Table Sandblast

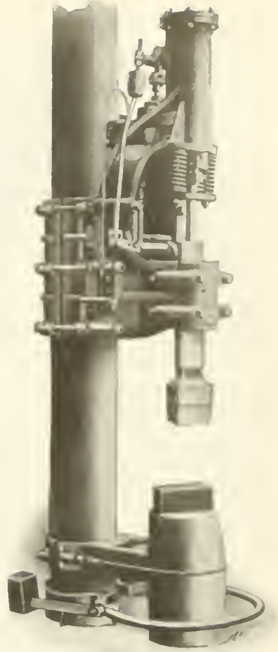
over after the first revolution is completed in order to be cleaned on the opposite side. It takes about five minutes for the table to make one complete revolution. The machine is built in two sizes with tables 90 and 70 inches in diameter; the larger machine is provided with two nozzles and the smaller has but one nozzle.

VULCAN POST HAMMER

The extremely high price of tool steel at the present time has led to the introduction of numerous economies in the use of this material. A case in point is found in the practice which has arisen in many shops of drawing down short pieces of tool steel, which were formerly scrapped, so that they can be used for small lathe tools and for cutters used in toolholders. The Vulcan Engineering Sales Co., 2063 Elston Ave., Chicago, Ill., has recently placed on the market an improved type of post hammer which is particularly adapted for doing this work in addition to the performance of general light forging operations. This machine is manufactured by the Q. M. S. Co. of Chicago.

An important feature of this hammer is that it is of compact construction and so designed that the blacksmith can easily control it without requiring the assistance of a helper. The machine can be operated by either steam or compressed air to suit the requirements of the user.

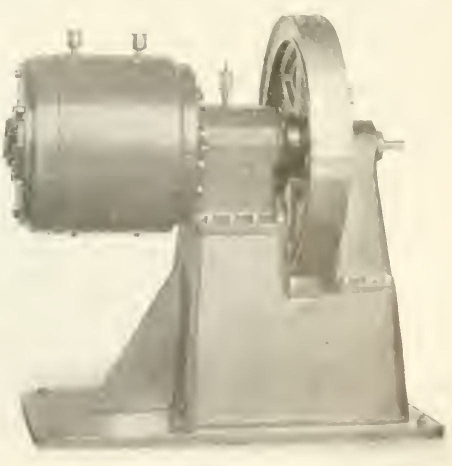
A patented valve movement on the hammer insures perfect control; if the treadle is brought down to the limit of its motion the ram will give a hard full blow, while if the treadle is only depressed part way the ram will deliver a succession of hard or light blows according to the position of the treadle. The change from one weight of blow to another may be made very rapidly.



Vulcan Post Hammer which can be operated without the Assistance of a Helper

ETNA COLD SWAGING MACHINE

The Etna Machine Co., Toledo, Ohio, is now building a line of heavy-duty swaging machines which are noteworthy on account of their exceptionally long die capacity. The range of operations for which the machines are adapted covers a wide field and allows for handling a great variety of parts from solid or tubular stock. Dies up to 18 inches in length are used on the machine. An idea of the productive capacity may be gathered from the fact that bicycle forks are produced in one operation at the rate of 300 or more per hour. Stock up to 4 inches in diameter can be swaged on this machine, and as the shaft is hollow, tubes of any length can be passed through the machine. Owing to the way in which the design of the shaft and die housing has been worked out,



Etna Cold Swaging Machine for Stock up to 4 inches in Diameter

a bright smooth finish is produced on the work.

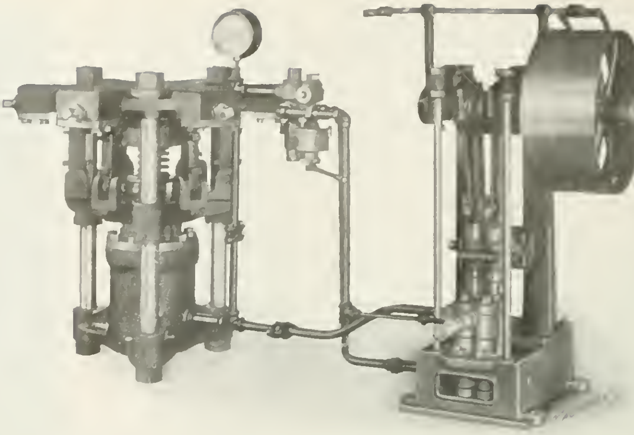
The machine shown in the accompanying illustration is used for tapering tubes 18 inches in length by 1¼ inch in diameter. The principal working parts are contained in the drum which is bolted to the housing. This drum is lined with alloy steel rings 1¼ inch in thickness by 10⅞ inches inside diameter, and inside these rings there is a cage containing ten hardened steel rolls which revolve and roll over the die-blocks. These die-blocks, in their turn, cause the dies to hammer the work. All working parts inside the drum are made of carefully selected materials which provide ample strength without danger of breakage. The shaft and housing for the dies is made in one piece from a special steel forging, and the shaft is lined with high-grade phosphor-bronze bearings. The flywheel is 36 inches in diameter by 5½ inches face width and is of ample weight to give the required power and stability to the machine. Oil-cups deliver lubricant to all working parts, and these cups are located in plain sight and within easy reach of the operator. The oiling facilities are made as simple as possible.

The following are the principal dimensions of the machine: size of flywheel, 36 inches in diameter by 5½ inches face width; size of bronze bearings, 4½ by 7 inches; outside diameter of die housing, 7 inches; size of rolls, 1 15/16 inch by 18 inches; number of rolls, 10; size of drum, 24 inches in diameter by 20 inches long; size of swaging die, 2⅝ by 1½ by 18 inches; speed at which machine is operated, 300 R. P. M.; floor space occupied by machine, 37 by 54 inches; and net weight of machine, 5500 pounds.

METALWOOD BANDING PRESS

A hydraulic press for compressing the copper bands onto shells from 3 to 6 inches in diameter is one of the recent products of the Metalwood Mfg. Co., Detroit, Mich. It will be seen that the hydraulic cylinder is located at the base of the press. The pressure is transmitted through a toggle mechanism, and means of adjustment are provided for regulating the amount of pressure and the length of stroke. The compression of the copper band is effected by six concentric dies which converge upon the common center and form a complete circle when closed, which is of the required diameter of the band.

The press is driven by a Metalwood vertical duplex pump, or it may be driven from an accumulator; the capacity is 20 strokes per minute. All bearings in the pump are lined with phosphor-bronze, and both the press and pump are controlled by a Metalwood single-lever valve which governs the pressure applied and the return of the dies to the starting position. It will be seen that all working parts are fully enclosed, but the dies are readily accessible so that they may be quickly changed for working on various sizes of shells. The toggle mechanism through which the pressure is applied, is arranged with adjustment so that the pressure applied to the dies can be regulated to suit the pressure applied in the hydraulic cylinder. The complete weight of the machine is 3390 pounds.



Metalwood Hydraulic Shell Banding Press for Shells from 3 to 6 inches in Diameter

NEWTON HORIZONTAL MILLING MACHINE

The 50-inch horizontal milling machine, illustrated and described herewith was originally designed and built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., for use in milling the heaviest types of locomotive side and connecting-rods, but the unusual features of design which were called for by the company for which the machine was built have made it possible to apply machines of this type for the purpose of cutting off shrapnel blanks at a very satisfactory rate of production. The most daring departure from accepted design insisted upon by the purchaser consisted in the elimination of the cross-rail to give a clear view of the work being machined, and when this manufacturer subsequently started equipping his plant for the manufacture of shells, it was discovered that these special milling machines could be provided with circular saws and used to excellent advantage for cutting off the shell blanks because the elimination of the cross-rail had left ample clearance for the saws.

The machines are driven by a 50-horsepower motor, the width between the uprights is 50 inches, and the width of the work-table over the finished surface is 42 inches. The method of handling the work is as follows: Bars 50 inches in length are cut off from sixteen bars of steel which are stacked from three to five high for this operation on the cold saw. The 50-inch lengths are then transferred to the milling machine to be cut up into eight short forging lengths by eight inserted-tooth saw blades mounted on an arbor. The rapidity with which this cutting can be done is such that the labor cost is only twenty-five cents per hundred for the short lengths, which includes the cost of

Newton 50-inch Horizontal Milling Machine that can be used as a Cold Saw

the preliminary operation of cutting the steel bars up into 50-inch lengths ready to be handled on the milling machines.

The spindle is arranged to drive a 4-inch arbor by means of a broad-faced key, the spindle being bored No. 7 Morse taper and provided with a through retaining bolt to hold the arbor in place, thus relieving the outboard bearing of all strain. The spindle is driven by a sleeve worm-wheel 35½ inches in diameter, the power being transmitted by a double set of keys. The teeth of the worm-wheel are of steep lead, and these teeth are cut in a bronze rim which surrounds the wheel; the driving worm is of hardened steel and provided with roller thrust bearings. These bearings are carried by the spindle saddle and in this way all strains are supported by the saddle and there is no tendency to transmit vibration to the saw. The spindle drive is carried through bevel and spur gears.

The feed is taken from a vertical shaft which transmits the motion through to the operating side of the machine where a gear-box provides three changes of feed of 0.100, 0.150, and 0.200 inch per revolution of the spindle. Reversible fast power traverse is also provided, by means of a friction clutch which controls the gearing employed for this purpose. One lever engages the clutch which governs the fast power traverse of the table, and the direction in which this lever is moved indicates the direction in which the table will travel. Another lever controls the clutch for the feed mechanism which is provided with an automatic trip. A handwheel provides hand movement of the table and another wheel governs the adjustment of the spindle saddle and outboard bearing which can also be raised or lowered by means of an independent three-horsepower motor.

The saddle is counterweighted and has square lock gibbed bearings on the upright, which can be adjusted by means of tapered shoes. These shoes are so arranged that it is an easy matter to detach the saddle should the necessity arise for so doing. The elevating screws for both the saddle and outboard bearing have a top and bottom bearing to maintain them in alignment at all times. The work-table is of heavy construction and is driven by a spiral rack and pinion. Three changes of feed are available for each spindle speed, as previously noted. The work-table and bed are both connected to the lubricating system and the drip pan is cast integral with the bed. The machine occupies a floor space of 21 by 15 feet and weighs 38,000 pounds.

Wickes Bros. 24-inch Engine Lathe built with Various Lengths of Beds up to 14 feet, 8 inches

WICKES ENGINE LATHE

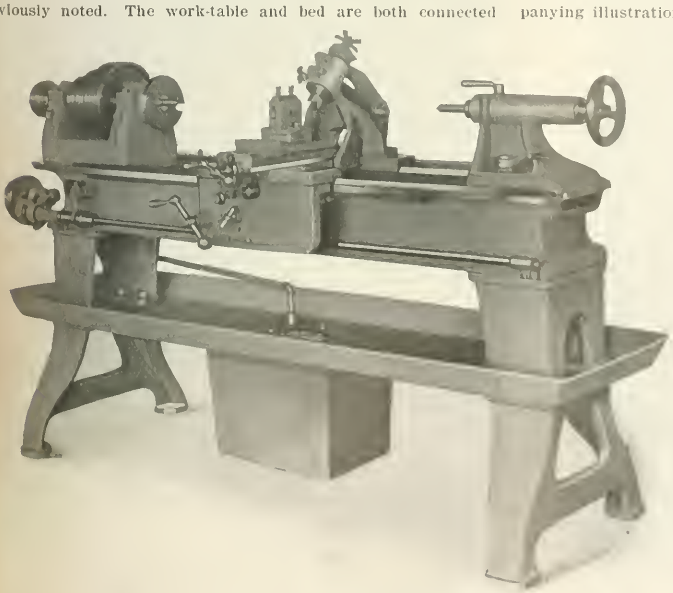
The engine lathe which forms the subject of the following description is a recent product of Wickes Bros., Saginaw, Mich., and is at present being made in a nominal 24-inch size. The lathe is of the double back-geared type and has a double plate apron; the spindle is hollow to provide for handling bar stock, the hole through the spindle being 2 3/16 inches in diameter. It will be seen that the lathe is equipped with a compound rest and change-gears for screw cutting. The regular equipment includes a large and small faceplate, steady-rest, countershaft, and the necessary wrenches. All gears are carefully enclosed to provide for the safety of the operator.

The principal dimensions of the machine are as follows: Actual swing, 26½ inches; width of driving belt, 4½ inches; range of threads which can be cut, from 1 to 18 per inch including 11½ threads per inch; approximate weight of machine 7700 pounds. Machines of this size are built with various lengths of beds up to 14 feet, 8 inches in length.

BAUSH RIFLE-BARREL TURNING MACHINE

The barrels of military rifles are forged to approximately the required shape and are finished on the outside by different types of machines employed for the purpose. The accompanying illustration shows a special rifle-barrel turning lathe which is a recent product of the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. Reference to the accompanying illustration will make it evident that the turning tool is carried in a substantial tool-block on the cross-slide, and that the pressure of the cut is supported by means of a back-rest. The object of the machine is to simplify the work of obtaining the required form for the rifle barrel as far as possible, and this result is obtained by having a master plate at the back of the machine which governs the form of the work.

The transverse movement of the cross-slide is governed by means of a roller which contacts with the master plate. It will be evident that in order for the back-rest to serve its purpose the position of this rest must be adjusted to correspond to the point of action of the turning tool. This result is obtained by having the back-rest supported on a pivoted bracket, the lower end of which carries a roller which also engages with the master plate. With this arrangement, the cross-slide is given the required movement to enable the turning tool to bring the barrel



Rifle-barrel Turning Lathe made by the Baush Machine Tool Co.

to the required form, and the back-rest moves in unison with the tool, so that adequate support for the work is provided at all times. There is a stop which engages the carriage at the required point and stops both the feed and rotation of the spindle.

BAUSH INVERTED STATION TYPE DRILLING MACHINE

The station type of drilling machine which is illustrated and described herewith has been designed and built by the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., for use in drilling the bolts and receivers of military rifles. At first sight this machine may appear similar to the multiple-spindle drilling machine of this company's manufacture, described in the November, 1914, number of MACHINERY, which was built for use in drilling the flywheels of Ford motor cars. As a matter of fact, there is a considerable difference in the design; on the earlier type of machine the drills were carried in multiple heads supported by the turret, and the work was mounted on a table supported by the base of the machine, while in the present case it will be seen that the work is supported in fixtures mounted on the turret, while the tools are carried on the base of the machine. In both cases the drive is from above, but in the case of the present machine the work revolves and the tools remain stationary; it also will be noticed that this machine takes advantage of the inverted drilling principle which is beneficial in clearing the chips from the work.

It has been mentioned that the work is mounted in fixtures supported by spindles carried in the turret, and that the work is rotated. The feeding of the drills to the work is accomplished by raising the spider on which the drills are carried. The drills increase progressively in length, in order to obtain the required depth of hole; and it will, of course, be evident that for each indexing of the work one finished part is produced. The use of various lengths of drills in this way serves the same purpose as backing out the drill at the required intervals, which is the practice in deep-hole drilling where a single drill is employed. On this machine the drills are of the oil-tube type which provides for delivering the oil direct to the point of the drill. It will be seen that the drive is provided by an electric motor carried at the top of the machine, and power is transmitted to the spindles which carry the work-holding fixture by means of a central gear which meshes with pinions carried on each of the spindles.

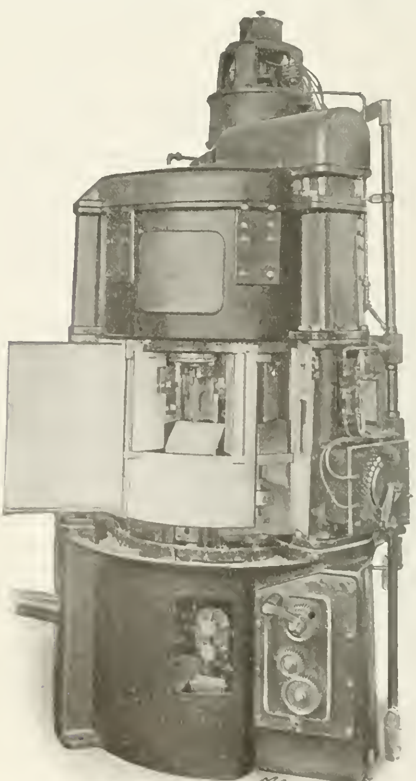


Fig. 1. Loading Station and Electrical Control on Baush Drilling Machine

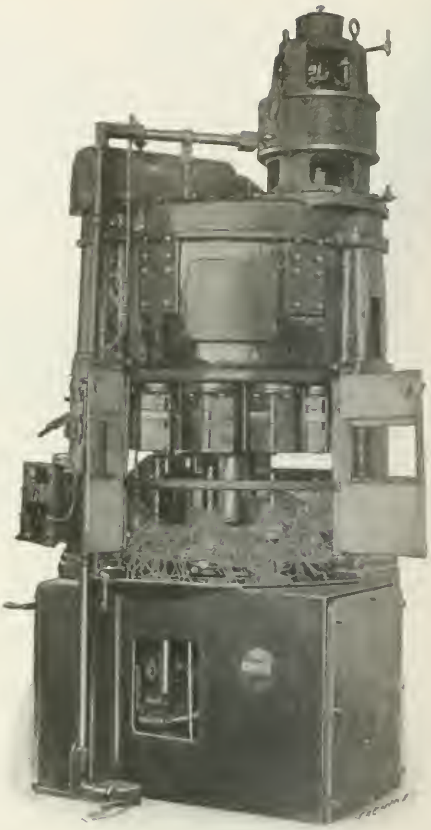


Fig. 2. View of Drills and Work-holding Fixtures

In the base of the machine there is a barrel cam which provides for raising or lowering the spider which carries the drills, in order to feed the tools to or withdraw them from the work. The indexing is accomplished by rotating the turret which carries the work-spindles, and the release of the locking bolt which secures this turret in place during the performance of each drilling operation is accomplished by means of an edge cam carried at the bottom of the feed cam. This edge cam actuates a bellcrank which extends up to the top of the machine and makes connection with the locking bolt. There is one idle position on the machine, *i. e.*, a work-holding fixture under which there is no spindle. This is the loading position at which the finished product is removed and fresh blanks set up in the machine. A pull switch and a controller are located within reach of this position so that the operator has the machine under control at all times. It will be seen that doors are provided to give access to each station on the machine, and these doors are fitted with mica windows to enable a view to be obtained of the work in each position without exposing the observer to oil which would be thrown from the machine if means were not provided to guard against this trouble.

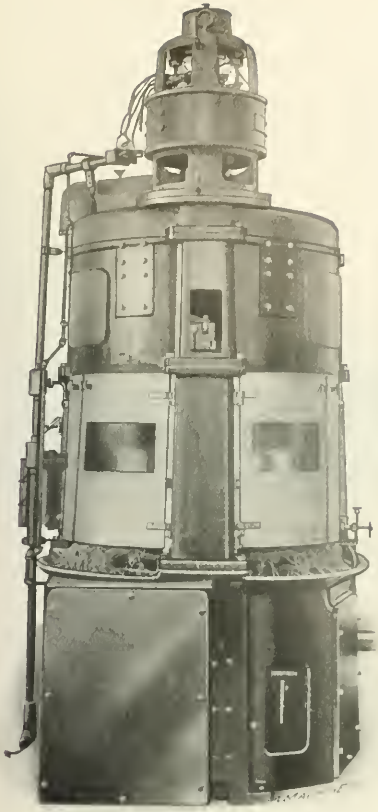


Fig. 3. Side View of Machine; note Lever that withdraws Locking Bolt

BAUSH STATION TYPE TAPPING MACHINE

The station type tapping machine which is shown in the accompanying illustration has recently been developed by the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., for use in tapping the receivers and bolts of military rifles. To adapt the machine for tapping either of these classes of work, it is merely necessary to substitute the proper work-holding fixtures on the turret and the proper style of taps in the machine. It will be seen that the machine is arranged with single-pulley drive, and the size of the pulley is proportioned to give a suitable tapping speed for the work that is to be done. There are six faces on the turret, each of which is equipped with a suitable work-holding fixture, and the machine is provided with five tapping spindles. This leaves one blank position, which is shown at the front of the machine, for the purpose of removing the finished product and replacing a fresh blank. The taps work progressively to tap the holes to the required depth.

The turret is indexed by hand, the long lever at the top of the machine being provided for this purpose. When it is required to index the turret, this lever is moved to the right, which withdraws the locking bolt and allows the turret to drop onto a ball bearing track over which it is suspended. The same lever is then moved in the opposite direction to advance the work to the next station, and when this has been accomplished the locking bolt springs up to secure the turret against further rotation in either direction. A slight additional movement of the indexing lever results in lifting the turret off the roller bearing track so that its upper face comes into contact with the finished face of an aligning block, which locates the work ready for the next operation. The five spindles on the machine carry pinions which mesh with a common central gear through which they are all driven. This central gear is carried by a stem, at the lower end of which there are a pair of bevel pinions that mesh with the teeth on opposite sides of a bevel gear carried by the driving shaft. A clutch is located between the two bevel pinions so that either pinion may be engaged to secure the forward or reverse motions for the tapping spindles.

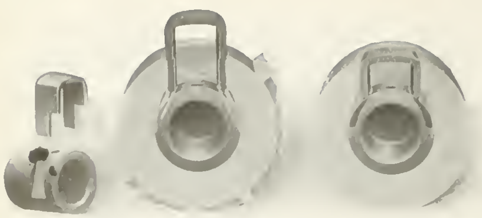
The rate at which the taps are fed to or withdrawn from the work is governed by independent lead-screws of the proper pitch, and it will be seen from the illustration that individual oil-tubes are provided to deliver cutting lubricant to the taps. The operation of the reversing clutch is automatic, and the starting or stopping of the machine is governed by the left-hand lever located just below the table. The right-hand lever provides for stopping all motions on the machine. Although this machine was particularly designed to meet the requirements of tapping rifle receivers and bolts, it will be evident that a machine of this type could be used to advantage in machining various other products. For this purpose it would simply be necessary to provide suitable work-holding fixtures.

"SIMPLEX" HARDENED STEEL BEARING LINERS AND KEYS

Templeton, Kenly & Co., Ltd., 1020 South Central Ave., Chicago, Ill., are now manufacturing a line of hardened steel bearing liners and keys which are adapted for use on practically all classes of high- and low-speed machinery. The important features of these bearing liners are the ease with which they may be applied and the positive locking device which precludes the possibility of rotary or lateral movement. The bushings are formed from a solid steel bar to produce a shell of accurate dimensions and finish. It will be seen that two keyways are milled on the outside of the shell, the keyways forming an acute angle with the diameter. The two keyways occupy similar positions relative to the diameter. The bushings are heat-treated and hardened to assure obtaining the maximum durability.

The key which holds the bearing liner in place is stamped from plate steel and formed to shape. The head of this key

Station Type of Tapping Machine built by the Baush Machine Tool Co.

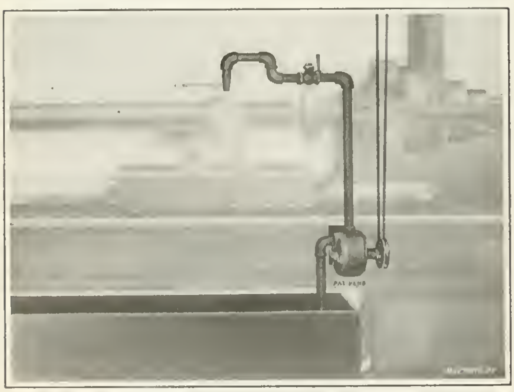


Bushing and Key, Method of assembling, and Assembled Bearing

fits snugly into the opening in the boss which carries the bearing and the two small lugs fit into the milled slots in the liner, which have been previously referred to. In this way the liner is held securely in place. In assembling this bearing the method of procedure is as follows: The shaft is placed in position and the bearing liner is slipped over the shaft and brought into place in the boss. The key is then inserted so that the ends of the lugs rest in the slots in the bearing liner, after which the key is driven home. The lugs follow the angles of the slots and expand to provide a driving fit between the frame of the machine and the outside of the bearing liner. It will, of course, be obvious that an opening is cut in the frame of the machine to receive the key.

CINCINNATI LUBRICANT PUMP

In designing the "Fulflo" lubricant pump which is illustrated and described herewith, the Cincinnati Lubricant



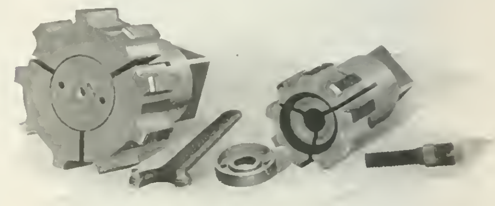
Application of Cincinnati Lubricant Pump on an Engine Lathe

Pump Co., Cincinnati, Ohio, has paid particular attention to the requirements of a pump for use on machine tools. This pump is of the centrifugal type and does not require priming, so that it is always ready to deliver a copious flow of lubricant to the tools as soon as the machine starts working. A feature of the pump is that it will pass any chips or grit which enter the intake pipe without danger of clogging or damaging the pump, and on this account it is unnecessary to use a fine strainer. The pump is mounted in a vertical position and can be placed anywhere on the machine. It will supply a volume up to 20 gallons per minute, which is sufficient to keep the tools and work cool under the most severe operating conditions.

"SOVEREIGN" ADJUSTABLE SHELL TAPS

The industry which has developed in this country in the manufacture of shrapnel and high-explosive shells for the belligerent European powers has developed some unusual conditions as regards the requirements of tools for performing the tapping operations. The tapping operations to be performed on shells are in the nose of the shell to receive the fuse and the fixing screw, and in the base of the shell to receive the gas check plug.

To meet the requirements of this work, Wood, Vallance & Co., Hamilton, Ontario, Canada, are now manufacturing a line of "Sovereign" adjustable taps, and the accompanying table



"Sovereign" Adjustable Shell Tap made by Wood, Vallance & Co.

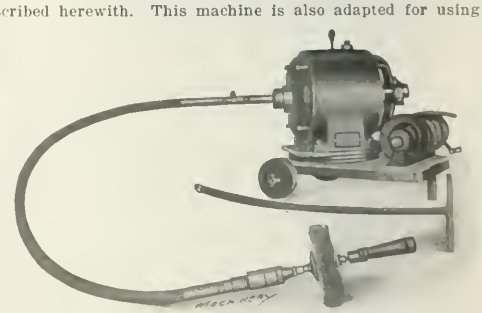
gives the sizes in which these taps are made, together with the specific operations for which each type of tap is adapted.

SIZE AND TYPE OF THREAD ON "SOVEREIGN" SHELL TAPS

Size of Tap: Diameter	Threads per Inch	Type of Thread	Tapping Operation performed in
2	14	Whitworth right hand	Nose of 18 Pr. high explosive shells Socket of 18 Pr. shrapnel Socket of 4.5 high explosive shells
2¼	14	Whitworth left hand	Base of 18 Pr. high explosive shells
2.492	14	Whitworth right hand	Nose of 18 Pr. shrapnel
2.497	14	Whitworth right hand	Nose of 18 Pr. shrapnel
2.5	14	Whitworth right hand	Nose of 4.5 high explosive shells
2½	14	Whitworth right hand	Nose of 60 Pr. high explosive shells
3.375	14	Whitworth left hand	Base of 4.5 high explosive shells
3½	14	Whitworth left hand	Base of 60 Pr. high explosive shells
0.250	20	Whitworth	Fixing screw hole in all shells

STOW PORTABLE GRINDER

In some shops it is found more convenient to take a grinding machine to the work than to attempt to follow the usual practice of taking the work to the machine, and to meet the requirements of manufacturers who have parts of this kind to grind, the Stow Mfg. Co., Binghamton, N. Y., has developed the portable grinding machine which is illustrated and described herewith. This machine is also adapted for using a



Stow Portable Grinding Machine equipped with a Wire Scratch Brush

buffing wheel or scratch brush, and is shown with a scratch brush set up ready for use. It will be seen that this outfit consists of an electric motor which drives the grinding wheel through a flexible connection, and the entire unit is mounted on a truck so that it may easily be moved from one position to another.

The motor is completely enclosed, and the starting equip-

ment is incorporated in the motor frame to provide a compact construction. Motors are provided for use on either direct or alternating current. In the direct-current equipment, variation of speed is secured by means of a plunger in the pole piece which operates to change the reluctance of the magnetic circuit. Speed variation provided in this way allows for using up emery wheels down to the minimum workable diameter and still maintaining a high cutting efficiency. The motor is designed to stand sudden overloads and is so balanced on the truck that it may be adjusted to the proper angle for all purposes.

KEUFFEL & ESSER LETTERING TEMPLETS

It is quite generally admitted that the quality of workmanship in lettering engineering drawings is below the average standard of work produced in the drafting-room. Many

Fig. 1. Example of Work done with Keuffel & Esser Lettering Templets. Part of the Templet is shown in the Upper Left-hand Corner

draftsmen realize their shortcomings in this respect and endeavor to correct the deficiency by taking particular care in lettering drawings, with the result that too much time is spent on this work. For the purpose of improving the quality of the lettering on drawings, and also to reduce the time and expense required for the performance of this work, the Keuffel & Esser Co., Hoboken, N. J., has developed a line of lettering templets which are made for various styles and sizes of letters. In addition to their application in drafting-rooms, these templets may be used to advantage in lettering signs, show cards, price tickets, and any other form of announcement on which neat lettering is required. The templets are made for different sizes of letters varying from 1/8 to 3/4 inch in height.

The templets consist of a strip of transparent xylonite with two rows of different sized holes uniformly spaced. When ink or liquid color is used for lettering, the templet is placed on a cardboard guide which raises it away from the surface of the drawing and prevents blotting. When a pencil is used, the templet is placed directly upon the drawing with its lower edge resting against the T-square, the use of the cardboard guide being unnecessary. The pen is guided along the edges of the templet holes, and lines that do not conform to the templet edges, such as the oblique lines of K, R, A, etc., may be drawn free-hand without disturbing the position of the templet. In such cases the start of the letters is made at the corners in order to establish the end points correctly; or if very careful lettering is required the end points of such letters can be marked as illustrated in Fig. 2, and subsequently joined by using a straightedge.

The first hole at the left-hand end of each templet is somewhat wider than each of the others, and is intended for draw-

Fig. 2. Method of Procedure in locating Diagonal Lines which are to be ruled in with a Triangle

ing such letters as M and W. To draw the vertical lines of the letters T and Y, and to insure correct spacing of the letter I, the templet is shifted the distance of the spacing bar to the right or left. The end points of the oblique lines in such letters as K, R, V, W, X and Y should be marked before the templet is moved in order to use the triangle or straightedge later on, or these lines may be immediately drawn free-hand. The horizontal center lines of letters A, E, F, G, and H are also filled in free-hand as the work proceeds, or later on with the assistance of the straightedge.

Two styles of pens can be used for lettering in connection with these templets, *i.e.*, the Keuffel & Esser glass pens or the Payzant pens. The glass pens are especially adapted for this work; both ends of the pen can be used, the larger end being intended for making the heavy lines and the smaller end for the light lines of the letters. The pen should be held in a vertical position and guided along the edge of the templet perforations like a pencil. The Payzant pen, although especially developed for use in free-hand lettering, is also well adapted for application in connection with the lettering templets.

BERGER STEEL LOCKERS

The campaigns in welfare work which have been conducted in leading manufacturing plants throughout the country have led to the installation of individual lockers for workmen to keep their street clothes in during working hours. Considerations of fire risk have made it advisable to install metal lockers for this purpose, and the accompanying illustrations show steel equipments of this kind made by the Berger Mfg. Co., Canton, Ohio. Fig. 1 shows what is known as the type No. 1011 locker with three lockers arranged in a unit, and Fig. 2 shows the type No. 1016 locker in two tiers with six

Fig. 1. Berger Type No. 1011 Steel Locker

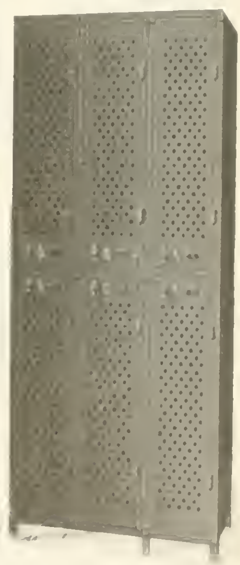


Fig. 2. Berger Type No. 1016 Steel Locker

lockers arranged in a unit. These lockers are also made in double- and single-tier types, respectively, and are typical of the line of steel lockers manufactured by this company. The single-tier lockers are made in two standard heights of 60 and 72 inches, and in various sizes ranging from 12 by 12 up to 24 by 24 inches. The double-tier lockers are made in two standard heights of 36 and 42 inches, and in sizes ranging from 12 by 12 up to 18 by 18 inches.

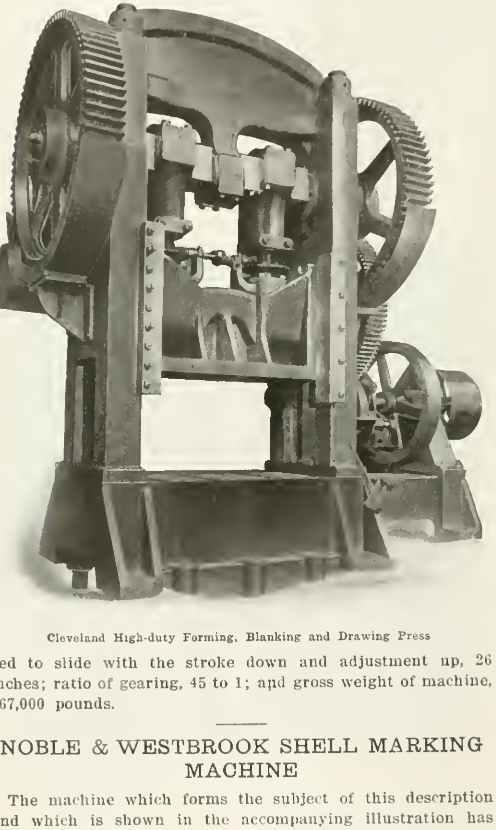
CLEVELAND HIGH-DUTY FORMING, BLANKING AND DRAWING PRESS

The high rates of production which are maintained in automobile factories have created a demand for stronger and heavier power presses for use in the making of the various parts. The machine which forms the subject of this descrip-

tion has recently been developed by the Cleveland Machine & Mfg. Co., 4944 Hamilton Ave., Cleveland, Ohio, for use in the manufacture of automobile frame cross-bars and for the performance of other heavy forming, blanking and drawing operations.

To enable it to stand up under the most severe conditions, the machine is designed with a large factor of safety so that danger of breakage is practically non-existent. A heavy spring drawing attachment (not shown) is mounted on the bed of the press and is used for operating knock-out pads and drawing or pressure rings. All of the gears on the machine are cut from steel, and the friction clutch is of the multiple disk type.

The principal dimensions of this machine are as follows: Size of bed, 48 by 72 inches; diameter of crankshaft in bearings, 10 inches; diameter of crankshaft on crank-pins, 11¼ inches; stroke of slide, 10 inches; maximum distance from



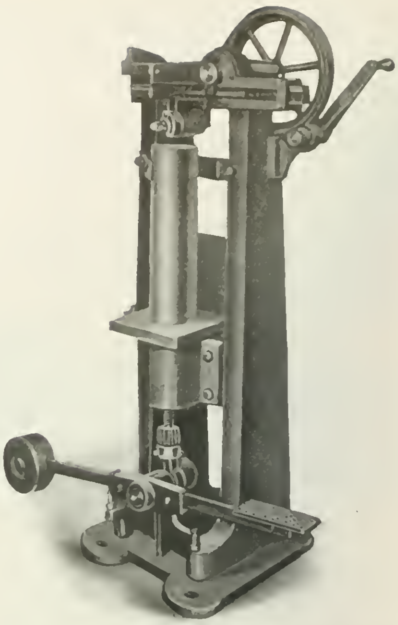
Cleveland High-duty Forming, Blanking and Drawing Press

bed to slide with the stroke down and adjustment up, 26 inches; ratio of gearing, 45 to 1; and gross weight of machine, 167,000 pounds.

NOBLE & WESTBROOK SHELL MARKING MACHINE

The machine which forms the subject of this description and which is shown in the accompanying illustration has been developed by the Noble & Westbrook Mfg. Co., Hartford, Conn., for use in marking the base of shrapnel and high-explosive shells up to 6 inches in diameter. The machines are made in two sizes known as Nos. 3-A and 3-B and have capacities for shells up to 12 inches in length and from 12 to 21½ inches in length, respectively. The design is similar to that of the Dwight Slate marking machines which have been manufactured by the Noble & Westbrook Mfg. Co. for a number of years.

In operation, the roll die passes over the base of the shell, and depressing the foot-lever raises the table to the proper position for any depth of marking. The No. 3-A machine is arranged with a hand-lever, and by one pull of this lever the die revolves and completes the marking operation. On the No. 3-B machine, a geared drive is provided in order to get the required pressure for marking large shells without requiring undue effort on the part of the operator. Using these machines, shells can be marked on the base practically as



Noble & Westbrook Machine for marking End of Shrapnel and High-explosive Shells

fast as they can be lifted to and from the machine, as the operation of marking only requires from five to ten seconds, according to the size of the shell.

NEW MACHINERY AND TOOLS NOTES

Shell Cutting-off Machines: Automatic Machine Co., Bridgeport, Conn. Machines adapted for use in cutting off the ends of shell forgings. These machines are built in two sizes, which have capacities for all shells up to 6 and 9 inches in diameter, respectively.

Boring and Turning Mill: H. Bickford & Co., Lakeport, N. H. A boring mill equipped with power rapid traverse for the tool spindles as well as for the saddles. The machine is of simple construction and easily operated. Machines of this type are built in 4, 5, 6 and 7 foot sizes.

Hydraulic Banding Press: Southwark Foundry & Machine Co., Philadelphia, Pa. A six-cylinder hydraulic machine for pressing the copper bands onto shrapnel and high-explosive shells. The machine is equipped with the usual form of hardened steel dies for compressing the band.

Boring and Tapping Tool: Murchey Machine & Tool Co., Detroit, Mich. A tool intended for machining automobile differential housings, but which is applicable for other classes of work. The tool is intended for the performance of boring and tapping operations and the work is clamped around it.

Heavy-duty Lathe and Turret Lathe: Oliver Machinery Co., Grand Rapids, Mich. A 16-inch quick-change lathe and a turret lathe. These machines are designed with ample power, and are rigidly constructed to enable them to stand up under the severe strains incident to operation in factories engaged in the manufactnre of shells.

Portable Electric Grinders: Standard Electric Tool Co., Cincinnati, Ohio. Two portable grinders, one of which is the so-called "aerial" type, in which the entire tool is suspended from overhead, while the other is a double wheel grinder of the pedestal type. These tools can be used for buffing operations as well as for grinding.

Combination Disk Wheel and Sander: Oliver Machinery Co., Grand Rapids, Mich. A machine intended for use in pattern shops, which is equipped with one spindle that carries a disk wheel and another spindle for a sander. These machines are built with 24- and 30-inch disk wheels, and with 2-, 3-, and 4-inch sanding drums.

Post Drilling Machine: Luther Grinder Mfg. Co., Milwaukee, Wis. A machine adapted for use on small, light or special work in pattern, repair and machine shops. The feed is easily regulated to suit the work which is being drilled. The tool is strongly made and adapted for hard service; it may be set up on any post or column in the shop.

Electric Soldering Machine: Detroit Electric Welder Co., Detroit, Mich. A machine for the performance of soldering operations, which works on the same principle as an electric welding machine, although the temperature obtained is not so high. The machine has a table to which a suitable holding fixture may be fastened for carrying the work.

Semi-automatic Turning Machines: Amalgamated Machinery Corporation, Chicago, Ill. A line of semi-automatic machines which includes turning, boring, drilling and inside finishing machines. These are designed for straight and form turning, boring, drilling, reaming, tapping, facing, and other operations on shrapnel and high-explosive shells.

Duplex Drilling Machine: Wilcor Mfg. Co., 4824 W. Lake St., Chicago, Ill. A machine in which the headstocks are mounted on the bed to provide a swing of 10 inches, and on which the headstocks are horizontally adjustable to provide the maximum gap of 30 inches. The spindles have a traverse in the heads of 3½ inches and are bored for Morse taper shank drills.

Shrapnel Box Machines: Greenlee Brothers & Co., Rockford, Ill. These machines are particularly adapted for use in boring the spacing boards used in boxes for holding shrapnel and high-explosive shells. Two machines are built for this purpose, which are of the multiple-spindle type, so that all of the holes in a spacing board may be drilled at one time.

Cutting Machine for Sheet Metal: W. J. Savage Co., Knoxville, Tenn. A machine provided with a vertically reciprocating tool, which is similar in its action to a slotting machine. The sheet metal to be cut is automatically fed to the tool by a pair of rollers. Straight or irregular shapes are readily cut at a speed of 20 to 42 inches per minute, and the capacity of the machine is for metal up to 3/16 inch in thickness.

Radial Drill: Almond Mfg. Co., Cleveland, Ohio. This machine is of similar design to the radial drill equipped with a tapping attachment which has been manufactured by this company for some time. It is built in two styles, one of which is mounted on a base while the other is intended for clamping to a column. Three changes of speed are provided, ranging from 390 to 1000 revolutions per minute. The drilling radius is 4 feet.

Electroplating Barrel: U. S. Electro-galvanizing Co., Brooklyn, N. Y. An automatic machine for the performance of electroplating operations. It consists of an automatic plating barrel for treating nails, screws and similar parts in bulk. The plating barrel is used in connection with automatic cleaning and drying outfits, so that electroplating is completed without requiring the work to be handled after it has been loaded into the machine.

Cylinder Grinding Machine: Boxill & Bruel Machinery Co., Cincinnati, Ohio. This machine is an improved design of the same type of grinder formerly manufactured by this company. On the improved machine, the frame is so designed that the grinding wheel may be withdrawn and swung to one side while calipering the work. The wheel head is pivoted to its base so that when the wheel is run up clear of the cylinder it may be swung to one side.

Upright Drill: Richards Machine Co., Milwaukee, Wis. The design of this machine follows established practice in the construction of this type of machine tool, but the parts subject to severe service have been made unusually heavy. The spindle is provided with the usual lever and ratchet movement, and a small pilot wheel at the opposite end of the pinion spindle assists in setting the drill spindle or running it up and down. The weight of the machine is 250 pounds.

Horizontal Drilling Machine: Moline Tool Co., Moline, Ill. This machine was designed for automobile work, but is applicable in various other classes of manufacture, where multiple drilling is to be done. The machine has two 20-inch rails on which any of the drill heads made by the Moline Tool Co. may be mounted. The spindles in these heads are driven through a worm which extends almost the entire length of the rail, so that the setting of individual heads is an easy matter.

Shell Under-cutting and Waving Machine: Thurlow Steel Works, Chester, Pa. A machine designed for finishing the band seat on shells. The work is held in a hardened and ground steel collet which is controlled by means of a lever at the side of the headstock. The machine is provided with four forming tools—two at the back and two at the front. The tools at the back cut the right- and left-hand sides of the under-cut, while the tools at the front rough out the band seat and perform the waving operation.

Manufacturing Lathe: Fairbanks-Morse & Co., New York City. This machine has been especially designed to meet the requirements of manufacturers of shrapnel and high-explosive shells. The drive is provided by a single pulley which carries an 8-inch belt. The machine is driven by a two-speed countershaft, and when so driven six changes of speed are available. The principal dimensions are: swing over bed, 26½ inches; swing over carriage, 14½ inches; distance between centers, 60 inches; ratio of double back-gears, 11 to 1 and 8 to 1.

* * *

QUOTATIONS OF WHOLESALE METAL PRICES

Week Ending November 26

Aluminum, pig, per pound, ton lots	$ 0.60
Antimony, Asiatic, per pound	0.39½
Black sheets, No. 28, per 100 pounds, Pittsburg	2.40
Copper, electrolytic, per pound	0.19¾
Copper, lake, per pound, New York	0.19¾
Galvanized sheets, No. 28, per 100 pounds, Pittsburg	4.25
Iron bars, refined, per 100 pounds, Pittsburg	1.86
Iron, pig, foundry No. 2, per ton, Philadelphia	17.75
Iron, pig, basic, valley, furnace, per ton	16.00
Iron, pig, Bessemer, per ton, Pittsburg	17.95
Iron, pig, gray forge, per ton, Pittsburg	16.45
Lead, per pound, New York	0.05¼
Nails, cut, per 100 pounds, Pittsburg	1.85
Nails, steel wire, per 100 pounds, Pittsburg	1.90
Spelter, per pound, New York	0.19
Steel angles, per 100 pounds, Pittsburg	1.70
Steel bars, per 100 pounds, Pittsburg	1.70
Steel beams, per 100 pounds, Pittsburg	1.60
Steel billets, forging, per ton, Pittsburg	50.00
Steel rails, per pound, at mill	0.01¼
Steel tank plates, per 100 pounds, Pittsburg	1.90
Tin, per pound, New York	0.39½
Tin plate, per 100-pound box, New York	3.54
Wire, barbed, galvanized, per 100 pounds, Pittsburg	2.75

The demand for metals continues unabated and prices are steadily advancing. Pig iron has gone up fifty cents a ton. The United States Steel Corporation, finding the demand for its products so great, has temporarily withdrawn quotations in foreign markets. The rumored merger of steel plants has not yet been confirmed. Charles M. Schwab, president of the Bethlehem Steel Co., denied that the Bethlehem Steel Co. and the Cambria Steel Co. were about to consolidate. He referred in the interview to a prediction made in 1900 that by 1920 the annual production of the United States would increase from 10,000,000 tons, the figure at which it then stood, to 40,000,000 tons in 1920. The production is now at the rate of about 37,000,000 tons annually and the prospects are that the prediction of 40,000,000 tons annual production will be realized before the time set. The quotations in the foregoing list are to a large degree nominal, fancy prices in many cases being paid for steel and other metals on quick delivery.

* * *

MONTHLY MEETING OF THE A. S. M. E.

The monthly meeting of the American Society of Mechanical Engineers was held Tuesday evening, November 9, in the Engineering Societies Bldg., New York City. Charles Melds Ripley delivered an address on individual power plants *vs.* the central station power plant for power purposes in New York City. Mr. Ripley has made an extended investigation of the size, age and performance of all the gas producer power plants in the city, that is, plants that are self-contained power producing units, using coal and converting its energy into electrical energy for power purposes, thereby obviating the necessity of purchasing electricity from a distributing company. The results of Mr Ripley's investigations indicate that the individual power plant is to be preferred in city office buildings because the power costs the owner practically nothing in winter when the building must be heated. Exhaust steam is practically as effective for heating a building as steam used direct from the boilers. The reduction of pressure due to the passage of the steam through a steam engine means loss of heat of only about four per cent, this being the heat energy converted into electrical energy

* * *

The National Machine Tool Builders Association, which held its annual meeting at the Hotel Astor, New York City, October 28-29, elected J. B. Doan, president, D. M. Wright, first vice-president, A. H. Teuchter, second vice-president, C. S. Taylor, secretary, A. E. Newton, treasurer. Cincinnati, Ohio, was chosen as the place for the spring convention in May.

* * *

MACHINERY has been advised that a young Englishman, familiar apparently with the machine tool trade in Great Britain and America, now in this country, is trying to borrow money from machine tool builders and dealers on the strength of his alleged trade connections. Charles Churchill & Co., Ltd., of London, whom he offers as reference, cabled that the man is an impostor.

Some Reasons Why

these machines represent a profitable investment for quality, production, accuracy and long service are to be found in the features described below. They are good points to consider when you are buying grinding equipment.

Independent Gear-Driven Speed and Feed Change Mechanisms

insure that all-important requirement in commercial grinding—complete separation of speeds and feeds. Through two simple, efficient, and handily located mechanisms, an operator can quickly secure the most productive combination of speed and feed for each job. No overhead belts to shift, no confusion—a quick start and maximum production every time.

Automatic Cross Feed

Here's a feature that not only saves time and trouble but also insures exact duplication of work. It is quickly and easily set and once set succeeding pieces are reduced to the predetermined size without attention from the operator, who can prepare work or run another machine while a piece is being ground.

Combination Plain and Universal Back Rests

Another handy B. & S. feature. Work requires proper support. That is essential. These rests can be used in three ways—as universal back rests with delicate adjustments for long slender work; semi-universal for work of medium weight, and solid rests to give rigid support to heavy pieces.

Low Setting, Rigid Headstock

The solid, compact design of the headstock meets that important requirement in a machine for heavy grinding—rigidity. The work centers are located directly above solid walls of metal extending to the floor and giving very solid support.

Wheel Spindle Speeds

can be readily varied to suit the requirements of various classes of work, by means of split pulleys which can be quickly changed. An automatic belt tightener maintains an even belt tension and compensates for differences due to changing pulleys and to the different positions of the wheel slide.

General Design Makes for Handy Operation

That's why operators like these machines. Every operating part is arranged for handy access and to eliminate confusion and waste motion. Convenience like that is a big factor in fast production. Write for descriptive literature and learn more about these efficient machines. Also ask for our booklet "Points About Grinding Machines and Their Selection."

Providence, R. I., U. S. A.

CANADIAN AGENTS: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver St. Johns, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfort a.M Germany; V Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia, Fenwick, Freres & Co. Paris, France Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; The F. W. Horne Co., Tokio, Japan L. A. Vail, Melbourne, Australia; F. L. Strong Manila, P. I.

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REPORTED MERGER OF MACHINERY PLANTS

Wide publicity has been given in the newspapers to a report that the plants of the National-Acme Mfg. Co., Cleveland, Ohio, and Montreal, Canada; Windsor Machine Co., Windsor, Vt.; American Steam Gage & Valve Mfg. Co., Boston, Mass.; R. B. Phillips Mfg. Co. of Worcester and Lowell, Mass.; and White Mountain Paper Co., Portsmouth, N. H., have been merged into a $25,000,000 corporation named the Phillips Corporation, a holding concern formed under the laws of Delaware, and that Ralph B. Phillips, treasurer and general manager of the American Steam Gage & Valve Mfg. Co., the moving spirit in the merger, is president, and Lloyd H. Atkinson, formerly of the Bethlehem Steel Co., is vice-president. The report includes a statement that Mr. Phillips and his associates have obtained contracts for the manufacture of war munitions aggregating about $60,000,000, and assurance is given that the constituent companies, which employ a total of about 7500 people, will continue to operate with few immediate changes in the present organization. The subsidiary concerns in the corporation are to make shells, fuses, munition parts, heavy ordnance machine tools and engage in shipbuilding. According to the report one-half of the stock issue of $25,000,000 is to be seven per cent cumulative preferred, and the balance common. At the time of going to press the principals would not confirm the foregoing.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly on the 1st, at New York, N. Y., for October 1, 1915, required by the Act of August 24, 1912.

Editor, Fred E. Rogers	140-148 Lafayette St., New York
Managing Editor, None	
Business Managers { Alexander Luchars, President	" " " " "
Business Managers { Matthew J. O'Neill, Gen'l Manager	" " " " "
Publisher, The Industrial Press	" " " " "
Owners of one per cent or more of the stock:—	
The Industrial Press	" " " " "
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "

There are no bondholders, mortgagees or other security holders.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 1st day of October, 1915

FRANK J. SCOTT,
Notary Public No. 321, Kings County,
Certificate filed in New York County No. 247.
(SEAL) (My commission expires March 30, 1917.)

PERSONALS

J. D. Sherman, formerly efficiency engineer of the Illinois Tool Works, Chicago, has been appointed superintendent of the plant.

Paul B. Goddard, general manager of the Illinois Tool Works, Chicago, Ill., has resigned his position and connection with the company.

Forrest E. Cardullo, a well-known mechanical engineer and contributor to the technical press, has taken a position with the Pierce-Arrow Motor Car Co., Buffalo, N. Y.

E. Lagerholm, until recently traveling representative of the Illinois Tool Works, Chicago, has been made sales manager. Mr. Lagerholm was previously with the Union Twist Drill Co. as manager of that company's Chicago branch.

Halbert P. Hill, well known in engineering circles as an inventor and designer in the early development of the rotary converter and allied apparatus for the conversion of alternating current into direct current, is now connected with the C & C Electric & Mfg. Co. of Garwood, N. J.

* * *

OBITUARIES

Daniel O. Rogers, for many years vice-president of the Skinner Chuck Co., New Britain, Conn., died November 12 at his home in New Britain, aged sixty-one years.

Abraham Van Brunt Bush, formerly master mechanic and chief draftsman for the Waterbury Rope Co., died October 24, at his home, 265 Seventh Ave., Brooklyn, N. Y., in his eighty-seventh year.

William Barker, one of the pioneer machine tool builders in the Middle West, died November 9, aged sixty-three years. He was president of William Barker & Co., lathe builders, Covington, Ky.

Baxter D. Whitney of Baxter D. Whitney & Son, the oldest manufacturer of wood-working machinery in America, died at his home in Winchendon, Mass., October 17, aged ninety-eight years. His father was a woolen manufacturer and he learned the trade of machinist at a very early age and went into business for himself before he was twenty years old. The first machines he made were used in the manufacture of woolen cloth, but soon he turned his attention to the improvement of machinery for working lumber. He began to study the cylindrical planer problem and finally built a successful machine that was sold to a local concern. Cylindrical planers had been built before Mr. Whitney made his, but in none of them was it possible to plane a board without clipping the ends. Among the most notable of Mr. Whitney's contributions to the art of wood-working, besides the cylindrical planer, is the gage lathe and the wood-scraping machine.

COMING EVENTS

December 6-8.—International trade conference, arranged by the Foreign Trade Department of the National Association of Manufacturers, at the Hotel Astor, New York City. William M. Benney, 30 Church St., manager, Foreign Trade Department, National Association of Manufacturers.

December 7-10.—Annual meeting of the American Society of Mechanical Engineers, New York City; Engineering Societies Bldg., headquarters. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

September 11-16, 1916.—Convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland Ohio.

NEW CATALOGUES AND CIRCULARS

Mesta Machine Co., Pittsburg, Pa. Circular of Mesta barometric condensers for steam power plants.

Allsteelquip Co., Aurora, Ill. Leaflet 101 advertising "Allsteelquip" steel lockers, general service cabinets, office shelving and transfer cases.

Adams Co., 715 Market St., Dubuque, Iowa. Catalogue 69 of the Farwell No. 0 quick-change milling machine, keyseater, profiler and cam cutter.

Richard W. Jefferis Co., Camden, N. J. Folder Y, covering dimensions and prices of Jefferis pressed-steel storage equipment and office wardrobes.

Standard Electric Tool Co., Cincinnati, Ohio. Bulletin G 9, superseding Bulletin G 8, of "Standard" high-power ball bearing portable electric grinders.

Gardner Governor Co., Quincy, Ill. Circular on air compressor installations, giving helpful hints to those concerned with the installation and maintenance of air compressors.

Pangborn Corporation, Hagerstown, Md. Bulletin 531 of the Type L A direct high-pressure rotary table sandblasting machine built in two sizes, with tables of 70 and 90 inches diameter, respectively.

Sidney Tool Co., Sidney, Ohio. Circular of the Sidney high-duty seventeen-inch and nineteen-inch double back-geared quick-change engine lathes built in six-, eight-, ten- and twelve-foot lengths of beds.

Vulcan Engineering Sales Co., 2063 Elston Ave., Chicago, Ill. Catalogue S of Hanna pneumatic riveters, screen shakers, revolving dumping riddles, suction oilers, cold metal sawing machines, jib cranes, etc.

Whiting Foundry Equipment Co., Harvey, Ill. Catalogue 14 treating of Whiting brass foundry equipment which includes furnaces, blast pipes, gratings, tongs, structural work for pits, tumblers, and cranes.

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill. Bulletin 17 of the Besly wide-face ring wheel grinder, illustrated with examples of work done and details of the pressed steel chuck and geared motion lever feed.

Roller-Smith Co., 203 Broadway, New York City. Pamphlet on "Junior-Imps," which is the trade-name used to designate Roller-Smith small direct-current ammeters and voltmeters for battery charging outfits, small switchboards, and similar applications.

United Engine & Mfg. Co., Hanover, Pa. Bulletin 22 of the "Manley" "long range" arbor press, having a leverage of 100 to 1 and a capacity of ten tons. The maximum capacity between standards is twenty-one inches and under the ram forty inches.

Jenckes Knitting Machine Co., Pawtucket, R. I. Circular describing the Chernack multiple lathe for rough-turning. This machine turns five pieces about ten inches in length and from three to six inches diameter simultaneously and can be adjusted to turn fewer pieces of greater length.

Bantam Anti-Friction Co., Bantam, Conn. Pamphlet called "Shopology," a statement of general authority and relations of employes, that is placed in the hands of each employe and all new men when put to work. This booklet concludes with some efficiency axioms of general application in all manufacturing plants.

Huther Bros. Saw Mfg. Co., 1108 University Ave., Rochester, N. Y. Pamphlet descriptive of the Huther inserted-tooth milling saw, which comprises two crucible steel plates between which are riveted high-speed steel teeth. The saw is designed for thin and fast cutting, and it is claimed that it will withstand severe strain and shock.

Clarence E. Van Auken Co., 216 N. Clinton St., Chicago, Ill. Circular of the Van Auken hacksaw, illustrating and describing a hacksaw machine with two opposed blades working on opposite sides of the stock simultaneously. The claim is made that the machine will saw four times as fast as the single saw dry machine.

Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York City. Circular of "Metalite" cloth furnished in rolls of fifty yards each. This form of abrasive cloth is economical for shop use, as it eliminates considerable waste. The rolls are supplied in widths from ¼ inch to 2½ inches and in grits Nos. 3/0 to 3½.

Foxboro Co., Foxboro, Mass. Bulletin 98 on Foxboro recording gages for continuously recording on a paper chart the amount and duration of fluctuation in vacuum or pressure. The booklet illustrates these gages and some of the charts made by them, and gives price lists of recording pressure gages and recording vacuum gages.

Porter-Cable Machine Co., Syracuse, N. Y. Circular of the Porter-Cable manufacturing lathe, especially designed for the economical production of duplicate parts in large quantities. The lengths of bed are 32 and 38 inches, having capacity between centers of 12 and 18 inches, respectively. The swing is 9 inches over the bed.

New Departure Mfg. Co., Bristol, Conn. Bulletin 51 FE, "Ball Bearing Mounting for Large Blower;" 52 FE, "Ball Bearing Installation in Ammonia Compressor for Refrigerating Work;" 53 FE, "Methods of Retaining Lubricant in Bearing Housings where Stream Lubricant is Necessary;" 54 FE, "Mounting Ball Bearings in Self-aligning Housings."

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletins 49126 and 49127 on ozonators for use in cold storage warehouses, and ozonators for use in stores, respectively. This equipment is used for deodorizing the air in storage rooms where food is kept or in other places where the air becomes rapidly contaminated.

Keuffel & Esser Co., 127 Fulton St., New York City. Pamphlet of "Simplex" lettering templets for lettering and numbering drawings without any preliminary layout. The work can be done uniformly and rapidly by a person who has had no previous experience in lettering by means of these templets. Either ink or pencil can be used, special glass pens being made for working with ink.

Southwark Foundry & Machine Co., 430 Washington Ave., Philadelphia, Pa. Circular of the McMeans-Bosler cutting-off machine for cutting rounds from one to thirteen inches diameter into shell blanks. The machine consists of a powerful

headstock driven by electric motor and six sets of cutters worked by air cylinders. The rate of production is claimed to be six cuts on 5½-inch rounds in sixty-five seconds.

Harrison Safety Boiler Works, Seventeenth St. and Allegheny Ave., Philadelphia, Pa. Booklet entitled, "Firing and Stopping of Waste in Modern Boiler Room." The value of feed-water and condensate meters as aids in the management of power plants is pointed out. With a feed-water meter installed it is possible to measure the effect of changes in boiler room management and thus to fix on the most economical practice.

Industrial Controller Co., 850-890 Greenbush St., Milwaukee, Wis. Handbook No. 4 of I. C. controlling devices, comprising D. C. motor starters; D. C. speed regulators; A. C. motor starters; A. C. speed regulators; D. C. automatic starters; D. C. starting speed regulators; accessories; battery charging rheostats and resistance units; and field rheostats. Walker Bros. & Haviland of New York, Philadelphia and Chicago, are the general sales agents.

American Metal Products Co., 3009-3021 Lisbon Ave., Milwaukee, Wis. Circulars of "Ampco" bronzes which, in sand castings, have a range of tensile strength from 50,000 to 100,000 pounds per square inch and an elastic limit of 25,000 to 45,000 pounds per square inch. When forged, hammered, rolled or drawn, the tensile strength is as high as 150,000 pounds per square inch. Die-casting "Ampco" bronze is successfully cast in iron or steel molds without causing rapid deterioration of the molds.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Leaflets 2389 and 2390 dealing with belt-driven and engine-driven alternating-current generators, respectively, with capacities ranging from 25 to 1750 kilovolt amperes; leaflet 3787 on type CS, large squirrel-cage induction motors, designed for heavy-duty, constant-speed continuous service; and leaflet 3811 on installations of electric drive in steel mills, with curve indicating the growth of this form of power in steel mills throughout the country.

Ingersoll-Rand Co., 11 Broadway, New York City, has issued two booklets, Forms 76 and 9201. Form 76 is an 80-page catalogue entitled "Water Lifted by Compressed Air," and describes in detail the air lift system of pumping. Form 9201 is a 128-page catalogue on "Calyx Core Drills." The principal function of the core drill is the determination of the character, order, thickness and extent of the strata beneath the earth's surface by means of cylindrical cores extracted by the drill. In coal and metal mines, stone quarries, contract work, canal or tunnel developments projected, etc., the core drill is used to prospect the unknown formation and give the engineers absolute knowledge of the formation that must be excavated.

American Express Co., 65 Broadway, New York City. Booklet entitled "Foreign Trade Building," dealing with the establishment of trade abroad. The company has had more than a quarter of a century of actual business experience in the foreign field, and the benefit of its experience is offered to American manufacturers in the hope that they will fully appreciate the importance of starting right. The foreign trade information bureau will furnish general information on any country regarding language, currency and exchange conditions, weights and measures, steamship lines and routes, postal regulations, distribution of imports and exports, competition, trade conditions, catalogue requirements, invoice regulations, insurance, collections, patent and trade-mark laws, etc.

TRADE NOTES

Hyatt Roller Bearing Co., Newark, N. J., has appointed J. D. Mooney manager of its commercial department. Mr. Mooney was formerly in charge of the belting sales for the B. F. Goodrich Co., Akron, Ohio.

Fafnir Bearing Co., New Britain, Conn., recently opened a new branch office at 39 S. Clinton St., Chicago, Ill., with D. D. Davis as manager. This office was established to take care of the increased business developing in the western territory.

C. & C. Electric & Mfg. Co., Garwood, N. J., will exclusively manufacture the horizontal and vertical ball bearing motor generator sets for moving picture machines and battery charging outfits, designed and patented by Halbert P. Hill.

Van Dorn & Dutton Co., Cleveland, Ohio, specialist in gears and gear cutting, has moved its New York office from 50 Church St. to 556 W. 34th St. Frank Van Anden has been appointed district sales manager in charge of the New York office.

Standard Mfg. Co., Bridgeport, Conn., has made plans to increase the working floor space of its plant approximately 13,000 square feet. The increase has been found necessary to properly take care of the large volume of work on hand and of the probable future business.

American Vanadium Co., 325 Vanadium Bldg., Pittsburg, Pa., has developed a carbon-vanadium forging steel which is claimed to give all the physical requirements of heat-treated, quenched and tempered plain carbon steel forgings of like section, without heat-treatment other than simple annealing.

Phoenix Mfg. Co., Eau Claire, Wis., builder of machine tools, has opened an eastern office at 1430 W. Sixth St., Cleveland, Ohio, in charge of W. L. Harrison. For the past two years the company has made a specialty of turret attachments, such as four-tool turret toolposts and four- and six-hole carriage turrets.

U. S. Electrical Mfg. Co., 459-461 E. Third St., Los Angeles, Cal., manufacturer of direct- and alternating-current machinery will immediately rebuild its factory, destroyed by fire October 27. The company requests catalogues of machine tools and other equipment used in the manufacture of electrical motors.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City, has recently opened a sales office in the Provident Bank Bldg., Cincinnati, Ohio, under the management of Frank H. Hill. The Cincinnati office has been established to facilitate the prompt and efficient handling of the increasing business in that section.

Kelly Reamer Co., Cleveland, Ohio, manufacturer of the Kelly type reamers, has recently brought out a special type of reamer for shell and shrapnel work, and the orders have accumulated so rapidly that plans are made for doubling the capacity of the plant. The company now occupies the entire floor of the building in which it is located.

W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y., has been purchased by J. M. Fitzgerald and associates and the name has been changed to the Davis Machine Tool Co., Inc. The capacity of the plant will be considerably enlarged. F. H. Brown, who has been with the company for years as secretary and treasurer, will be retained as assistant to the president. The capitalization is $750,000.

Cleveland Galvanizing Works Co., Cleveland, Ohio, has acquired an entire city block adjacent to its works at E. Cooper Ave. and Pennsylvania R. R. The additional property will permit the company, which manufactures a line of weldless wire chain, sash chain, and chain of all kinds, to greatly enlarge its plant. The demands for its product are now much greater than the capacity of the present plant.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa., whose rights under the Conrad patents on ball bearings were sustained by broad decisions rendered by the United States courts, has licensed the Standard Roller Bearing Co., Philadelphia, Pa., the New Departure Mfg. Co., Bristol, Conn., Gurney Ball Bearing Co., Jamestown, N. Y., and the U. S. Ball Bearing Co., Chicago, to manufacture ball bearings under the Conrad patents.

Springfield Grinding Co., Springfield, Mass., manufacturer of abrasive wheels, has been incorporated with an authorized capital of $400,000. The company will operate the abrasive plant in Chester, Mass., formerly operated by the Massasoit Co. This plant was sold last August at a foreclosure sale to Dwight O. Gilmore of Springfield, who will act as president of the new company. A. D. Robinson of Westfield, Mass., is vice-president and C. J. Wetsel treasurer. The factory manager is A. F. Blouin.

National Tool Co., Cleveland, Ohio, manufacturer of milling cutters, reamers, taps and other small tools, has recently made important additions to its plant which will considerably increase the shop capacity. The new building for heat-treatment is constructed along original lines worked out by Ed. Noll, president and general manager. Mr. Noll has spent many years in the manufacture of small tools, and during the past ten years has built up an independent business under the name of National Tool Co. A new office building will be erected at an early date.

F. H. Kappen & Son, Milwaukee, Wis., have opened an office at 93 W. Water St., for the sale of wood- and iron-working machinery and other specialties. They have taken over the merchandise and machinery of the O. L. Packard Machinery Co. and in addition will act as manufacturers' agents. F. H. Kappen was connected with the O. L. Packard Machinery Co. as salesman and manager up to 1891, when the Kappen corporation was formed of which he became secretary and treasurer. Ralph A. Kappen, the junior member, has been active in the same business in various capacities for about five years.

Billings & Spencer Co., Hartford, Conn., has reorganized under the general law of Connecticut and increased its capitalization from $200,000 to $500,000. The limitations of the company's old charter made necessary the organization of a new corporation in order to increase its capital. The Billings & Spencer Co., which has taken over the entire assets and business of the old corporation, has assumed its liabilities. The officers are: C. E. Billings, president and general manager; F. C. Billings, vice-president and superintendent; Lewis D. Parker, treasurer; E. H. Stocker, secretary; and F. H. Stocker, assistant secretary and treasurer.

Simonds Mfg. Co., Fitchburg, Mass., has signed contracts with the United States Steel Corporation for license and with the American Bridge Co. for the installation of a five to six gross ton Heroult three-phase electric melting furnace. The results obtained by the company with electric furnaces during the past five years have indicated to its engineers that a larger furnace of the type now building would be desirable. It is expected that the complete installation will be one of the best yet made in this country for the manufacture of high-grade carbon and alloy steels. The new furnace will be put into operation about January 1, 1916.

Walker M. Levett Co., 10th Ave. and 36th St., New York City, maker of "Magnalite" pistons for gas engines, furnished the pistons for all the American cars entered in the 350-mile Astor cup race that was run October 9. Of the eight cars that finished "in the money," only one had pistons of another make, these being machined from solid steel billets. In the foreign cars that were compelled to drop out of the race because they were unable to withstand the terrific strains imposed in the 102-mile an hour pace, broken connecting-rods proved the biggest factor, thus emphasizing the importance of eliminating as much weight as possible in reciprocating parts.

Hoover Steel Ball Co., Ann Arbor, Mich., has increased its capital stock from $250,000 to $500,000, the addition of capital being required for further expansion of the company's business. In the past twelve months, the company has erected three new buildings, affording 30,000 square feet additional floor space, and has installed ball-making machinery worth $160,000. But these additions to the productive capacity were not sufficient to provide for the increased demand for steel balls. Last January the company brought out a new ball known as the "Micro-chrome" steel ball. Within six months, orders had been booked for approximately $800,000 worth of these new balls, which had met with general approval.

R. E. Parsons Co., Bridgeport, Conn., which for the past forty-three years has been in operation at the corner of Barnum Ave. and Hallet St., will now be controlled by other parties interested very closely in the product of the concern. The business was started in a small way by R. E. Parsons, who until recently was the controlling stockholder, but who on account of advancing years wished to be relieved of his responsibility in the concern. His holdings were bought by Clarence E. Bilton, president of the Standard Mfg. Co., and Frederick Rhodes, treasurer of the Salt's Textile Mfg. Co. These gentlemen, together with John W. Cottrell, the president of the R. E. Parsons Co., will conduct the business as heretofore under the same name.

S. K. F. Ball Bearing Co., 50 Church St., New York City, announces that Frank A. Vanderlip of the National City Bank has been elected director of the S. K. F. Ball Bearing Co. of Hartford. The company was recently incorporated under the laws of Connecticut for the purpose of taking over the business of the S. K. F. Ball Bearing Co. of New York, a house importing ball bearings made in Sweden. The new company has acquired the right to manufacture S. K. F. ball bearings in America from the Swedish company and is about to erect a factory for this purpose at Hartford, Conn. It has a fully paid up capital of $2,000,000. The board of directors will consist of B. M. W. Hanson, Franklin B. Kirkbride, A. Carlander, S. Winquist, B. G. Prytz and Frank A. Vanderlip.

Federal Machinery Sales Co., 12 N. Jefferson St., Chicago, Ill., has completed its organization and leased the building which was formerly occupied by the Niles-Bement-Pond Co. and the Pratt & Whitney Co. The company is incorporated with an authorized capitalization of $50,000. The officers are: James L. Gough, president; J. B. Doan, vice-president; Charles T. Bush, treasurer; and James Jay Sheridan, secretary. Mr. Gough has had long experience in the machine tool business from his connection with several prominent houses. Mr. Doan and Mr. Bush need no introduction to the trade, having been associated as vice-president and general manager of the American Tool Works Co., Cincinnati, and the Charles A. Strelinger Co. of Detroit, respectively. Mr. Sheridan is a prominent Chicago attorney. The new organization will handle a complete line of new and used machine tools and allied lines.

Nicholson File Co., Providence, R. I., has been made a member of the Rice Leaders of the World Association. The company was incorporated in Rhode Island in 1864 to manufacture files and rasps. Its main plant and offices are in Providence and other factories are maintained at Paterson, N. J., Anderson, Ind., and Port Hope, Ontario, Canada. William Thomas Nicholson, founder of the company, while operating a small machine shop of his own, built his first file-cutting machine. The superior merits of Nicholson files soon became known and the business grew rapidly. The company manufactures at its Providence plant alone more than 3500 kinds of standard files. The officers are: Samuel M. Nicholson, president and general manager; Walter W. Griffith, secretary; Paul C. Nicholson, vice-president; Henry W. Harman, assistant treasurer; Harold C. Field, assistant secretary; Ernest S. Craig, assistant to the president; and Wallace L. Pond, manager sales department.

Hyatt Roller Bearing Co., Newark, N. J., announces that the increase in its business has so far exceeded expectations that the construction of three buildings, instead of one, as planned, has become imperative. A. P. Sloan, general manager of the company, states that business everywhere is going forward and his company must not be behindhand in preparing for it. The three new buildings will increase the facilities by one-third. When they are complete, the company will have a total of over 600,000 square feet floor space devoted exclusively to the manufacture of roller bearings, which will make it by far the largest plant of its kind in the world. Two of the new buildings will be twin structures, each 200 feet long, 50 feet wide, and eight stories high. The third building will be 90 feet wide, 110 feet long and six stories high. The twin buildings will be used for press work, assembly of roller bearing parts and shipping. The other structure is especially designed for the heat-treating processes so important in bearing manufacture. The heat-treating building will be provided with an elaborate ventilation system which will insure that the men may work at all times in comfort. A central duct, which increases in size from the first floor to the top, changes all the air on each floor every minute. The system is operated by four fans, each ten feet in diameter, located in a housing on the roof. The gases will be taken out through separate ducts that lead directly to the main flue. By this system, the employes will suffer no inconvenience from combustion gases or excessive heat. The heat-treating building is being constructed of reinforced concrete and brick veneer, while the twin buildings are to be of concrete, steel and brick.

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JANUARY
1916

VOLUME 22
NUMBER 5

THE INDUSTRIAL PRESS, Publishers
140-148 Lafayette Street, New York

News in Advertising

"Milling 150 Transmission Cases a Day"; "Machining 150 Universal Joint Housing Caps in 10 Hours"; "Cutting 6,000 Gears Per Day on Gear Hobber"; "Machining 200 Grenade Bodies Per Hour—labor cost 15 cents per hundred—material, cast iron—operations: faced, chamfered, bored, seated and tapped"; "Threading 200 Cylinder Plugs Per Day"; "Cutting these Big Drop Forged Steel Sprockets 14 inches pitch diameter, one inch face, 7 teeth, 5 at a time on Gear Cutter."

We could quote dozens of similar headlines and sentences from MACHINERY'S advertising pages, but the foregoing will serve as well as a hundred quotations would, to indicate the highly interesting character of a great deal of the advertising now regularly published in MACHINERY. Mechanical executives tell us that they scan the advertising pages of MACHINERY as a staff officer studies despatches from the firing line. They find it absolutely necessary to keep in touch with this vital news, fresh from the shops—*from the most efficient shops.* Mechanical advertising now has its own staff correspondents, its field force, gathering the news right in the shops where the tools are at work, yielding under highly competitive conditions the last ounce of power and efficiency that is in them.

The man responsible for results appreciates the shop data and photographs of operations above the ordinary, which the advertising in MACHINERY now gives him; and he has discovered that this important data is to be found practically nowhere but in MACHINERY'S advertising pages. MACHINERY has organized the work and is the only journal that has developed and maintains an adequate field force of trained, technical men to do that and nothing else. Practical men will appreciate the fact that this is no work for ordinary photographers. All shop operations look alike to them, and they would rather show a lathe resting on a lovely landscape than to show the tool in an ordinary shop environment demonstrating extraordinary efficiency. It takes a man with practical shop experience to sense the unusual job—one which means high productive capacity and lower costs.

Efficiency News we would call such advertising. MACHINERY'S Selling Service is the name by which it goes in the trade. The data presented again and again in the advertising pages starts many an executive checking up his own shop methods and results when he reads what others are doing with the same kind of tools he has, or with the more efficient tools which he should have. There is hardly any service MACHINERY can render the mechanical field of greater practical value than this.

The Production of Die-Pressed Castings

Edward K Hammond

Until recently, the production of many machine parts was limited practically to one of two methods—either turning the pieces from bar stock or casting them in sand molds. The disadvantage of the former method lies in the large proportion of the material that is converted into scrap; and it is well known that the castings produced in sand molds are likely to be defective from several causes. These objectionable features have been overcome by the development of a method for making "die-pressed" castings which can be brought extremely close to the required dimensions of the part, with a smooth surface and uniform structure of the metal. Such defects as blow-holes, pin-holes, etc., which occur in ordinary castings, are not found in die-pressed castings. The method is applicable for use in producing a great variety of parts, and that it may be successfully applied on a commercial scale is attested by the fact that thousands of different parts are being produced by it in the leading manufacturing countries of Europe. Brass, bronze, copper, aluminum, nickel and other metals lend themselves to this treatment.

WHILE the production of die-pressed castings has only become of importance in this country since the outbreak of the European war, this process of improving the quality of soft metal castings has been used in Germany for some years in making a great variety of parts. An idea of the range of work for which this method of manufacture is adapted will be obtained from the fact that the Allgemeine Elektricitäts Gesellschaft, Berlin, Germany, is producing over 5000 different parts in this way. The term "die-pressed casting" is used to denote a part which is made by pressing the metal to the required shape in a suitable die, and the pieces which can be produced vary greatly in shape and size. Parts with long extensions or undercuts may be made with satisfactory results, and there are several metals which lend themselves to this method of treatment.

Die-pressed castings are used as a substitute for ordinary castings, over which they possess several noteworthy advantages. The finish obtained is equal to that secured on die-castings, and in many cases no subsequent machining operation is required; but where a very fine finish is necessary die-pressed castings have a further advantage over ordinary castings in that they are of absolutely uniform size and give no trouble when a magazine attachment is employed to feed them to a chucking lathe for performing the finishing operation. Another important feature is that there is no hard outer skin, as in the case of ordinary castings, and as a result, the life of the cutting tools is considerably increased.

The high pressure under which die-pressed castings are formed results in the production of a very dense metal, the tensile strength of which has been increased about 15 per cent by the mechanical treatment; and all such defects as blow-holes, pin-holes, and other imperfections found in ordinary castings are eliminated. An idea of the magnitude of the refining action which takes place will be gathered from the photomicrographs of the metal before and after being pressed in the die, which are reproduced in Figs. 3 and 4. These show a magnification of fifty-five diameters. In many cases the cost of producing die-pressed castings is lower than the cost of making ordinary castings, and the method is much cleaner. The metal is generally worked hot, but it is sometimes feasible to perform the pressing operation on cold metal, the shape of the parts to be formed and the metal from which they are to be made being the governing factors. The selection of a suitable metal for the work is extremely important, and the manufacturer who considers the employment of this method for making his castings will do well to give this matter careful consideration. Die-pressed castings of brass, bronze, copper, aluminum, nickel and other metals are now being produced in this country with satisfactory results. In making brass parts, an alloy of 54 per cent copper, 44 per cent zinc, and 2 per cent lead will be found to give satisfactory results.

The dies used are of two general types. Where possible, the metal is entirely confined in the die, and in such cases the part produced has a uniform surface without any fin. For certain classes of work, however, it is necessary to employ dies of the type used in making drop-forgings, and parts pro-

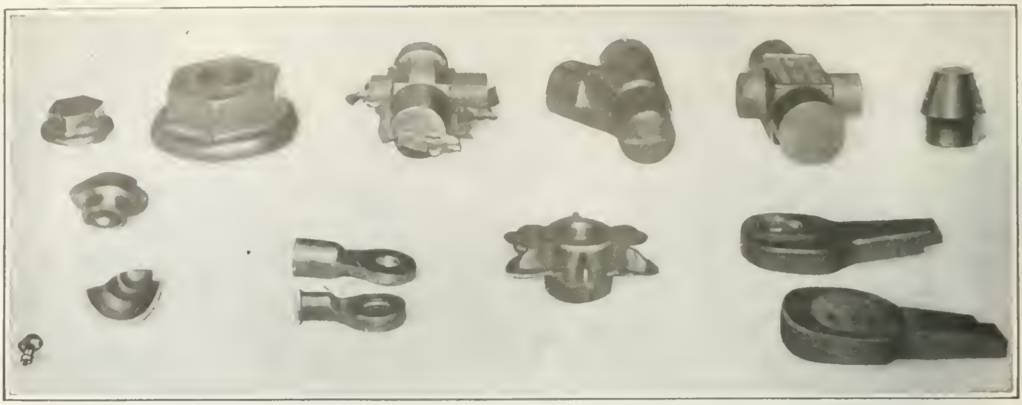

Fig. 1. Die-pressed Castings for Use on Oxy-acetylene Welding Equipments, Phonographs, Electrical Apparatus, Watches, etc.

duced in dies of this kind have a fin around the entire periphery which must be removed by a subsequent operation. In both of these types of dies, but more especially in the type where the metal is completely confined, the pressure is extremely high. The condition produced is essentially one of hydrostatic pressure, and the dies must be carefully designed to withstand this pressure according to the established practice followed in designing high-pressure hydraulic cylinders.

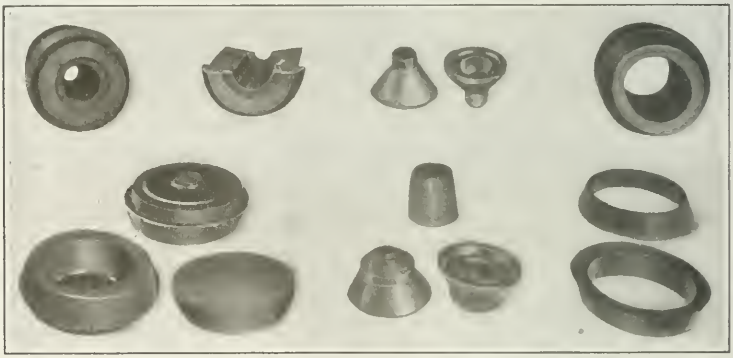

Fig. 2. Examples of Die-pressed Castings for Fuse Parts and Similar Pieces—note High Quality of Finish that is obtained

Suggestions in Regard to the Design of the Dies

After gaining some experience in the manufacture of die-pressed castings, the designer will be able to form an accurate opinion as to the pressure capacity of the press required to produce a given part. In determining the unit pressure which the die will be called upon to resist, he will divide the number of pounds which represents the pressure capacity of the press by the number of square inches in the cross-sectional area of the space in the die on a plane at right angles to the line of travel of the ram. This will give the pressure per square inch which will be set up in the die, and as it is known that hydrostatic pressure acts uniformly against the retaining walls in all directions, it will be an easy matter to determine the total pressure on the walls of the die.

The foregoing will probably be better understood by following through the steps in an actual example. Suppose the size of the die-pressed casting and the metal from which it is to be produced are such that a press developing 100,000 pounds is required, and that the cross-sectional area on a line at right angles to the line of travel of the ram is 2 square inches. The unit pressure set up in the die in pressing this part will then be:

$$\frac{100,000}{2} = 50,000 \text{ pounds per square inch.}$$

Assuming that the total surface area of the die-pressed casting to be produced is 3 square inches, the total pressure imposed upon the walls of the die will be:

$3 \times 50,000$ pounds $= 150,000$ pounds.

The walls of the die will then be made of the necessary thickness to safely withstand this

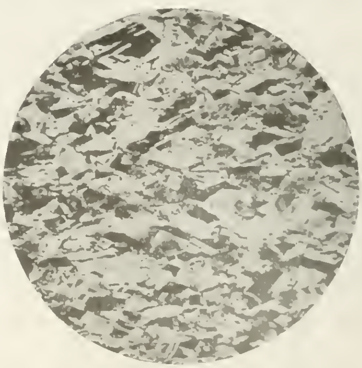

Fig. 3. Photomicrograph of Brass Surface before being subjected to Pressing Operation—note Coarse Structure of Metal. Magnification, 55 Diameters

Fig. 4. Photomicrograph of Same Brass after being subjected to Pressing Operation—note Improvement in Metal Structure. Magnification, 55 Diameters

pressure, the design being worked out according to standard practice in the design of high-pressure cylinders.

In addition to the two general classes of dies referred to, there is a third class which is really a special case of the type of die in which the metal is completely enclosed. These dies are made in halves in order that they may be parted to remove the work in a manner similar to that in which an ordinary sand mold is opened to take out the pattern. Parts which are of such a shape that they could not be removed from solid dies can be made in split dies of this type. It will be evident that any ordinary clamping device for holding the halves of such dies together would be entirely inadequate to withstand pressures up to 150,000 pounds per square inch which are sometimes developed in these dies. The method employed consists of making the outside of the die so that it will fit into a tapered shoe possessing ample strength for holding the halves of the die rigidly in place. When this practice is followed, it is customary to have the knock-out on the press arranged so that it will lift the two parts of the die out of the shoe on the up-stroke. As the ram rises, the operator removes the work with a pair of tongs and puts a fresh blank in place in the die. The two parts of the die are then released and allowed to drop back into place in the shoe ready for the next operation. Although the description may make the tool appear rather complicated, the die may be operated quite rapidly.

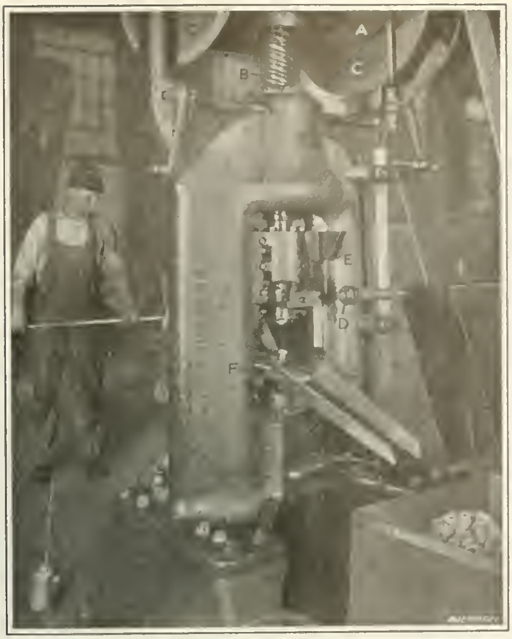

Fig. 5. Zeh & Hahnemann Percussion Press used for making Noses for Shrapnel Shells—note Compressed Air Nozzle F which blows Finished Castings into Chute

It has been stated that in making die-pressed castings of brass, the slugs of metal are heated to a forging temperature preparatory to pressing them into shape; and it will be evident that this temperature would result in drawing the temper of ordinary tool steel. As a matter of fact, the continual operation of the dies on hot metal results in raising their temperature to a red heat; consequently, the steel used for making the dies must be of a type which possesses the property of red-hardness. To prevent danger of damaging the dies through overheating, each of the presses is equipped with a nozzle which delivers a blast of air onto the die at each upstroke of the press, to keep the temperature of the die down as far as possible, and this air blast serves the further purpose of blowing all scale and other foreign matter off the die.

Tungsten steel is the material best adapted to the requirements of making dies for pressing hot metal, but owing to its high price at the present time, it would be extremely costly to make the dies entirely from this material. As a result, the expedient has been adopted of making the inner part of the die of tungsten steel and shrinking one or more machine steel collars around it to give the required strength. This practice is similar to that followed in the construction of heavy artillery, and in addition to effecting a saving in the cost of material, it also affords ample strength, because the application of pressure results in first reducing the tensile stress in the die to zero before any stress is introduced in the die as a result of the pressure set up while pressing the work to the required form.

In starting to design a pair of dies for use in the manufacture of parts where the metal must be worked hot, allowance must be made for the fact that the pressing operation is performed on the metal at a red heat, so that it will shrink considerably while cooling. As a result, the dies must be made over size in order that the work will shrink to the required size when cold. For example, the fact has been established that the coefficient of contraction of brass is 0.00000957 inch per inch per degree F., and in cooling, the temperature of the metal will be reduced from 1500 degrees F. to approximately 70 degrees F.; hence we find that the following allowance per inch must be made in determining the required size of the dies:

$$(1500 - 70) \times 0.00000957 = 0.014 \text{ inch.}$$

The tendency of the work to shrink while cooling has another important effect upon the


Fig. 6. Opposite Side of Zeh & Hahnemann Press shown in Fig. 5—note Arrangement of Chute for carrying Blanks from Heating Furnace to Press

Fig. 7. Melting Furnaces and Metal Molds used for casting Blanks

Fig. 8. Molding Bench, Sand Molds and Melting Furnace for producing Blanks

Fig. 9. Loading Side of Continuous Milling Fixture used for facing Blanks cast in Molds shown in Fig. 7

practice followed in the design of dies. When the work is of such a form that a hole or socket is formed by a pilot in the die, the shrinkage of the metal in cooling may cause it to bind so tightly on the pilot that its removal will be an extremely difficult matter. To avoid trouble from this source, such pilots must be tapered to facilitate the removal of the work, and experience has shown that the amount of taper necessary varies from 4 to 8 degrees according to the size of the work and the metal from which it is made. The dies are usually provided with automatic ejectors for removing the finished parts. The dies must be lubricated while in action, and experience has shown that a mixture of oil and flake mica is one of the most satisfactory lubricants which can be employed. When this mixture is applied to the hot die there is sometimes a tendency for the oil to "flash," but in such cases the mica still remains and provides a very satisfactory lubricating action.

Type of Power Press Used for Applying Pressure to Dies

In the manufacture of die-pressed castings, there are several reasons which make the friction-screw or so-called "percussion" type of power press well suited to the requirements of this industry. The most important of these is the fact that it is practically impossible to avoid slight variations in the volume of the slugs of metal from which the die-pressed castings are made. It will be evident that the presence of an excess of metal in the die will result in a tendency for the press to be stalled, but trouble from this source is eliminated in two ways: first, the driving member on the machine does not pass over a dead-center, and so the drive is continuous without any one point at which there is a particular tendency for the machine to stall; second, in the event of the excess of metal in the dies being so great that the machine cannot complete its stroke, the drive will reverse automatically without danger of damage to the tools or to the machine. Conversely, if the slug placed in the die contains too small a volume of metal there will be a slight over-travel of the ram, the reversal taking place when the maximum rated pressure of the blow has been applied to the work. As a result such parts will receive the required amount of pressure to obtain the desired compression of the metal.

To explain the reasons for the peculiar adaptability of the percussion press to the manufacture of die-pressed castings, it will be necessary to refer briefly to the method of operation of the friction-screw drive. Referring to Fig. 5, which shows one of these presses in operation, it will be seen that there is a friction wheel *A* mounted at the top of screw *B* which actuates the ram, this wheel being driven in opposite directions for the down- and up-strokes of the ram by alternately engaging the disks *C* mounted on each end of the horizontal driving shaft which runs continuously. The driving shaft is free to move laterally through a distance of about 1/32 inch in either direction, which results in bringing one of the disks *C* into contact with the friction wheel *A* for driving the ram down, after which the shaft is automatically moved over to engage the disk *C* on the opposite side of the wheel *A* to provide for making the return stroke.

The press is tripped by the usual form of foot-lever, and when the ram has reached the bottom of its stroke an automatic trip *D* is engaged by a dog *E* on the ram, which throws over the driving shaft and brings the return disk *C* into engagement with the friction wheel *A*. The ram stops when it reaches the top of its stroke. Presses of this type have been used in Germany for a number of years, but until recently they have not been manufactured in the United States. The Zeh & Hahnemann Co., Ave. A and Vanderpool St., Newark, N. J., specializes in the manufacture of percussion power presses and the tools used for making die-pressed castings. The engineers of this firm have made a careful study of the subject, and we are indebted to them for much of the information presented in this article.

Importance of Performing Pressing Operation at a Suitable Speed

In making die-pressed castings, the speed at which the blow is delivered by the press is an important factor. If the speed at which the blow is delivered is extremely fast, the metal will not have sufficient time to flow into the corners of the die and produce a fully finished casting. In pressing hot metal, if the blow is too slow, the slug will have cooled below a forging temperature before the operation has been completed; as a result, there will be a tendency for the chilled metal to disintegrate instead of taking the form of the die. With the friction-screw or so-called percussion type of press, just the right speed may be obtained, as adjustment may be made to provide a suitable speed for all classes of work. The regulation of the speed is also important because it is required to have the pressing operation extend over a sufficient period of time so that the pressure will be uniformly distributed through the metal and produce a homogeneous structure.

Fig. 10. Opposite Side of Continuous Milling Fixture where Blanks are removed and delivered to Heating Furnace

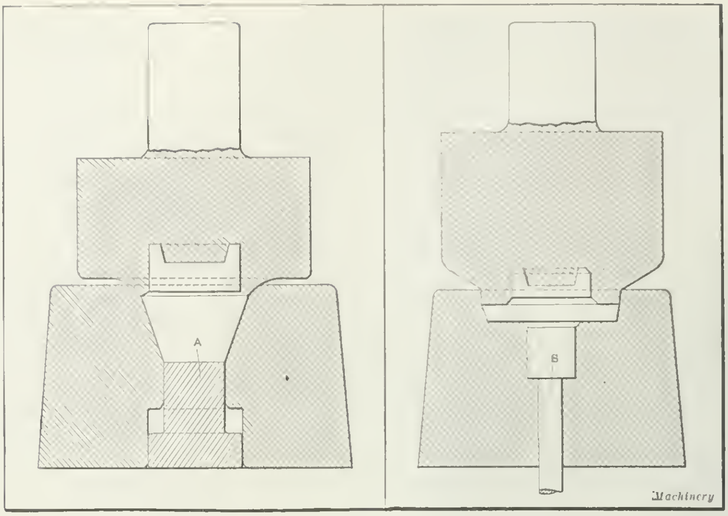

Fig. 11. Two Examples of Dies in which Metal is completely confined

In connection with the action of the percussion power press, it is of interest to note that the lead of the driving screw does not govern the force of the blow which is delivered by the ram. When the screw has a steep lead, its mechanical driving power is low, but the screw advances the ram at high speed, and so the kinetic energy of the ram is high. By reducing the lead of the screw, the speed of the ram and the value of the kinetic energy are correspondingly reduced, but this loss of power is offset by the fact that the screw of more gradual lead has a greater mechanical driving power. In practice, the presses are designed to take advantage of the maximum mechanical driving power which can be obtained from the screw, and so the lead is made as small as possible, the limiting condition being that point where the inclination of the thread is so gradual that the screw will tend to bind in the nut. The screws are designed to go as close to the sticking point as possible, without actually giving trouble. In the preceding discussion, the kinetic energy is that resulting from the combined mass of the flywheel, screw, ram and upper die moving at the speed of the ram at the time it engages the work.

Raw Materials of the Industry

The slugs of metal which form the starting point in manufacturing die-pressed castings that are pressed hot, are heated in oil or gas furnaces preparatory to the performance of the pressing operation. Two operators are required to work each press. One man stands at the back of the machine to remove the slugs from the heating furnace and place them in position in the die. The other stands at the front of the press; and this man operates the machine, lubricates the dies, and removes the finished castings. As the metal is hot, it must be handled with tongs, and so there is practically no danger of the workmen getting their hands caught in the dies.

In the manufacture of die-pressed castings, it is a fundamental principle that the metal should be required to flow through the minimum distance in order to bring it to the required shape of the finished part. There are two ways of applying this principle: first, the dies should always be designed so that the distance through which the metal has to flow is reduced to a minimum; second, the slugs of metal from which the castings are to be pressed may be made of such a shape that the distance through which the metal must flow during the pressing operation will be materially reduced. In the latter case, either of two methods of procedure may be followed. According to one plan, extruded bars of metal are made of a cross-section which approximates that of the finished parts, and slugs containing the required volume of metal are cut off from these bars and subjected to the pressing operation. When it is not possible to use extruded metal, it is often feasible to make castings of approximately the required shape and size, and then subject these castings to a pressing operation. The use of castings made in sand molds is avoided as far as possible, as they are covered with scale and foreign matter which has a deleterious effect upon the dies. The best results are obtained when the slugs are cut off from bars of metal which are produced either by cold-drawing or by the extrusion process.

Description of a Shop Equipped for Making Die-pressed Castings

One field in which the method of making die-pressed castings has recently found wide application is the manufacture of the fuses used on shrapnel and high-explosive shells; and the following description of the practice of a well-known American manufacturing company will give an idea of the manner in which the work is carried on and the rate of production that it is possible to attain. This concern is following the practice of casting blanks containing the required volume of metal and then pressing them into shape. The metal is melted in three 400-pound "Monarch" gas furnaces

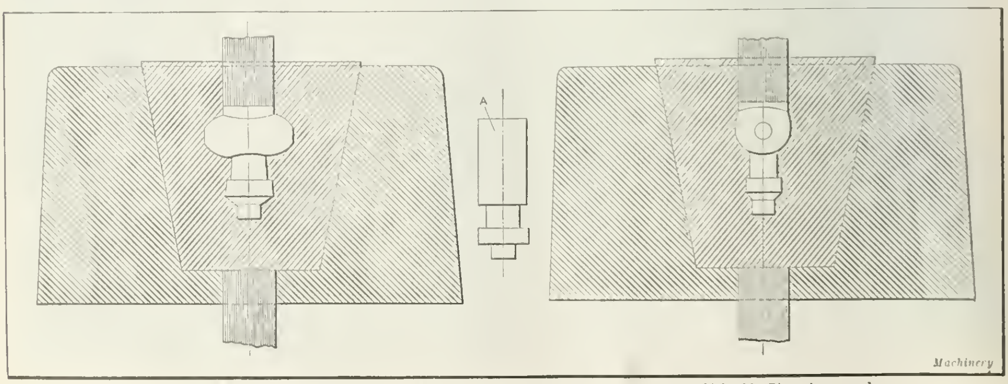

Fig. 12. Example of Split Die used for making Watch Pendant and Blank A from which this Piece is pressed

which use gas at a pressure of 8 ounces per square inch and air at a pressure of 10½ ounces per square inch. One furnace is provided as a reserve, and is used while repairs are being made on either of the other two furnaces. Two methods of casting are employed. Some of the blanks are cast in sand molds, each mold being made up on a match plate which provides for casting twenty-four blanks. Other blanks are cast in special metal molds of the form shown in Fig. 7, which does away with trouble resulting from the dies being damaged by sand sticking to the castings. Reference to this illustration will make it evident that the molds consist of iron plates, each of which contains twelve impressions. After the metal has been poured into these molds and allowed to cool, the molds are turned over on their pivotal support so that the blanks are dumped out into a receiver after which the molds are ready to receive a fresh lot of metal.

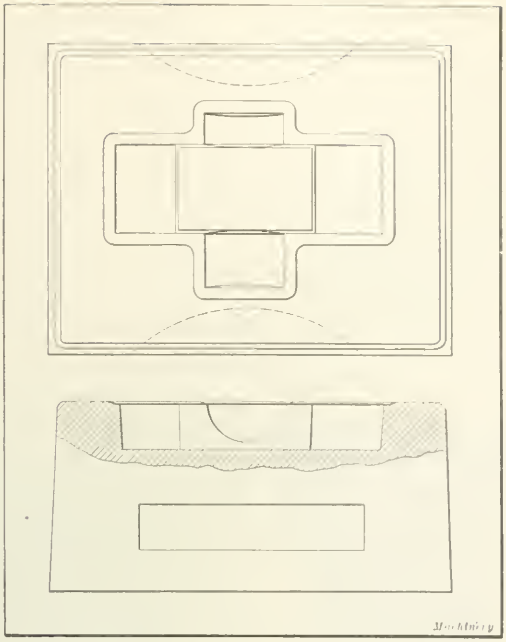

Fig. 13. "Drop-forge" Type of Die used for making Die-pressed Castings

The only treatment given to blanks cast in the metal molds, before they are subjected to the pressing operation, consists of facing off their top surface, for which operation a No. 4 Brown & Sharpe milling machine, equipped with a continuous milling fixture, is employed. The machine and fixture used for this operation are shown in Figs. 9 and 10, where it will be seen that the fixture consists of a large disk with collet chucks arranged around the periphery. Two operators are employed; the man at one side of the machine loads the rough blanks into the collets as they come around and tightens up the nut at the back of each collet, which secures the work in place. As the fixture revolves, the blanks are fed over a milling cutter which faces them off, and continued rotation of the fixture brings the faced disks around to the second operator who removes them.

The faced blanks are next taken to the heating furnace in which they are brought to a temperature of approximately 1500 degrees F. preparatory to pressing them to shape. The furnaces used for heating the blanks were especially constructed for the purpose; they are heated by gas and have a door at both front and back. One furnace is provided to heat the blanks for each of the presses. The work is introduced through the back door and pushed forward into the body of the furnace, where it is allowed to remain long enough to reach the required temperature. The press operator has a helper stationed at the front door of the furnace, and there is a metal chute leading from the door to the die-bed of the press. The helper reaches into the furnace with an iron hook and draws out one hot blank at a time. The blank is pulled to the top of the chute, down which it runs by gravity to the bed of the percussion press. The arrangement is clearly illustrated in Fig. 6.

The press operator picks up the piece with a pair of tongs, places it in position in the die and trips the press; then the ram descends and presses the part into approximately the desired shape, and as the ram rises a stripper lifts the pressed part out of the die. Just before the ram reaches the top of its stroke, a trip opens the valve of a compressed air nozzle with the result that the finished part is blown off the die into a receiver put in position at the opposite side of the press. The dies are lubricated with mineral lard oil which is applied with a swabber at intervals of twenty operations. In addition to blowing the finished piece off the receiver, the compressed air jet serves the purpose of keeping the die cool and of removing particles of scale dropped from the work.

The method of procedure followed in handling the parts cast in sand molds is essentially the same, except that these parts do not receive any preliminary machining operation. They are broken off the gates and shaken in an ordinary riddle to remove particles of sand which might exert a harmful effect upon the punch and die. The brass blanks in the riddle are then dumped into the back door of the furnace and pushed forward ready to have their temperature raised to 1500 degrees. In both cases the parts produced in this way are brought to within about 1/64 inch of the finished size, and after being pressed into shape they are taken to the machine shop where the finishing operations are performed. The rate of production is about 2500 pieces of each kind from each machine in a ten-hour day, and this surprisingly high output is obtained with an exceptionally small amount of labor. The complete force of men includes four men to look after skimming the dross from the melting pots and pouring the metal, and these men also shake out the sand molds; two men to operate the milling machine; an operator and helper for each of the two percussion power presses; one sand molder; and a foreman in charge of the department.

Examples of Typical Forms of Dies that Illustrate Principles of Design

As a supplement to the information presented in regard to the different types of dies employed in making pressure castings and the data in regard to the design of such dies, the following description of typical dies will doubtless prove of interest. Fig. 11 shows two examples of the type of die in which the metal is completely enclosed, and the construction of these dies will be fairly evident from the illustration without requiring an extended description. About the only thing that need be said is that in each case provision is made for automatically removing the work

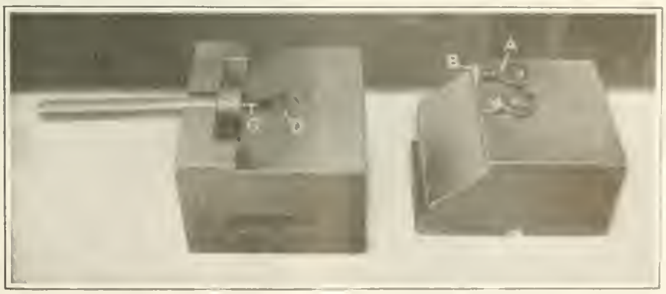

Fig. 14. Pair of Dies used for pressing Electrical Cable End from a Copper Blank. Piece made in Die is shown at A

from the die by means of ejectors A and B which are operated by the knock-out on the press.

Fig. 12 shows a case in which it was necessary to split the die in order to provide for removing the work after it has been pressed into shape. The piece to be produced is the pendant (shown in Fig. 1) for an Ingersoll watch, and the material is nickel. The blank from which the piece is pressed is a screw machine product of the form shown at A, and it will be evident from the illustration that the long cylindrical portion of this blank extends up into the hole at the top of the die. The punch is a plain cylindrical member which merely applies the necessary pressure to the top of the blank to cause the metal to flow into the die and take the desired form. An interesting feature of this operation is that the work is done cold, and the finish obtained is extremely fine.

Fig. 13 shows an example of the type of die which is of the same general class as the dies employed in making drop-forgings. The particular form of die shown in the illustration is used for making part of an oxy-acetylene welding outfit,

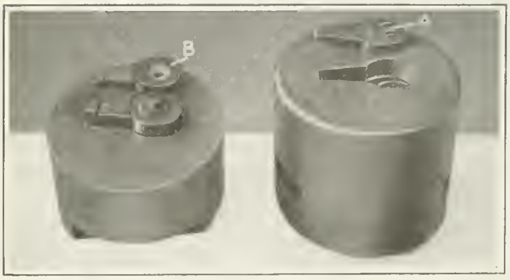

Fig. 15. Pair of Dies used for pressing Phonograph Part. Opposite Sides of the Piece produced are shown at A and B

which is shown in Fig. 1, and the design of the die will be evident from the plan and cross-sectional views of the lower member. The construction of the upper member is essentially the same as that of the lower member shown in the illustration.

The die shown in Fig. 14 is used for making an electrical cable end from copper, and one of the finished parts is shown at A in this illustration. The interesting feature of this die is the manner in which the longitudinal hole is formed in the work at B. It will be evident from the illustration that this result is obtained by means of the mandrel C, but in order to allow the knock-out D to eject the work from the die it was necessary to provide means for lifting the mandrel out with the work. This was done by having the mandrel carried on a stem which fits into a slot in the die-block so that it is free to be lifted vertically when the knock-out lifts the work from the die.

Fig. 15 shows the die used for making a phonograph part, and one of the finished parts is shown at A and B in order to illustrate opposite sides of the piece. The design of the die will be evident from the illustration, but it may be mentioned that there is a knock-out in the lower half of the die which ejects the work on the up-stroke of the press.

The die shown in Fig. 16 is interesting for two reasons. In the first place, this is a case in which a shrink-ring A of machine steel is provided to surround the tungsten steel die in order to reduce the cost and still provide sufficient strength to withstand the pressure which is developed. This illustration also affords an example of a case in which the metal is not completely enclosed, and as a result a fin is left on the work which must be removed by a subsequent operation. A clearance space B is provided in order to allow the excess metal to escape from the die.

Probable Future Application of Die-pressed Castings in the United States

In order to give an idea of the range of parts that are being produced from die-pressed castings in Germany, the statement was made that the Allgemeine Elektricitäts Gesellschaft is making over 5000 different pieces in this way. These are used chiefly on electrical apparatus, but the application of die-pressed castings is by no means confined to this field. A few examples of die-pressed castings which are at present made in this country are shown in Figs. 1 and 2, and in these illustrations the work ranges in size from a small watch pendant up to the bodies of shell fuses.

The discussion of the production of die-pressed castings which we have presented has been restricted to the methods employed in making these parts under a power press; but the possibilities extend beyond the range of such machines. In making certain large parts from brass and bronze, it is found desirable to work the metal cold, and in such cases the dies are operated by a hydraulic press of suitable capacity. The speed at which the operation is conducted by a hydraulic press would be too slow for working hot metal, but in the case of cold metal, the only limitation imposed by the speed of operation is in so far as it affects the cost of production. Examples of large brass and bronze parts pressed from cold metal are shown in the heading illustration.

Another interesting application of the method of producing die-pressed castings is in the case of nests of small gears and other parts, where the positions of the individual members of a group are required to bear a definite relation to each other. Die-pressed castings of this kind are used in place of parts which are made separately and then assembled together, and the chief advantage of the new method of manufacture is that it eliminates the labor cost of assembling. An idea of the work that can be done along this line will be obtained from the fact that one manufacturer is producing these nests of small gears from steel. The material used is machine steel and the blanks are pressed to the desired form in dies operated in a hydraulic press; no subsequent finishing is necessary. The metal is worked cold to avoid damage of the work from oxidation.

The manufacture of die-pressed castings is a comparatively new art in this country, so that any forecast as to the possible applications of the method is purely a matter of conjecture. But the gratifying results which have been obtained by those manufacturers who have taken up the work, coupled with the

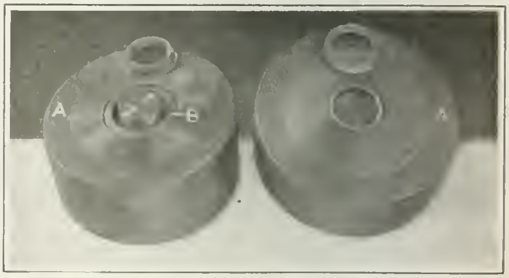

Fig. 16. Example of Die on which Shrink Ring A is employed to give Additional Strength—note Clearance Space B for Excess Metal which forms Fin on Work

fact that a great variety of parts are being successfully produced abroad, justifies the statement that the industry is one that is destined to fill an important place in the list of American manufactures.

* * *

A great deal has been said about the South American market in broad generalizations and, no doubt, with much exaggeration, for after all, the South American market cannot amount to so very much for many years to come. On the other hand, very little is being said about the Russian market, although Russia, with a population of 170,000,000 people and enormous natural resources, forms a much larger, and probably also a more desirable, market for American exporters. Of the total imports of Russia during 1912, amounting to nearly $600,000,000, more than 45 per cent were supplied by Germany, 12 per cent by Great Britain and only 7½ per cent by the United States. There is a great future for the machine industry in Russia, and after the war there will be a considerable demand for all classes of machinery.

HISTORY OF MACHINE TOOLS*

A REVIEW OF THE EARLY DEVELOPMENT OF MACHINE TOOLS IN ENGLAND AND THE UNITED STATES

BY JOSEPH W. ROE†

THE development of simple tools into complex structures to replace manual labor is comparatively recent, and may be considered as having begun near the end of the eighteenth century. The history of civilization since that time has been so profoundly affected by the work of the engineer and the mechanic that the past and the present century may well be called the "age of machinery." Every student of economics and history recognizes the influence of the steam engine, the steamship, the locomotive, and the great textile inventions on modern life, but few outside of the mechanical field know that these inventions could hardly have been conceived, and, if conceived, could not have been realized, until machines were developed with which to build machinery; hence, the development of machine tools is the basis of the development of all other classes of machinery and of modern inventions generally.

The facilities for cutting metal in 1780 were little better than those of the Middle Ages. The mechanics or millwrights of that day worked almost wholly with the hammer, chisel, and file. Without doubt, the best mechanics during the eighteenth century were the French, and their work contained suggestions of a number of the modern machine tools; but their tendency was toward refined handicraft and ingenious novelties, and they showed little aptitude for commercial production on a large scale. The real development of the modern machine tool has taken place almost wholly in England and in the United States. The general machine tools, such as the lathe, planer, shaper, drill press, and steam hammer, and the small tools, such as taps and dies, were developed in England from about 1800 to 1850. In America, partially overlapping this period, but in the main in the latter part of the nineteenth century, were developed the automatic lathe, the universal milling machine, drop-hammers, special machine tools of all kinds, and the interchangeable system of manufacture, the last involving the use of jigs, fixtures, and limit gages.

Early British Boring Machines

The first "modern" tool was a boring machine built by John Wilkinson in 1775. Smeaton had built one in 1769 which had a large rotary head, with inserted cutters, carried on the end of a light, overhanging shaft. The cylinder to be bored was fed forward against the cutter on a rude carriage, running on a track laid in the floor. The cutter-head followed the inaccuracies of the bore, doing little more than to smooth out local roughness of the surface. Watt's first steam cylinders were bored on this machine and he complained that one, 18 inches in diameter, was 3/8 inch out of true. Wilkinson thought of the expedient, which had escaped both Smeaton and Watt, of extending the boring-bar completely through the cylinder and giving it an outboard bearing, at the same time making it very much larger and stiffer. With this machine, as shown in Fig. 1, cylinders 57 inches in diameter were bored within 1/16 inch of true. Its importance can hardly be overestimated, as it insured the commercial success of Watt's steam engine, which up to that time had not passed the experimental stage.

Development of the Slide-rest

The real foundation for modern tools was laid about twenty years later in the development of the slide-rest. The best lathes then in existence were substantially like the present patternmakers' speed lathe, having wooden ways or shears, a light headstock and tailstock, and an adjustable rest for a hand tool which was used for metal as well as for wood. To Henry Maudslay, of London, belongs the credit for the development of the slide-rest. About 1800, Maudslay combined with this the lead-screw and change-gears, and from then onward the development of the modern machine tools is continuous and rapid. This combination is distinctly Maudslay's, and deserves to be classed as one of the greatest inventions of history. In the South Kensington Museum (London) are three lathes which show how rapidly the idea developed. The first is an old wooden "pole" lathe, with two dead centers set in wooden blocks. A string or strap passed from a foot treadle below, around the piece to be turned, and up to a wooden spring-pole attached to the ceiling. By working the treadle the piece was rotated alternately backward and forward, the cut being made with a hand tool during the forward movement. This lathe was built in 1800 and fairly represents the state of the art at that time. The second is one of Maudslay's first screw-cutting lathes. It has two triangular bars for a bed, cast-iron headstocks and tailstocks, and a lower spindle in the headstock between the bars connected to the live spindle by a single pair of gears. This lower spindle carried on the end toward the slide-rest a forked clutch into which was fitted a lead-screw of the desired pitch, which controlled the longitudinal movement of the tool. When a screw of another pitch was desired, the lead-screw was changed for one of the required pitch. This machine was built about 1797. The third machine, built in 1800, is distinctly modern. It has a well designed cast-iron bed, a single lead-screw with thirty threads to the inch, change-gears, and a strong, well built carriage with a back-rest to prevent springing of the work. There were twenty-eight change-gears with teeth varying in number from fifteen to fifty. With this machine are exhibited sample screws, about 2 feet long, which were cut on it, having threads varying from sixteen to one hundred per inch.

Maudslay's Influence on Machine Tool Developments

Shortly before his death in 1831, Maudslay built a lathe having a faceplate 9 feet in diameter, capable of turning fly-wheels 20 feet in diameter and boring steam cylinders up to 10 feet in diameter. This would be a good-sized machine even today, and shows how rapid was the development of the lathe within the lifetime of a single man. Maudslay built the machinery installed in the Portsmouth (England) navy yard during the years 1801 to 1807 for the manufacture of wooden pulley blocks for the British navy. This plant consisted of forty-four machines, constituting a complete range of special tools, each performing its part in a definite series of operations. The general scheme of the substitution of special machinery for the labor of skilled workmen was originated by Sir Samuel Bentham, and the design of the machines by Sir Marc Isembard Brunel. It was the first large order Maudslay undertook, and credit for the excellence of detail and workmanship in the Portsmouth machinery was largely due to him. It established his reputation and was the beginning of the wide influence over the English mechanics which he exercised for the rest of his life. One of the machines for making pulley blocks is shown in Fig. 2. It was used for cutting the groove for the fixed rope or cable. Two blocks were chucked by clamps on a swinging frame *D*, which also carried a former *G*. The cutting wheels *F* were guided in their path by a disk *H* which was in contact with the edge

* The following articles relating to the history of machine tools and kindred devices have previously been published in MACHINERY: "How we came to have the Micrometer Caliper," June, 1915; "An Early Automatic Gear Cutting Machine," September, 1913; "An Old Gear Cutting Machine," March, 1913; "Donkin's Dividing Engine—Early Machine Tools," August, 1910; "Primitive Boring Machines," July, 1910; "Chapters in the Early History of Machine Tools," September, October, November, 1909; "Recollections of an English Machine Shop," June, 1903; "Early Machine Shops and Mechanics," October, 1902.

† Address: 84 Trumbull St., New Haven, Conn.

‡ Joseph W. Roe was born at Geneva, N. Y. He took a mechanical engineering course at Yale University, and graduated with the degree of Ph.B. He has been employed by the Henry R. Worthington Pump Co., the Winchester Repeating Arms Co., J. H. Williams & Co., and the Crane Co. in the capacity of draftsman, chief draftsman, assistant superintendent and mechanical engineer, and is, at the present time, assistant professor of mechanical engineering at Yale University. His specialty is machine design. He has written a number of articles on the development of machine tools, and has made a special study of the history of the development of machine tools.

of the former-plate *G*. Maudslay & Field's shop became one of the most influential in the whole world. Joseph Clement, Richard Roberts, Sir Joseph Whitworth, James Nasmyth, and a host of others less well known, worked there; going to other shops, they laid the foundation of the supremacy which England had in tool building for two generations.

Development of the Planer

The planer, a development and inversion of the slide-rest, was invented independently by a number of men. Claims have been advanced for no less than half a dozen. Matthew Murray, of Leeds, is said to have built one as early as 1814 to plane the surfaces of D slide-valves, which were invented by Murdock, Watt's assistant, but were improved by Murray, who seems to have been the first to manufacture steam engines operated by them. Richard Roberts, of Manchester, was another of the inventors of the planer. The South Kensington Museum has a planer built by him in 1817, one of the oldest machines still in existence. It was hand-operated, with a chain-driven bed 52 inches long and 11 inches wide. Its general design is quite like that of the modern planer. It has vertical and horizontal feeds, angular adjustment and separate tool feed for the head, and a hinged tool clamp to allow the tool to swing clear of the work on the return stroke. The chisel and file marks on the bed and ways indicate that the machine was made without the aid of another planer.

James Fox, of Derby, the founder of a well known tool building concern, is said to have built a planer about 1821 for the manufacture of the frames of lace-making machinery. George Rennie, a brother of Sir John Rennie, also built a planer about 1820 without knowledge of the others existing at that time. Joseph Clement built a remarkable machine about 1825 which is illustrated and described in the *Transactions of the Society of Arts*, London, 1832. It took in work 6 feet square and about 12 feet long, and was for years known as "the great planer." The bed ran on rollers and is said to have been so accurately mounted that if a piece of paper were put under one of the rollers the rest would stop. It was arranged to cut on both the forward and backward strokes. "The power of one man was sufficient to keep it in motion for ordinary work, though two were employed to make long and full cuts both ways." For more than ten years it ran day and night on jobbing work and formed the principal source of Clement's income. Smiles says that his charge for planing, which was 18 shillings or $4.32 per square foot, amounted to about ten pounds for a day of twelve hours; or, with two shifts, to about $100 a day.

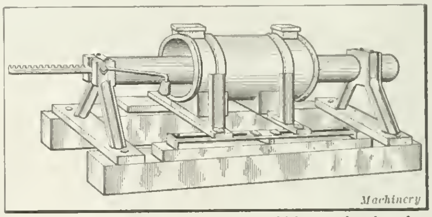

Fig. 1. Wilkinson's Boring Machine which may be classed as the First "Modern" Type of Machine Tool

Nasmyth and His Inventions

James Nasmyth was one of Maudslay's pupils. Nasmyth's autobiography, edited by Samuel Smiles, is a book which anyone interested in mechanics will read with pleasure. Nasmyth had played in his father's private workshop from earliest boyhood, and before he was twenty had become an expert mechanic with one ambition in life, to work for the great Mr. Maudslay. He went to London with his father, and together they called on Maudslay, who showed them courteously through his plant. Maudslay at first declined to consider employing Nasmyth, as he said he had never had any success with gentlemen apprentices and had definitely determined that he would never employ another. Nasmyth, however, showed him a number of drawings and a working model of a steam engine which he had brought with him from Edinburgh. Maudslay at once perceived that Nasmyth was an extraordinarily skillful workman, and he not only employed him, but took him into his own office as his personal assistant. Nasmyth stayed here for several years, until Maudslay's death in 1831, when he started in business for himself. He became one of the foremost tool builders in England, and invented the shaper which was long known as Nasmyth's "steam arm." While still with Maudslay he invented an index milling machine, shown in Fig. 3, for milling the sides of hexagon nuts. He was the inventor of the foundry ladle tilted by a worm and gear between the frame and ladle. Prior to that time, ladles were operated by hand-levers and were a source of frequent and serious accidents. Nasmyth generously refrained from patenting his invention in the interest of the safety of the workmen, and its use soon became general.

His greatest contribution to the machine-building trade was the steam hammer, invented in November, 1839. Before he had had time to build one, the immediate need for it passed and he did nothing further with it. His sketch of it, however, was shown from time to time to various people, among them M. Schneider, of Creuzot, France. In 1842, three years after the sketch was made, Schneider showed Nasmyth, when in France, some wonderful forgings, made, he said, on his steam hammer. Nasmyth, in wonder and surprise, was taken out to the forge shop and saw for the first time the steam hammer which he himself had invented. Fortunately he could still cover the machine by patent, and two months later one was obtained. The history and the influence of the steam hammer are well known. This tool enormously increased the facilities for manufacturing heavy machinery.

Whitworth as a Factor in Machine Tool Development

The work of the earlier generation of English tool builders culminated in that of Sir Joseph Whitworth. He, like most other English mechanics, was a North-country man, who had worked for both Maudslay and Clement. The succession of influence running through these men is singularly illustrated in the development of standard screw threads. Maudslay standardized the screw-thread practice of his own shop, settling upon and adhering to a definite number and size of threads for each size of screw then in use. Clement, who worked for Maudslay, adopted these standards, improved them, began the manufacture of taps and dies, and invented the tap having a small shank to enable it to fall through the tapped hole, thereby avoiding the necessity of backing out the tap. Whitworth took up the work of Clement and Maudslay, and after making a careful study of all the threads in general use, proposed, in a paper before the Institute of Civil Engineers in 1841, the standard which became general throughout the country and continues today as the Whitworth standard thread.

Most of the general tools had been invented by the time Whitworth began his independent work, but he so improved their design and workmanship that he dominated English tool practice for several generations. He introduced an accuracy in commercial work unknown until that time, which was made possible by his improvements in the methods of measurement. His gages became the standard for the country and, in fact, for the world. In 1853, Whitworth visited the United States as a member of an English commission, and it was through the recommendation of this commission that American gun machinery and interchangeable methods were introduced into England. He had an enormous influence on the development of rifles and artillery; his work in this field alone would mark him as one of the great mechanics. The very ascendancy of Whitworth's methods seems to have been an element in the loss of mechanical leadership by the English tool builders. In 1850, Whitworth was the most advanced tool builder in the world, but so great was his authority that the English mechanics adhered to his designs and methods for the next fifty years, and the leadership in tool building gradually shifted to America.

Early American Machine Tools

Tool building in America began at about the same time as in England, and has two quite independent sources. In 1789, Samuel Slater, an English mechanic, trained under Arkwright,

escaped the embargo and came to America. After a short stay in Philadelphia, he settled in Pawtucket, R. I., and there built the first textile machinery made in America. Northern Rhode Island was the home of a race of mechanics. The names of Jenks, Wilkinson, Brown, and Greene, continually occur in the records of the beginnings of manufacture in New England. Slater soon became a leader among those about him. He was a good business man, as well as mechanic, and to him more than to any other one man is due credit for the rise of the New England cotton industry. General machine tools were developed in America by these mechanics to manufacture cotton machinery, and for nearly a generation the machine industry centered about the Narragansett Bay. From here it gradually spread northward. In 1822, Slater, Larned Pitcher and Ira Gay took over a small textile enterprise in Manchester, N. H., and founded the Amoskeag Mfg. Co. Though now known as one of the greatest textile mills in the world, it manufactured in its early years locomotives, engines, boilers, machine tools, and all kinds of textile and general mill machinery. Its influence was great, and assisted materially in the development of Nashua, Lowell and Lawrence. Ira Gay left Pawtucket and later founded Gay, Silver & Co., in North Chelmsford, Mass., which, although a small shop, has been one of considerable influence.

With the development of steam navigation, Providence outgrew Pawtucket in commercial importance, and became, and has always remained, a great manufacturing center. Many of the shops which have become famous had their beginnings in the early part of the last century. The Builders Iron Foundry was started about 1820. The Rhode Island Tool Co. had its beginnings in 1834 with Jeremiah Arnold, who worked as a young man for David Wilkinson. The American Screw Co. began with the Eagle Screw Co., organized in 1838 by William Angell.

Joseph R. Brown and American Machine Tool Development

The largest of the Providence shops, the Brown & Sharpe Mfg. Co., one of the most influential in the world, was established in 1833 by David Brown and his son, Joseph R. Brown.

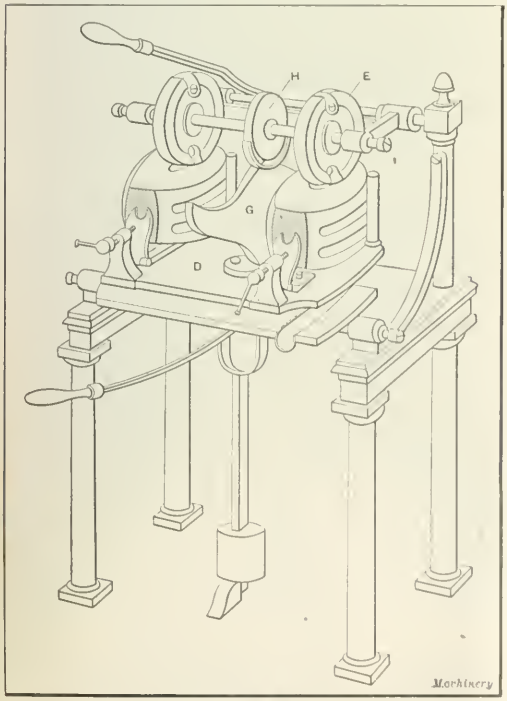

Fig. 2. One of the Machines built by Maudslay for making Pulleys for the Portsmouth (England) Navy Yard

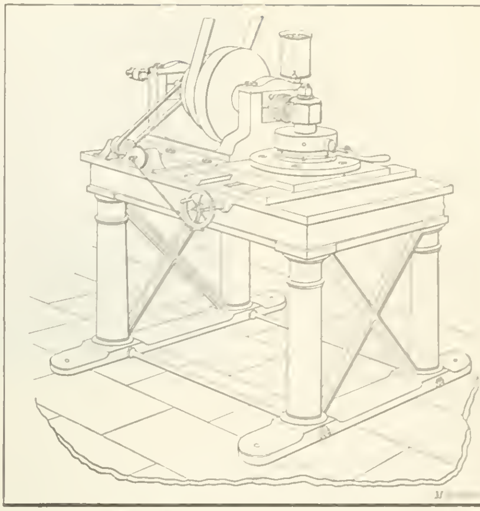

Fig. 3. Index Milling Machine designed and built by Nasmyth about 1830

Their business at first was the repairing of watches and clocks and the making of mathematical instruments. About 1850, Joseph R. Brown developed a linear dividing engine and the next year brought out the vernier caliper, reading to thousandths of an inch, which for the first time made accurate measurements possible for the everyday mechanic. The micrometer caliper, inseparably connected with the name of Brown & Sharpe Mfg. Co., was brought out in 1867. The general principle of the measuring screw is very old, and was in use in England more than 200 years ago. Watt had one, and Nasmyth tells of one built by Maudslay, which he called "the Lord Chancellor." Whitworth had before this developed measuring machines of marvelous accuracy on the micrometer principle. In all cases, however, they were either machines standing upon a bench, or were so large and clumsy as to preclude their general use. Combining a design of Mr. Wilmot, of Bridgeport, with a system of graduations devised by a French mechanic named Palmer, Mr. Brown developed the micrometer as we know it today. It is hardly necessary to call attention to the immense influence this instrument has had in the spread of good workmanship throughout all mechanical trades. As early as 1855, the Brown & Sharpe Mfg. Co. also built precision gear-cutting machines; in 1861, Mr. Brown developed the universal milling machine in order to mill the grooves in twist drills; his company also developed the relieved milling cutter, and was largely responsible for the use of diametral pitch in America. The universal grinding machine was evolved by him for the purpose of grinding hardened sewing machine parts. While by no means the originator of the automatic turret screw machine, the firm has long been one of the foremost builders of this type of machine.

Other New England Machine Tool Centers

With the spread of machine shops north from Pawtucket, Worcester became the center of tool building. A number of small shops had grown up there to manufacture textile machinery, and by 1840 these had come to have a wide influence. Samuel Flagg established the first tool building shop in the city in 1839. An apprentice, L. W. Pond, trained in this shop, ultimately bought out the business, which became the Pond Machine Tool Co., was moved to Plainfield, in 1888, and is now part of the Niles-Bement-Pond Co. In Fitchburg, nearby, the two brothers, John and Salmon W. Putnam, laid the foundations of the Putnam Machine Co. They, too, began manufacturing cotton machinery and later developed their business into the manufacture of tools. They were also manufacturers of steam engines, and had an important part in the invention of the rock drill.

Eli Whitney and Interchangeable Manufacture

The American development considered so far sprung directly or indirectly from the first of the two sources mentioned, namely, the early influences in and about Pawtucket; but the most typically American development came from another source. Eli Whitney graduated from Yale University in 1791, and in the fall of the same year he developed the cotton gin, one of the few great inventions clearly traceable to one man. Despite the fact that his patent was ultimately sustained, widespread infringements and long, expensive litigation deprived him of any adequate financial reward. Whitney, who was a clear-headed business man, saw that he would never realize much from it, and turned to the manufacture of an unpatented article, relying upon improved methods. In 1798 he obtained a contract from the government for 10,000 muskets, built a shop in the outskirts of New Haven, and laid the foundations of the interchangeable system of manufacture. Using limit gages, milling machines and rude jigs, he demonstrated that guns could be manufactured by machine tools not only interchangeably but more cheaply than by the old hand methods. About the same time, Simeon North, a gun-maker in Middletown, Conn., obtained contracts for pistols, and began a connection with the government which lasted for fifty years. A later contract signed by him in 1813 contained the first clause specifying interchangeability; "the component parts of pistols are to correspond so exactly that any limb or part of one pistol may be fitted to any other pistol of the 20,000." It is probable that the North contract of 1813 was not so much the beginning of a new method as the recognition of one which had already come into existence, for Whitney's letters and the reports of Capt. Wadsworth, the government inspector, show clearly that Whitney, at least, had been developing the idea from the "very beginning," that is, from 1798. Whitney was probably the earlier of the two, but it is certain that North was not far behind. There is no evidence that the two men knew each other or had any communication, but it seems improbable that two manufacturers, in closely allied industries, but twenty miles apart, should not have been more or less familiar with each other's work and influenced by each other's method. It is certain that the interchangeable system as a successful process of manufacture had its birth in the work of these two men. There is no question as to which had the greater influence. Whitney was already well known through his cotton gin, was located in the larger center, and did more than North to spread the system elsewhere. The armory which he founded continued in business for ninety years, when it was sold to the Winchester Repeating Arms Co. Samuel Colt had his first pistols made by the Whitney Arms Co., and when he went to Hartford to build the Colt armory in the early fifties, he not only adopted their methods of manufacture but greatly extended them. E. K. Root, his superintendent, built the new armory and designed much of its machinery. It was without question the most highly developed manufacturing plant in existence at that time, having over 1400 machines, with tools and fixtures costing about as much as the machines themselves, a proportion unheard of before. Famous mechanics worked there, among them F. A. Pratt and Amos Whitney, of the Pratt & Whitney Co., C. E. Billings and C. M. Spencer, of the Billings & Spencer Co.

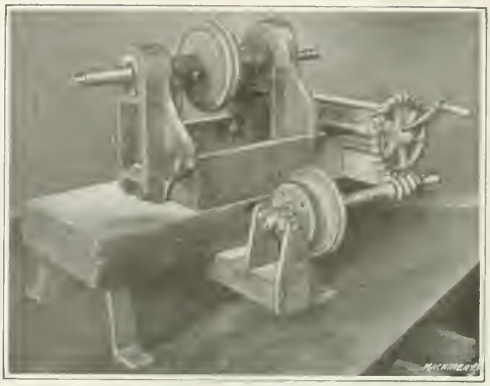

Fig. 4. Milling Machine built by Eli Whitney about 1818, supposed to be First Milling Machine built. Now in the Mechanical Engineering Laboratory of Yale University

Northern New England's Machine Tool History

Of the early gun shops three stand out clearly by reason of their far-reaching influence. The Whitney and Colt armories are two, and the third is that of Robbins & Lawrence, of Windsor, Vt., which was started a few years earlier than the Colt armory. It was one of the plants visited by the English commission in 1853, and furnished much of the machinery that was installed at Enfield. The work of R. S. Lawrence, Frederick W. Howe, and Henry D. Stone gave it wide recognition. Lawrence was a self-trained mechanic and a born gunmaker. Howe served his time in the old Gay & Silver shop at North Chelmsford, and brought from there the beginnings of the Lincoln type of miller and the turret lathe. Fig. 5 shows the Robbins & Lawrence milling machine which was a forerunner of the Lincoln type. The illustration is made from a reproduction of a drawing made by F. W. Howe, about 1853. The improvement introduced by F. A. Pratt, which differentiated the Lincoln milling machine from the machine shown in the illustration, was the substitution of a worm-feed for a rack-and-pinion drive for the table. From the Robbins & Lawrence shop Howe went to Providence as superintendent of the Providence Tool Co., and later to the Brown & Sharpe Mfg. Co. From the Robbins & Lawrence shop also sprung the Sharps Rifle Works at Hartford, which became the Weed Sewing Machine Co.; later the Pope Mfg. Co.; the White Sewing Machine Co.; the Cleveland Automatic Machine Co., of Cleveland; and the Sullivan Machinery Co., manufacturing mine equipment at Claremont, N. H. Although the old shop at Windsor passed through a number of hands, it was for many years under the superintendency of Henry D. Stone. In 1879 the company, which had become the Jones & Lamson Machine Co., moved to Springfield, Vt., and has taken a leading position among the world's builders of machine tools. Its later development is largely due to James Hartness, the inventor of the flat turret lathe, who became superintendent in 1889.

The interchangeable system is characteristic of many other industries, such as the manufacture of sewing machines, clocks, watches, typewriters, etc., but they did not originate it. Starting later, these industries utilized

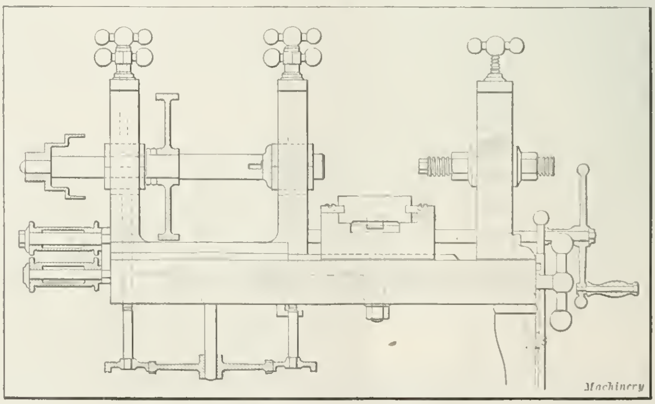

Fig. 5. Robbins & Lawrence Milling Machine reproduced from Drawing made by F. W. Howe about 1853

and developed a system already in existence. It is quite natural that the system should have been developed, as it was, by the gun-makers, since guns, particularly for military purposes, were the first articles produced in great numbers where interchangeability was clearly desirable.

Machine Tool Development in Philadelphia

Under the leadership of William Sellers and William Bement, Philadelphia took the leadership in tool building for the next generation. Bement was a New England man who, like so many others, began his work in the manufacture of textile machinery. He was a leading workman in the old Amoskeag shop and later in the Lowell machine shop. Sellers was a Pennsylvanian who received his training at Wilmington, but was for several years superintendent of the machine shop of Fairbanks, Bancroft & Co., in Providence. Three years later, in company with Mr. Bancroft, he founded the business of William Sellers & Co. There is a singular parallelism between the work of Sellers in America and of Whitworth in England. Both were superb mechanics, of commanding influence, and each standardized the screw thread practice of his country. Both Bement and Sellers are identified more with heavy machine tools than with the lighter ones; the latter have always been associated with New England.

Machine Tools in the Middle West

The spread of machine-tool building westward has been the characteristic feature of the past generation. W. R. Warner and Ambrose Swasey in Cleveland, both of them foremen with the Pratt & Whitney Co., in Hartford, have taken westward the best traditions of the New England mechanics. They have not only extended the reputation of the American mechanics for tool building, but are the foremost builders of large telescopes. Cincinnati was the center of engine building and repair work in connection with the old river traffic in the Mississippi valley. With the decay of this traffic, the attention of mechanics was turned in another direction, very largely through the influence of William E. Lodge, who went there as a journeyman mechanic in the early seventies. He was president of the Mechanics Union and widely known among the workmen of the city. In 1880, having saved a thousand dollars, he started in business for himself. His rapid success encouraged many of his old friends to undertake the manufacture of machine tools, and a large number of successful companies, each specializing in a single type of tool, has resulted. At the present time, Rockford, Ill., and Milwaukee and Madison, Wis., are becoming machine tool centers of importance.

Conclusion

Early machine tool manufacturers in the United States by no means confined themselves to copying the tools that were developed in England. The wide-spread commercial use of jigs, fixtures, and limit gages is distinctly American in origin. Maudslay's slide-rest made the lathe possible, but the turret and cam control, developed by the New England gun-makers, made it fully automatic, and enormously extended its capacity as a manufacturing machine. The board drop-hammer was also developed by the gun-makers, at Harper's Ferry, Ilion, and at Colt's. Boring mills seem to have been first used by Boduer in Manchester, England under the name of rotary planers, but their present development is American. The same is true of precision grinding machinery and the universal milling machine. Milling, as a manufacturing process, while not original in America, has been greatly extended and refined here. In the broad sense, the great contribution of America has been the automatic machine tool and the extension of precision methods to production on a large scale.

* * *

MILLING CLUTCH TEETH ON STEM-GEARS

The New Process Gear Corporation, at its factory in Syracuse, N. Y., manufactures a great many nickel-steel stem-gears on one end of which there is a three-jawed clutch. The shanks of these stem-gears are approximately two inches in diameter, there is a 1-inch hole through the center, and the three-jawed clutch is proportioned about as

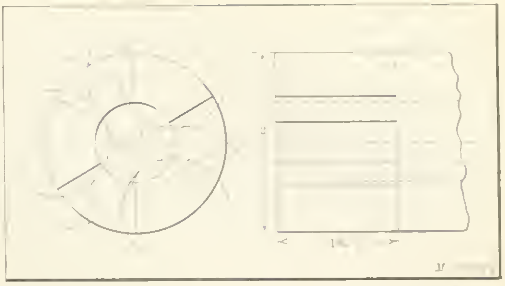

Fig. 1. Clutch Teeth and Method of removing Stock between them

shown in the line illustration, Fig. 1. The clutch teeth are milled $1\frac{3}{8}$ inch deep. It will be readily appreciated that machining these by passing a milling cutter straight through from one tooth to the other would not remove quite all the stock; there would remain a small triangular section in each of the milled sections, which would have to be removed by end-milling. In looking for a quicker way of removing this stock, it was decided to try hollow-milling. Accordingly, a circular hollow mill was made that would remove the bulk of the metal from the two spaces adjacent to one of the clutch teeth in one cut. The milling cutter was made 5/16 inch wide and of a radius that would just clear the tooth and mill away most of the stock from two adjacent sections. By setting the cutter properly, three passes clean out the stock, except for a small section on the side of each tooth, as shown in Fig. 1.

Fig. 2 shows the fixture and cutter as used in the drill press. The stem-gear is inserted from below, and by means of a strap and swing-bolts is clamped in position. The top of the fixture has three bushings spaced 180 degrees apart and these are used successively to guide the cutter for the three operations necessary to complete the milling. The base of the fixture is strapped to the table, but the housing may be turned to bring the work into the three milling positions. After the circular milling has been done, the sides of the teeth are finished by running through a straight milling cutter to size and clean up the sides of the clutch teeth. Three cuts finish the job. An operator can do the circular milling on eight stems per hour. C. L. L.

Fig. 2 Cutting Teeth with Hollow Mill

TURNING IVORY BILLIARD BALLS

HIGH DEGREE OF ACCURACY AND FINISH OBTAINED WITH SIMPLE TOOLS

BY EDWARD K. HAMMOND*

IT WILL doubtless surprise all mechanics who are familiar with the degree of accuracy and perfection of finish which is demanded on the highest grade of ivory billiard balls to know that the work of turning them is done with an extremely simple outfit of tools. Successful billiard ball turners depend upon the skill they have acquired through years of experience in the trade, rather than upon the use of mechanically controlled machining contrivances. The turning is done on a speed lathe, and the complete set of small tools is illustrated in Fig. 1. In setting up a lathe for ivory turning, particular care must be taken to have the bearings fit the spindle accurately, and to have the lathe bolted down to a solid foundation. If these precautions are not observed, vibration is likely to develop, which will make it impossible to obtain the required degree of accuracy and perfection of finish.

The Ivory that is Used

It is a matter of general knowledge that ivory is obtained from elephants' tusks, but there are probably few persons

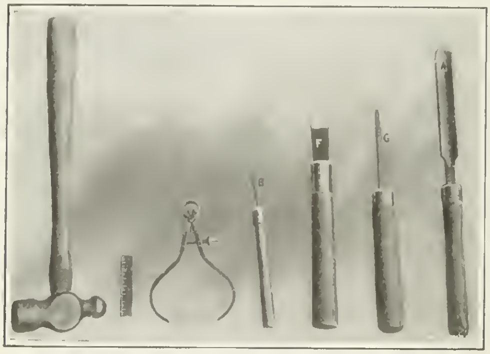

Fig. 1. Complete Set of Tools required for turning High-grade Ivory Billiard Balls

who are aware of the fact that the quality of the ivory varies greatly according to the part of the world in which it is obtained. Commercial ivory may be roughly subdivided into "hard" and "soft" ivory, and for use in turning billiard balls the soft ivory obtained from East Africa is far superior. There are several reasons for this, most important of which is that the soft ivory is more easily worked by cutting tools; also, it is not so liable to be cracked by the impact of the billiard balls while in use, or by sudden changes in climatic conditions. The ivory comes to the billiard ball turner in short cylindrical shaped pieces known as "blocks," which are nothing more nor less than sections obtained by sawing them from the tusks at the point where the latter are slightly larger than the required diameter.

The market price of ivory is in the neighborhood of $4.50

Fig. 2. Roughing out the Ball, showing how Rings are obtained

per pound, and this high price makes it necessary to work the material as economically as possible; hence only those portions of the tusks are used which are of sufficient size to enable a ball to be turned with the minimum amount of waste. This need for economy imposes a further test upon the skill of the billiard ball turner. Pool balls range from 2¼ to 2½ inches in diameter, and billiard balls are 2⅜ to 2½ inches in diameter, while the sizes of the ivory blocks from which the balls are turned are such that there is only an excess of from 1/32 to 1/16 inch of stock. Consequently, it will be evident that great care must be taken to prevent spoiling the work.

By-Products in the Billiard Ball Industry

Another interesting point about billiard ball turning is that the work is done in such a way that from six to eight ivory rings are secured as by-products in turning out each ball. The average mechanic confronted with the problem of turning a billiard ball from a commercial ivory block would naturally think that the method of procedure is to first rough out the ball and then finish it by one of the methods commonly used for turning a sphere; but while such a method would be satisfactory when working in metal, the cost of ivory is so high that the amount of material wasted would involve a serious loss. To overcome this waste, the ivory turner has developed a method of procedure by which six or eight rings are secured as by-products. These rings are of various forms and are used on high-grade harnesses, by horse breeders, and for various other purposes. While the production of these rings enables the amount of ivory wasted to be greatly reduced, the method also imposes a further test upon the skill of the turner.

*Associate Editor of MACHINERY.

Fig. 3. Natural Ivory Block, Ball half roughed out, and Three Rough Rings obtained from First Half of Block

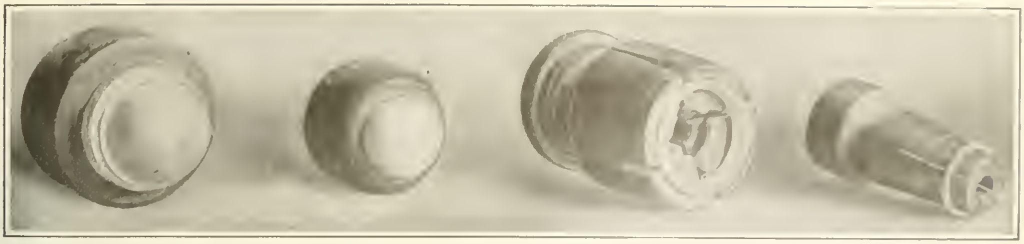

Fig. 4. Types of Chucks used for Roughing and Finish-turning Operations on Balls and Rings

The following description applies to the methods of turning billiard balls employed by Phil. Jost, Jr., 102 N. Franklin St., Chicago, Ill., and the illustrations are reproduced from photographs taken in his shop. The lathes on which the turning is done are fitted with wooden chucks which are made of either dog-wood or beech-wood. Beech-wood chucks provide the best gripping surface, but difficulty is experienced with chucks made of this material owing to the tendency for the threads to strip when the chuck is screwed onto the lathe spindle. This trouble is not so likely to occur with dog-wood chucks, and their gripping power is practically as good.

The form of chuck used for the first operation has a conical shaped gripping surface, and the ivory block is first ground down at one end on a disk wheel so that it can be driven into the chuck by striking it with the end of the hammer handle. In setting up the block ready for the first operation, care must be taken to have it run practically true in order that all of the ivory in the block will be available for turning the ball and rings. With the work set up in this way, the turner first uses the gouge *A* to take a light roughing cut over the outside of the block, and then he takes the tool *B* and starts to work in at the end of the block to bring it to the condition shown in Fig. 2. From this illustration it will be seen that a start has been made on the spherical surface and that there is also a small ring *C* which is practically ready to be cut off. The turning tool used for doing this work is ground up from an old file and is somewhat similar to a very thin parting tool, the cutting end being square with a slight clearance provided on each side of the blade. The temper of the steel in the file is drawn considerably so that the tool is fairly springy and not very brittle.

Fig. 5. Method of performing Final Turning Operation

After the small ring *C* has been removed, the turner continues to work in from the end of the block until a considerable depth has been reached; then he cuts in from the side of the block as shown in Fig. 2, in order to remove the first large ring *D*. When this large ring has been removed, the turner continues to work out the spherical surface from the end of the block, and after he has cut in far enough another large ring is removed, as indicated at *E* in Fig. 2. Half of the rough ball has now been formed, the work having reached the condition shown in Fig. 3. The block is next removed from the chuck and set up in the reverse position, so that the rough end of the block is exposed ready to continue the turning operation. A different form of chuck is used for this purpose, which has a hemispherical cavity into which the rough ball is driven. After the block has been set up, the turner works in the manner previously described, roughing out the other half of the ball and obtaining a similar number of ivory rings as by-products.

Finishing the Ball

After the rough ball has been obtained, it is still held in the chuck used for the second rough-turning operation, and the tool shown at *F* in Fig. 1 is used for removing the tool marks left in roughing out the ball and also to bring it to the condition of a more nearly perfect sphere. The method of procedure is shown in Fig. 5, where it will be seen that the only assistance given the operator in guiding his tool is that afforded by an ordinary hand-rest. After half of the surface of the ball has been turned in this way, a sharp lead pencil point is applied to the revolving ball to draw a line around it. The ball is then removed from the chuck and set up in the reverse position so that the pencil line is in approximately the same position that it formerly occupied. The same method is then followed in turning the opposite half of the ball.

After the work has progressed to this point, the ball is again removed from the chuck and set up on the reverse center, *i. e.*, while the axis of the lathe spindle was formerly perpendicular to the plane of the lead pencil circle drawn on the ball, it now lies in the plane of this circle. The turner now goes over the surface of the ball a second time, scribes another lead pencil circle in a plane perpendicular to that of the first circle, reverses the work in the chuck and turns

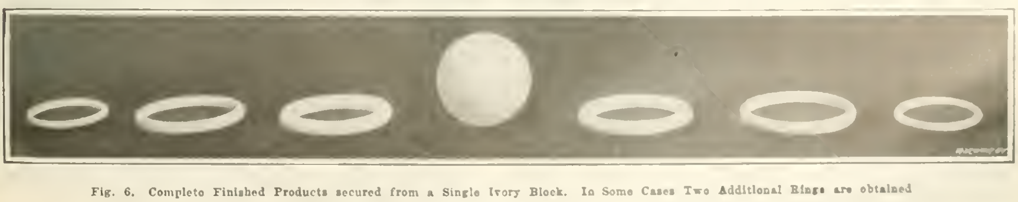

Fig. 6. Complete Finished Products secured from a Single Ivory Block. In Some Cases Two Additional Rings are obtained

the opposite side of the ball. When the work has reached this condition, the turning of the ball is practically completed.

The ball is tested for accuracy by applying a very sharp lead pencil point so that it just touches the surface of the work, and noting whether a uniform line is left as the ball rotates; the ball is then turned in the chuck and the test repeated. If uniform lines are drawn in two positions of the ball at right angles to each other, it shows that there is only a negligible amount of error in sphericity. The ball is next taken to a polishing lathe where it is set up in a similar chuck to that used for the finish-turning operation. The preliminary polishing is done with a fine grade of sandpaper that removes all tool marks from the surface of the ball, after which a white diamond polishing cake, made by the Matchless Metal Polish Co., New York City, is used to remove all scratches left by the sandpaper. After the complete surface of the ball has been gone over with this cake, the final polish is obtained by rubbing the ball with a cloth saturated with alcohol, while it is held in the rotating chuck. The finish obtained in this way is that with which we are familiar on the highest grade of billiard balls.

Turning the Rings

Fig. 3 shows the ivory block as it was cut from the elephant's tusk, the condition of the work after half of the ball has been roughed out, and the three rough rings obtained from half of the block. The method of procedure in finishing the ball has already been described, and we are now concerned with the way in which the rings are finished. The two forms of chucks used for this purpose are shown at the right-hand side in Fig. 4, where it will be seen that one is of similar design to a collet, except that the grip on the work is obtained by the spring in the wood; while the other is an expanding chuck which secures its grip in the same way. In roughing out, the rings are placed in the internal chuck and reduced to approximately the required shape. The tool used for turning the rings is shown at G in Fig. 2. The finishing operation is generally performed with the ring held on the expanding chuck shown at the extreme right-hand side of Fig. 4, and this chuck is always used for finishing the small rings shown at the extreme ends in Fig. 6, which are the finished products obtained from a single ivory block. That such a high quality of workmanship can be obtained with such simple tools speaks highly for the skill of the men employed in this industry.

* * *

MAKING SLUSH CASTINGS*

The process of slush-casting is used extensively in the manufacture of ornamental objects of spelter or zinc. Hollow and therefore relatively light castings are produced. The molds used are of metal, usually bronze or brass which can be machined evenly and which will not be injured by the molten metal. Faithful reproduction of intricate designs can be made by this means provided a metal suitable for casting purposes is available which melts at a relatively low temperature and which will not crack and pull apart under cooling stresses. The process is substantially as follows:

The metal is poured into the hollow mold until it is full and then the mold is immediately emptied, leaving a thin-walled casting chilled upon the inside surface. The mold is usually mounted upon trunnions or otherwise arranged to facilitate rapid emptying.

Because of extensive use for ornamental purposes castings so produced are often plated, stained or treated in other ways to produce color effects. Therefore other properties are required of the cast metal besides that of perfection of surface and accurate reproduction of pattern. The surface must not only be a faithful reproduction of the mold with a smooth surface but must be free from small cracks or pin-holes. A large flaw which can be readily seen can be removed by chipping and filling with solder, or the casting may be rejected and remelted, but a small flaw may escape a careful inspection; flaws of this kind may take up and hold some of the liquor from the plating solutions and thus cause a stain to appear later. Hence, for good work, it is necessary to use a metal which will give castings entirely free from cracks or flaws of any kind. Following are some conditions that must be borne in mind both as to the metal used and the casting practice: (1) The production of as light castings as possible, consistent with the strength demanded by the use to which they are to be put, thus making for economy in metal. (2) The use of a metal that is subject to minimum losses of oxidization, drossing, etc., while standing molten in the pot. (3) The production of as large a percentage of perfect castings as possible, thus cutting down the loss of time and labor to a minimum.

These three factors necessarily interfere to some extent. Their dependence on the conditions of operating is very close. Economy in the use of metal is possible only with a metal possessing a small solidification range and high fluidity at the time of casting. A high casting temperature will aid this. Economy of metal as regards loss by oxidization at the surface is obtained only by low casting temperature and the least possible manipulation of the bath. This conflict between the high and low casting temperatures as required by the first and second conditions means a compromise decided by experience. Economy of time depends upon the employment of a reliable metal, one giving uniformly dependable results, and experience on the part of those handling the process, together with the strictest attention to the control of the operating conditions. The constant use of the thermocouple and galvanometer should replace judging temperatures by the eye.

The common impurities of spelter are cadmium, lead, iron and zinc. The American Society for Testing Materials has separated the spelter into four grades depending upon the amount of impurities present as follows:

High-grade spelter shall contain not over 0.5 per cent cadmium, 0.7 per cent lead, and 0.3 per cent iron, and the sum of these impurities shall not exceed 0.10 per cent.

The intermediate grade of spelter shall contain not over 0.5 per cent cadmium, 0.2 per cent lead, 0.3 per cent iron, and the sum of these impurities shall not exceed 0.5 per cent.

Brass special spelter shall contain not over 0.75 per cent cadmium, 0.75 per cent lead, 0.04 per cent iron, and the sum of these impurities shall not exceed 1.2 per cent. No aluminum is allowed in any of the foregoing spelters.

Common or prime western spelter shall contain not more than 1.5 per cent lead and 0.08 per cent iron.

The qualities required to make up a perfect casting metal may be summed up as follows: (1) The metal must yield casting free from cracks or flaws of any kind. (2) The surface must be smooth and bright. (3) The weight must be low enough to be economical. (4) The metal must not be too sensitive to variations of temperature of pouring.

* Extract from paper presented at the annual meeting of the American Institute of Metals, held at Atlantic City, N. J., September 28 to October 1.

* * *

About two years ago, the General Electric Co. announced that its research laboratory had developed a process for the protection of metals subjected to high temperatures. The process, originally called "calorizing," produced a rich aluminum alloy upon the surface of the metal to be protected. In other words, the metal is insulated with aluminum, from which was derived the name "insuluminum." The process by which insuluminum is produced consists briefly in packing the parts in a mixture consisting of alumina, powdered aluminum and ammonium chloride in a gas-tight crucible. The crucible is filled with a reducing or inert gas to prevent oxidization of the aluminum. The temperature is slowly increased until it reaches 1742 degrees F. at which temperature the pieces are held for approximately three hours. The process is similar to the cementation process used for converting iron into tool steel. The result is not a coating of aluminum but an alloy of aluminum with the metal beneath. The claim is made that steel pipe treated by the insuluminum process will withstand exposure to combustion gases without deterioration at a temperature from 800 to 1700 degrees greater than the uncalorized metal can withstand. Experiments have been made at temperatures of about 2500 degrees F. on calorized pipe without causing apparent deterioration. Sulphur dioxide gas at high temperatures has little or no effect.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Ford Sale Contracts Uninforcible

(Federal) The United States District Court, Southern District of Ohio, has recently held in Ford Motor Co. v. Union Motor Sales Co. that the form of sale contracts used by the Ford Motor Co. is in restraint of trade and uninforcible. The Ford Motor Co. manufactures "flivers" under its own patents and sells the same to dealers, receiving therefor the prices it has fixed, but by contracts with such dealers it is provided that the machines will be resold by them at the full advertised list price only, and that a violation of such provision shall constitute an infringement of the patent, subject the dealer to the payment of a fixed sum as damages, and authorize a cancellation of the contract; also that title to the particular machine or machines so sold shall revert to the Ford Motor Co.

The Union Motor Sales Co., the Cincinnati distributor, sold Ford cars in violation of its contract. The Ford Motor Co. brought this suit to recover damages and to cancel the contract of agency.

The District Court held that the contract was one of sale of the machines, and not the right to sell, that on full payment of the purchase price of a machine it passes beyond the patent monopoly, and that so far as the contract attempts to fix the price at which only it may be sold thereafter it is illegal, as in restraint of trade and uninforcible. Justice Hallister said in part, "For the purposes of this case it may be assumed that if the contract partakes of the quality of a sale, of the exclusive right to sell, or of a license to sell, it is a good contract, which the complainant may legally enter into with its dealers, and, under the facts proved in this case, an injunction must issue against the defendants. But if, under the terms of the contract, the complainant has sold the automobiles made by it and delivered the same to its dealers, passing the title upon receipt of the contract price, then, under the decisions of the Supreme Court and on principle, the conclusion, in my judgment, must be that by such sale the complainant has exercised its exclusive right to sell, so far as the particular commodity sold is concerned, and cannot legally fix the price at which the dealer shall resell.

This contract does not give the vendee the right to sell. It sells to him the article, and attempts to give him the right to resell. He buys. The manufacturer-patentee sells the product to him, and then seeks to control the price at which he shall resell. If, upon payment by the dealer of the purchase price, the title of the machine passes to him, how can it be taken away because the user, to whom the dealer has sold, has paid a less price than the list price?

The purpose of complainant's contracts with its dealers is to prevent competition between its dealers, each of whom has paid it all it asked. The vice in them is that the patent law does not confer power on the patentee to prevent competition among those who have purchased the patented article from him. I am therefore of opinion that these contracts (the opinion being restrained to the facts in this case) are invalid, and that the defendants in causing them, or attempting to cause them, to be broken, have done the complainant no wrong cognizable by the law." *(Ford Motor Co. v. Union Motor Sales Co., 225 Fed. 373.)*

Violation of Factory Rule with Relation to Machinery

(South Carolina) An overseer of a section of a mill who opens and cleans machinery in motion in violation of a rule of employment forbidding the cleaning of machinery in motion is guilty of negligence as a matter of law, and an employe working under him sustaining injury while at work in cleaning machinery in motion may recover from the employer therefor. *(Newsom v. Poe Mfg. Co., 86 S. E. 195.)*

Proximate Cause of Accident

(Mississippi) Where a lumber company provided a safe contrivance to control its machinery, employed in hauling logs up an incline to its saw shed, and a servant, instead of using such means to stop the machinery, when a belt was slipping off the wheel, placed his foot against the moving belt, a projection on which struck his foot and injured him, the servant's act was the proximate and sole cause of his injury, and the master was not liable. *(Ovett Land & Lumber Co. v. Adams, 69 So. 499.)*

Sale of Stock in Machine Company

(Delaware) Where a corporation owned a patent, and the sole inducement for the purchase of its stock by another corporation was to obtain control of such patent, the buying corporation could have specific performance of the contract for the sale of stock against the seller rather than recovering damages for the failure to perform, since the equitable doctrine of specific performance applies to contracts for the sale of personalty having a unique value, and not generally dealt in on the market, so that money damages will not afford a certain and adequate remedy at law. *(U. S. Fire Apparatus Co. v. G. W. Baker Mach. Co., 95 A. 294.)*

Statement of Salesman Excluded

(South Carolina) Where plaintiff manufacturer of machinery for re-weaving jute bagging gave written warranty upon a sale that its machine would work jute bagging, but not that it would work sugar sacks, in an action for the price, in which the buyers counter-claimed for damages, the action of the court in excluding evidence proving damages from the alleged failure of the machinery to work sugar sacks was proper, since a written warranty cannot be enlarged by parol testimony.

Such was the holding in Smith & Furbush Machine Co. v. Johnston, Supreme Court of South Carolina.

The machine company brought the action to recover $4150, the balance of the purchase price of the machinery sold to Johnston. Johnston denied liability on account of defects in the machinery. He also alleged that the machinery had not come up to warranty. In the trial court an effort was made to introduce in evidence certain verbal statements made by the machine company's salesman at the time the machinery was sold, such statements in effect warranting the use to which the machinery might be put. The judge of the trial court refused to permit the introduction of this evidence saying that the warranty was in writing and incorporated in the contract of sale. The trial court found for the machine company and an appeal was taken to the Supreme Court where the judgment was affirmed. *(Smith & Furbush Machine Co., v. Johnston, 86 S. E. 490.)*

* * *

CONSISTENCY IN WAGE PAYMENTS

Nothing is so vital to the workman as the pay he gets. Working conditions may be bad but if the pay is good he will generally stick, and if he leaves there will be no lack of others competent to fill his place. But let the wages be low, and all the welfare work and comfortable shop facilities will not reconcile him to the fact that he is not adequately compensated in dollars and cents.

The just employer recognizes this simple fact and pays the going rate to ordinary workmen, and higher rates to those more highly skilled and efficient. But when he has done this, has his duty been done to labor in general that makes the things he buys if he invariably buys from the lowest bidder? Emerson wrote that "consistency is the vice of little minds only", and apparently few have little minds if this be a test. One of the largest employers of labor in the metal-working industries has raised the wages of employes far above the going rate, but he screws the prices of the things he buys down to the last notch. In fact, this policy is so well known and notorious that a manufacturer who has secured a large contract from the aforesaid concern is looked on with suspicion by the bankers when he tries to borrow money on the strength of it. The banker knows from experience that the contractor has probably made a losing bargain or one that will net him but little profit.

Is this just to labor? Surely not. The workmen in the contractor's shop must work for low wages or at heart-breaking speed if the contractor makes good. These workmen are entitled to good wages as much as the men in the manufacturer's own plant. How can he make flesh of one and fish of the other?

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THE press working of metals is a highly interesting subject and one having many varied developments which by no means have yet reached their climax. New problems are being worked out daily and metal working practice is being changed to a marked degree. The forging of iron and steel in dies has been practiced by blacksmiths from time immemorial, and drop-forging by means of dies in drop hammers has within the last fifty years become a highly important industry. The shaping of sheet metal cold in power presses also has attained much importance, and is another great specialized industry, producing yearly vast numbers of manufactured parts in iron, steel, copper, brass, aluminum and nickel. Coining presses used for the cold impression of coins, medals, transmission chain parts and other pieces produced in large numbers which require embossing or chamfering have an important place in the manufacturing world. The ramifications of press and hammer working presses are many, and a list of all would be extensive. Cold and hot swaging by rotary and vibrating hammers and rivet spinning are more examples of the many that might be cited.

Within the past decade, another application of presses of both the hydraulic and so-called power types has come into use, which up to this time has not been featured prominently in the technical publications. This is the press molding in dies of metal "ingots," both hot and cold. Brass, bronze, copper, aluminum and nickel castings and forgings are compressed and made true to form by being squeezed in dies by special presses of great power. Press molded castings are improved in physical characteristics, minute blow-holes are closed, the roughness inevitable with sand castings is corrected, and in some cases the need of subsequent machining is dispensed with. The possibilities of press molding are apparently limited only by the available sizes and power of presses and strength of the dies. The intensity of pressures produced is very great, often exceeding those developed by the explosion of the powder charge in large guns, and in some cases being over 100,000 pounds to the square inch.

In another part of this number is the first article of importance dealing with the work, dies and machines used in this machine die molding or casting practice. Who can say to what extent this process may displace the typical machine tool operations? Press molding of steel is already being done on a limited scale, and greater developments undoubtedly will be worked out when more highly resistant steels are available for die construction, opening a field for fruitful investigation in determining the laws governing the flow of metals under pressure. Much is yet to be learned about the action of highly refractory metals under great pressure and the forms of dies that favor the greatest displacement with the least pressure.

* * *

A COMMITTEE appointed by the American Society of Mechanical Engineers recently completed a boiler code which probably will rank with the most valuable standardization work accomplished by any engineering society. This code, which represents months of untiring work by men thoroughly familiar with boiler design and the conditions of the trade, is based not merely on theory, but on the common sense of practical men, who took into consideration all the trade as well as technical conditions with which the boiler industry is concerned. Boilers built under this code are already acceptable to the boiler departments of the states of Ohio and Indiana, and to the cities of Detroit and Chicago. The authorities of Pennsylvania, Wisconsin and California have accepted the code, to be put in force later, and a movement is on foot to secure legal adoption by all the other states.

The code has been endorsed by the American Society of Mechanical Engineers, the American Boiler Makers' Association, the National Tubular Boiler Manufacturers' Association, the Master Boiler Makers' Association, the Hartford Steam Boiler Inspection & Insurance Co., Fidelity & Casualty Co., Maryland Casualty Co., London Guarantee & Accident Co., Ltd., National Threshman's Association and the National Electric Light Association.

The legal adoption of the code throughout the United States would undoubtedly result in great benefits to boiler makers and users, making for the preservation of human life and property, and for increased engineering efficiency.

* * *

THE development of toothed gearing and the machinery for cutting gear teeth, is one of the most interesting phases of machine design and construction. The earliest gears were made entirely of wood and were followed in mill construction by mortise gears, that is, cast-iron centers and rims with wood teeth set in mortises cast in the rims. The all-cast gear was made possible by improvements in patternmaking and foundry methods. But no perfection of foundry practice, even machine molding the teeth, resulted in producing gears with the accuracy of pitch and tooth contours required for smooth and even power transmission. Helical gears used in rolling mills were cast with all the care possible, and while superior to cast spur gears were still short of the perfection sought.

Some years ago it was realized that gears of the largest size should have machine cut teeth; but the difficulties of accurately cutting steel gears of three or four feet face and twelve or fifteen feet diameter, especially helical gears, were enormous. The development of hobbing machines for cutting spur and spiral gears of common dimensions opened the way for successful machines, capable of handling the largest gears used in steel mills. The progress of the hobbing cutter across the face is not localized between two adjacent teeth, but takes place comparatively slowly as the hob traverses the entire periphery. Thus the evil effects of heating and consequent distortion of the blank and cutter are minimized.

The great hobbing machine described in this number is believed to be the largest machine of this type yet built. It is interesting not only because of its unique features, but also because it marks another forward step in the perfection of heavy machinery. The millwright's limits are no longer the smaller divisions of a carpenter's two-foot rule—he requires the transit and other instruments of precision when massive cut gears are erected. A watch movement is no more accurately made, comparatively speaking, than the best rolling machinery now provided for the modern steel works.

WEIGHING-SCALES

PRINCIPLES OF OPERATION OF THE COMMON TYPES OF SCALES AND METHODS OF INSPECTING AND TESTING

BY F. J. SCHLINK*

F. J. Schlink †

THE operation of weighing is so familiar to those in the engineering trades and professions that very few give any thought to the process itself or to the principles involved. As a matter of fact, however, the accurate determination of the weights of commodities involves considerations of considerable complexity. Most people have a false impression of the accuracy which is attained in ordinary commercial weighing; the belief seems to be very common that any sort of apparatus is good enough for this work, and that the most perfunctory care or no care at all is sufficient to keep it in serviceable condition. Work recently done by the Bureau of Standards in the inspection and testing of weighing-scales has illustrated very forcibly the need of improvements in the methods of design and manufacture, of better care of weighing-scales in service, of a systematic provision for their regular test, and of the supervision of the conditions of their use.

Frequently scales are found whose condition is such as to make their use in the highest degree inadvisable for any sort of weighing; they may even be inaccurate to the extent of 10 per cent or more, while inaccuracies of 3 to 5 per cent are not at all infrequent. Yet such scales are often used for the weighing of high-priced commodities and the weights obtained are made the basis of purchase or sale. Even new scales are often unsatisfactory and inaccurate, whether on account of defects of design or manufacture, or what is perhaps more common, improper installation. A general knowledge of the principles of operation of the various types of scales in common use, and of the proper methods of their inspection and testing is a desirable acquisition for any man whose duties bring him into close relation with such apparatus. It is the purpose of this article to outline these principles in such a manner as to make them of service to the engineer and the mechanic.

Types of Weighing-scales

Let us first note briefly the types of weighing-scales in common use in the mechanical industries. The first is the precision balance, used in chemical and metallurgical laboratories, and wherever the weight of small quantities must be determined to a high degree of precision. Such balances are usually of the equal-arm type, with pans hung below the beam and carried on knife-edges of agate or hardened steel. The use of such balances requires a high degree of skill and care, and is usually confined to the laboratory, where the requisite freedom from vibration and other disturbing factors can be maintained.

Where large quantities are to be weighed and the character of the work is such that great precision is not needed, platform scales are commonly used. Most of the scales used in shops and industrial establishments are of this sort. Under platform scales may be classed the portable platform scale, adapted to be moved from place to place, the large so-called dormant scale used in warehouses and factories for weighing heavy crates and trucks, the wagon or auto truck scale, for weighing loaded horse-drawn or motor-driven vehicles and the track scale, used for weighing railway cars, either as the basis of purchase or sale of a commodity, or for the determination of the charge to be made for transportation.

In addition to those named, there are a few other types of scales in common use. Among these may be named the crane scale, used for weighing loads while they are suspended from a crane, the dynamometer, for the measurement of the power output of a prime mover, or for the determination of the tractive force required to move a car or truck, and the materials testing machine, which is used to determine the breaking strength and elastic properties of structural and other materials.

Construction of Platform Scales and Causes of Inaccuracy

Fig. 1 shows in diagrammatic form the construction of a common type of platform scale, giving the names which are commonly applied to the various parts. The small triangles are the knife-edges, and the cross-hatched parts indicate members which are affixed immovably to the frame of the scale. In order that the weight indication may be independent of the position of the load on the platform, the following relation must apply:

$$\frac{a_1}{c_1} = \frac{a_2}{b_2} \qquad (1)$$

The leverage ratio R, or multiplication of the scale, is defined by the equation:

$$R = \frac{b_2}{a_2} \times \frac{c_2}{a_2} \qquad (2)$$

The amount of weight required on the counterpoise pan to balance a given load on the platform is found by dividing the platform load by this ratio R. In order that this multiplication may be a definite and unchanging quantity, the knife-edges must be affixed to the lever and not to the connecting element; they must be sharp, and hard enough so as not to flatten appreciably under the loads which they are to carry; and the knife-edges in any lever must be parallel to each other. The knife-edges in any lever should lie approximately in a single plane, for reasons which will appear later. The planes through the bearing lines of the knife-edges belonging to the several levers must be parallel to one another, and the same is to be said of the loops and rods which connect the levers to each other. In practice, the levers are usually arranged so as to lie with the plane of the knife-edges horizontal and the lines of the connections vertical.

These are points which are not well understood. In adjusting the distance between the knife-edges, the manufacturer uses standard weights which are hung from the knife-edges, the lever and the attached weights being mounted so as to swing freely as a simple balance. The forces acting on these knife-edges, then, are in the direction of gravity, that is, vertical, and the parts of the scale when installed must be so placed that the same direction of the forces will obtain. If this is not the case, the lever arms of these forces will not be the same as they were at the time the adjustment was made, and the scale will be incorrect.

These relations will be easily understood from Fig 2. Suppose that the lever shown here was so adjusted that the ratio of its arms was 4 to 1; this relation having been obtained by hanging weights of, say, 10 and 40 pounds, respectively, from the two end knife-edges, and then altering the distances a and b by shifting the knife-edges or by grinding back their faces so that the lever balance so formed came to a condition of equilibrium. If now this lever were set up in a scale in such a manner that the loops connecting its knife-edges to those of another lever were not vertical but inclined, as indicated by the dotted lines in the figure, the ratio would no longer be $a:b$, but another value which would be defined as $R = \frac{a \cos \alpha}{b \cos \beta}$ The force relations which were intended to prevail would no longer exist, and the scale would be incorrect, the amount of this inaccuracy depending, as shown by the equation just

* Assistant physicist, Bureau of Standards, Washington, D. C.

† F. J. Schlink was born in Peoria, Ill., in 1891. He graduated from the University of Illinois in 1912 with the degree of B.S. in mechanical engineering. He has worked for the Harmon Engineering Co., Matthiessen & Hegeler Zinc Co., Goldschmidt Detinning Co. and Bureau of Standards, in the capacity of draftsman, designer of machinery and plant equipment assistant mechanical engineer and assistant physicist. His specialty is weighing scales and related weights and measures problems.

given, upon the lengths of the lever arms, and the degree of inclination of the two connecting-rods to the plane defined by the knife-edges in the lever.

Sensibility of a Scale

The quality of accuracy in a scale is not alone sufficient to insure its suitability for a given purpose. It must also have a proper sensibility. The sensibility of a scale or of any engineering instrument is its ability to respond to small variations in the quantity which it is to measure. It is usually expressed in terms of the distance or angle traversed by the pointer or other reading or indicating device for a unit change in the quantity being measured.

In a weighing-scale it is found convenient and advantageous for a number of reasons to invert the ratio and use the term "sensibility reciprocal." The following definition of this quantity has been adopted at the tenth annual conference on the weights and measures of the United States: The term "sensibility reciprocal" is defined as the weight required to move the position of equilibrium of the beam, pan, pointer, or other indicating device of the scale a definite amount at the capacity or at any lesser load, the effect of friction in causing inconstancy of this position of equilibrium being eliminated.

A platform scale, as illustrated in Fig. 1, is usually provided with a loop at the end of the beam, or other means to limit the motion of the beam to a suitable and convenient amount. Therefore in the case of platform scales the sensibility reciprocal is defined as follows: In scales provided with a beam and trig-loop the sensibility reciprocal is the weight required to be placed upon the platform to turn the beam from a horizontal position of equilibrium in the middle of the trig-loop to a position of equilibrium at the top of the loop. The sensibility reciprocal may be determined by subtracting the weight instead of adding it, thereby causing the beam to assume a position of equilibrium at the bottom of the loop; or indirectly, by moving the sliding poise on the beam the required amount in either direction, to obtain the specified change in the position of equilibrium of the beam; or by adding or subtracting small weights to or from the counterpoise until the specified change is obtained, and determining the equivalent of the small weights used, in terms of weight on the platform.

Distinction between Sensibility and Accuracy

The sensibility and accuracy of scales are often confused, for the user is likely to assume that a scale which responds readily to slight changes of load is an accurate scale. The sensibility of a scale is not directly a measure of its accuracy. It indicates only to what degree of precision readings may be

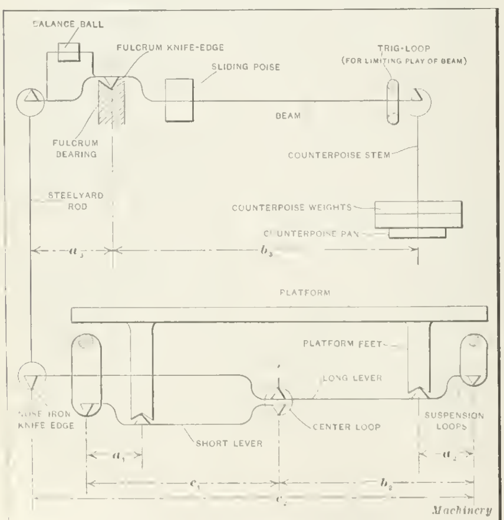


Fig. 1. Construction of Common Form of Platform Scale and Names of Parts

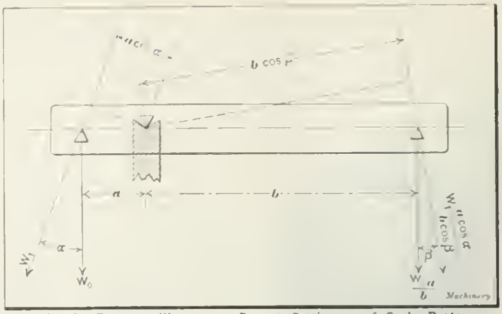


Fig. 2. Diagram illustrating Correct Setting-up of Scale Parts

taken, provided proper allowance be made for the error or correction of the scale at that reading, the effect of friction being considered eliminated.

The factors which determine the sensibility of a platform scale or of any scale in which the reading is obtained through the operation of a lever system oscillating about a definite position of equilibrium, are given by a complex expression which it will be of little service to develop here. It may be said, however, that within certain limitations, the sensibility, which in practice is controlled by adjustment of the beam of a scale, increases with: (1) increasing length of beam; (2) decreasing weight of beam; (3) decrease of distance at which center of gravity of beam lies below its center or fulcrum knife-edge; (4) decrease of multiplication or leverage ratio of scale.

Determination of Indications of Scales

The indications of a platform scale are obtained as a rule in either one of two ways or by a combination of the two. The first method, and the one allowing the higher accuracy consists in the use of counterpoise weights which are placed upon the counterpoise pan in sufficient amount to bring the scale to a balance under the applied load.

The second method consists in employing a sliding or traveling weight which is adapted to be moved along the beam until the effective lever arm upon which the poise acts is sufficient to bring the scale to balance. In many of the commoner types of scales these two methods are used in combination, the sliding poise being used for the determination of the weight in the intervals between the values represented by the counterpoise weights. In many of the later designs, especially those of large capacity, sliding poises alone are used, as by this means the handling of loose weights and the attendant possibility of errors in totaling are eliminated, and besides the speed of weighing is materially increased.

In order that the graduations on the beam may not be too closely spaced for convenient reading, the principal poise is often constructed so as to be set accurately in position by engagement with notches in the beam, and is provided with a secondary and smaller poise or a bar moving within its body, this secondary poise being used for estimation of the values between those represented by the notches on the beam.

Relation of Fineness of Graduation to Sensitiveness of Scale

The sensitiveness of a scale should be properly correlated to its probable accuracy and the fineness of its graduation. In the case of platform scales, the sensibility reciprocal should not be greater than the value represented by two of the minimum graduations upon the beam. This relation is based upon the assumption that the reading of the scale cannot be estimated more closely than one-half of the sensibility reciprocal, as this corresponds to about the smallest motion of the beam in the trig-loop which may be discernible with certainty in ordinary use. One might be inclined to ask why a scale should not be made as sensitive as possible, in order that the utmost precision of reading could be secured. The obtaining of a very high sensitiveness is fraught with numerous practical difficulties. The least wear occurring in a scale will change the position of the center of gravity of the levers in relation to their centers of rotation, so that a scale always tends to become less and less sensitive with use. Further-

more, a high sensibility is always accompanied by a slowness of action, that is, a long period of oscillation of the beam, increasing the time consumed in weighing. In the case of platform scales for industrial use the precision of reading and the fineness of graduation necessary for a given purpose should be determined by experience or the special needs of the case, and the scale then adjusted to have a sensibility reciprocal to correspond.

Testing Scales

The test of a weighing-scale is ordinarily made with standard weights; loads are applied at the nominal or rated capacity and at several fractions of the capacity, and the indications of the scale compared with the known load. The errors of a scale vary somewhat from time to time, and according to the position of the load on the platform, so that it is as a rule impracticable to determine the errors of a scale once for all. For this reason, the commercial and routine test of a scale is usually a tolerance test, that is, the test is made, and the scale adjusted, if necessary, so that the errors are within certain small predetermined values, chosen by experience and properly suited to the general uses to which the scale is put and the conditions of its service. These values are called tolerances, and are given for platform scales in Table I.

Tolerances

The tolerances to be allowed in excess or deficiency on all platform scales, except counter platform scales, shall not be greater than the values given in Table I; provided, however, that the manufacturers' tolerances or the tolerances on all new platform scales, except counter platform scales, shall not be greater than one-half of the values given; and provided further, that these tolerances on all these platform scales, shall in no case be less than the value of one of the minimum graduations on the beam except that the manufacturers' tolerances or the tolerances on new apparatus shall in no case be less than the value of one-half of one of the minimum graduations on the beam. The maximum sensibility reciprocal allowable on all platform scales, except counter platform scales, shall not exceed the value of two of the minimum graduations on the beam, at the capacity of the scale or at any lesser load. Provided, however, that the manufacturers' maximum sensibility reciprocal or the maximum sensibility reciprocal on all new platform scales, except counter platform scales, shall not exceed the value of one of the minimum graduations on the beam at the capacity or at any lesser load.

The test of a scale is usually performed at its capacity load, if practicable to apply weights to that amount; at one-half of the capacity or less, with the load concentrated at prescribed points upon the platform; and at certain loads determined by the maximum reading of the several bars of the beam, or of the reading face. A detailed outline of such a test will be given hereafter.

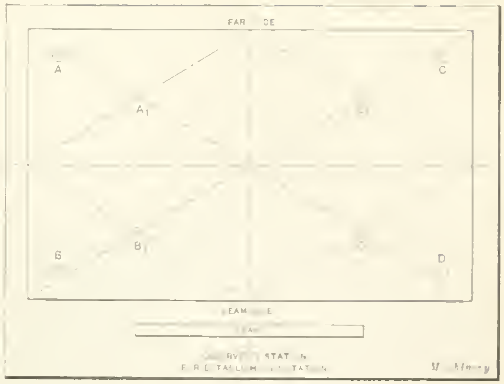


Fig. 4. Notation for Load Positions on Platform Scales

Test Weights

The test weights used are made in various denominations and forms, but for making up the platform load used in the test of a platform scale, fifty-pound test weights are most useful. These weights should be accurately adjusted in conformity with the national standards of the country. Their adjustment can only be maintained by protecting them from abuse or misuse, and by occasionally checking them up against standards of known constancy and accuracy. Fig. 3 shows a common and satisfactory form of fifty-pound test weight, made of cast iron and well adapted to the testing of platform scales. The weight is provided with a cavity as indicated, in which lead or other material is added to bring it accurately to its value. This cavity is closed with a screw, over the head of which is placed a seal of lead or aluminum, which secures the adjusting material from unauthorized or careless alteration. Cast-iron weights change in value slightly from time to time on account of changes going on within the mass, due to atmospheric and other causes, and the wear and abrasion common to all weights affect these also. They must therefore be checked at regular intervals against standards of higher constancy. For weights of higher grade, used as reference standards, brass, protected by a coating of lacquer or gold-plating, is commonly used.

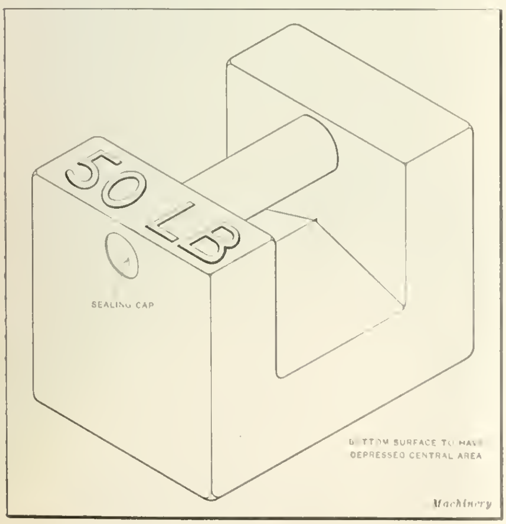


Fig. 3. Satisfactory Form of Fifty-pound Test Weight

Inspection of Parts of Platform Scale

In the following will be taken up briefly the mode of inspection and test of a platform scale. The test of a scale should invariably be preceded by a thorough inspection of its parts. The knife-edges and bearings should be carefully examined for the presence of rust and dirt. If the knife-edges are badly flattened from rust or wear, or if the operating parts are jammed with dirt and foreign material, the test should not be carried out until the parts are set aright. Knife-edges which are rusty and worn should be replaced and refinished by a competent scale mechanic.

The moving or "live" parts of a scale must not touch or rub against parts of the rigid structure. Loops and connecting links should be plumb. Care should be taken to see that knife-edges are properly centered on their bearings. The check-rods, which retain the platform in position on its knife-edges against the action of the jar and impact due to the application of the loads being weighed, should fit loosely on their pins or other supports, and should lie in a horizontal plane. If any are broken, they should be replaced.

In connection with the question of rust and corrosion of scale parts, it cannot be too strongly urged that every care be taken to keep scale pits clean and dry. If the scale is exposed to the weather, provision should be made for the drainage of the pit. If the pit can be ventilated as well, the deposition of moisture on the parts will be reduced, as will also the tendency to rust.

Detailed Test of a Platform Scale

The first step in the test of a scale is to put it in a condition of balance at zero load. This can be accomplished by setting all the sliding poises at their zero marks, removing all loose counterpoise weights and then moving the balance ball provided for the purpose of balancing, or by adding or removing shot from the counterpoise pan, which, when provided, is usually made hollow for this purpose.

Next apply to the center of the platform, test weights about equal in value to one-quarter of the scale capacity. Take a reading of the scale, using standard counterpoise weights if the scale is not provided with a full-capacity beam. If all the readings of the scale are taken with the sliding poise, advance this poise and any auxiliary poises, as may be necessary, until a balance is obtained. Note the reading. Then determine the sensibility reciprocal as indicated in the definitions above.

Now move the test weights, in turn, to each of the four corners of the platform, locating the center of gravity of the stack of weights directly over the principal platform bearings A, B, C, and D as denoted in Fig. 4. Note the readings in each case. In case the platform bearings of the scale are so close to the corners of the platform that it is impracticable to place the weights as just described, test weights amounting to one-half the capacity of the scale or more may be placed with their center of gravity, in turn, at the centers of the rectangles denoted in Fig. 4 by A_1, B_1, C_1, and D_1.

Next test the scale at its full capacity, if sufficient test weights are at hand. Determine the sensibility reciprocal at this load also. If the beam has one or more sliding poises moving on individual bars, these should each be tested at their maximum graduation. The remaining graduations should be uniformly spaced, for equal increments of reading, and, in practice, this will usually be found to be the case. The errors of the scale which have been determined should be compared with Table I. If they exceed the values given in this table, the scale is incorrect and should be adjusted.

TABLE I. TOLERANCES FOR PLATFORM SCALES

Load in Pounds	Class A		Class B	
	Tolerance		Tolerance	
	On Ratio in Ounces	On Beam in Ounces	On Ratio in Pounds	On Beam in Pounds
50	½	1	...	...
100	1	2	...	...
200	2	4	...	...
240	3	6	...	...
300	3	6	...	...
400	4	8	...	...
500	5	10	⅝	1¼
600	6	12	¾	1½
		Pounds		
800	8	1	1	2
1000	8	1	1	2
1200	10	1¼	1¼	2½
1500	12	1½	1½	3
1800	14	1¾	1¾	3½
Tons	Pounds			
1	1	2	2	4
1¼	1¼	2½	2½	5
2	2	4	4	8
3	3	6	6	12
4	4	8	8	16
5	5	10	10	20
6	6	12	12	24
8	8	16	16	32
10	10	20	20	40
12	12	24	24	48
15	15	30	30	60
20	20	40	40	80
40	40	80	80	160
50	50	100	100	200
80	80	160	160	320
100	100	200	200	400
150	150	300	300	600
200	200	400	400	800

Machinery

"Class A" scales include the following: scales of the portable platform type; and also scales of the dormant type which are installed inside a building having side walls and roof, which protect the scale from weather effects and from sudden changes of temperature.

"Class B" scales include the following: scales of the railroad track and wagon types, and also scales of the dormant type which are not installed inside a building having side walls and roof, and which are exposed to weather effects and sudden changes of temperature. The latter effect, since it causes the condensation of moisture on the scale parts, often has as serious results on the condition of the scale as have weather effects.

The columns with the heading "Tolerance on Ratio" refer to the error in the ratio or multiplying power of scales with which counterpoise weights are used.

The columns with the heading "Tolerance on Beam" refer to those parts of scales not requiring the use of removable weights, for example, a beam.

The column with the heading "Load" refers to the amount of weight on the platform of the scale.

TABLE II. TOLERANCES FOR COUNTERPOISE WEIGHTS FOR MULTIPLYING LEVER SCALES

The tolerances to be allowed in excess or deficiency on commercial weights shall not be greater than the following values: Provided, however, that the manufacturers' tolerances or the tolerances to be allowed on new commercial weights shall not be greater than one-half of the values given.

Weight	Ordinary Weights (Ratio 1: 1)	Ratio less than 100: 1	Ratio 100: 1, and less than 1000: 1	Ratio 1000: 1 and over
Pounds	Grains	Grains	Grains	Grains
50	100.0	60.0	40.0	20.0
25	60.0	36.0	24.0	12.0
20	60.0	36.0	24.0	12.0
15	40.0	24.0	16.0	8.0
10	40.0	24.0	16.0	8.0
8	30.0	18.0	12.0	6.0
5	30.0	18.0	12.0	6.0
4	20.0	12.0	8.0	4.0
3	20.0	12.0	8.0	4.0
2	15.0	9.0	6.0	3.0
1	10.0	6.0	4.0	2.0
Ounces				
10	10.0	6.0	4.0	2.0
8	5.0	3.0	2.0	1.0
5	5.0	3.0	2.0	1.0
4	5.0	3.0	2.0	1.0
2	3.0	1.8	1.2	0.6
1	2.0	1.2	0.8	0.4
½	2.0	1.2	0.8	0.4
¼	1.0	0.6	0.4	0.2
⅛	0.5	0.3	0.2	0.1
1/16	0.5	0.3	0.2	0.1
1/32	0.5	0.3	0.2	0.1
1/64	0.2	0.12	0.08	0.04
Ratio of Tolerances	5/5	3/5	2/5	1/5

Machinery

It has been assumed that the test of the scale has been conducted with standard counterpoise weights if any were used, that is, counterpoise weights having errors within a known small tolerance. If standard counterpoise weights are not at hand, those furnished with the scale may be used for the purpose of test, but their errors must be determined, and the actual values of the individual weights used in computing the errors of the scale. The counterpoise weights may be tested on a sensitive balance of the equal-arm, suspended-pan type. Such balances are made up in portable form especially for use in weights and measures inspection work, inspector's kits usually including also a set of standard weights. After determining the errors of the counterpoise weights, they should be compared with Table II, which gives the tolerances on weights used with multiplying lever scales, for various multiplications.

Establishment of Inspection System

Every industrial plant should provide in some manner for the regular test and inspection of all the scales which it uses. A record should be kept of the date of their installation, their cost, the dates on which inspections, tests, repairs, and adjustments are made, and the cost of all repairs and replacements of parts. The accompanying chart shows a form which has been found convenient for recording the test data. It will be found to cover most of the points which are to be noted and recorded and may, of course, be modified to meet special needs.

This work should be under the responsible charge of one competent man, who should inform himself as to the methods and equipment necessary. He should supervise the weighing methods used throughout the plant, should be made individually responsible for the maintenance, care, and adjustment of all test weights and scale-testing equipment, and should see that every scale in use in the plant is at all times kept within the required accuracy and in good repair. He should be familiar with the various kinds and types of scales on the market, in order that he may be in position to make proper recom-

mendations when the purchase of new scales is contemplated. He should further satisfy himself that every new scale purchased complies fully with approved tolerances and specifications. It is certain that when the importance of the weighing operation is better appreciated, such an organization will be adopted in every large plant where the services of a competent weights and measures official (state, county, or city sealer) are not readily available.

If a sealer properly equipped for the work is at hand, who regularly inspects and tests the scales in a plant, the manufacturer should cooperate with him as fully as possible. Money expended in securing correct weights is money well invested.

Cooperation of Bureau of Standards with Manufacturer on Weights and Measures Problems

The Bureau of Standards has accumulated a large experience in the design, testing and inspection of weighing-scales of every sort, from the small eight-ounce capacity letter scale used in the postal service to the three hundred thousand-pound capacity railroad track scales used in the weighing of carload shipments of commodities. This bureau is always ready to lend every possible assistance to the manufacturer in solving weights and measures problems.

The tolerances and specifications for weights and measures and weighing and measuring devices, as adopted at the tenth annual conference on weights and measures of the United States, are issued as a publication of this bureau and may be obtained upon application. In addition, there are also available Circular 47, giving definitions and tables of equivalents of the units of weight and measure, and a special publication entitled "The International Metric System of Weights and Measures." Several publications of interest on the testing and inspection of scales are at present in preparation.

SECRETIVENESS IN THE BRASS INDUSTRY

Old Home Week was celebrated in Waterbury, Conn., in the latter part of November and naturally a spirit of hospitality pervaded the famous home of brass working industries. Some good souls evidently feared that this warm glow might cause some indiscreet manufacturers to admit visitors to their plants and disclose to strangers secrets that have been carefully preserved lo! these many years. The *Waterbury American* offered the following cautionary advice in an editorial in the November 23rd number:

> A good part of Waterbury's industrial efficiency lies in the machinery its men of mechanical genius have invented and made to produce the goods it manufactures and sells. We are proud to have others notice this efficiency and the ways and means by which we accomplish it. But if they learn how we do it, and obtain from us the machinery by which it is done they will be able to make the goods we now sell to them. They will be aided also by cheaper labor and nearness to the market. Let us not be inhospitable—nor give ourselves away.

Secretiveness is characteristic of the brass working industry generally. The average proprietor of a brass shop is a hermit as regards visiting competitors or allowing them to visit him and exchange ideas. It would be interesting to trace this extreme conservatism to its source and to ascertain the reasons why secretiveness in the industry so generally persists. There can be few good reasons for it. Are not there hundreds of brass manufacturers, all prospering and all probably using many of the same methods, kinks and devices for facilitating manufacturing? It must be so. Otherwise how could they successfully compete? Secretiveness has become a tradition—a policy to be preserved when the chief reasons for it long ago disappeared.

SCALE TEST AND INSPECTION RECORD

Place.......................... Owner.............................. Manufacturer.............................

Scale Number........... Designation........... Test Number........... Page........... Inspector........... Date.....

Observation Number	Value of Load	Position of Load	Counterpoise Weight at End of Beam*	Sliding Poise Reading	Balance†	Total Reading‡	Sensibility Reciprocal	Error of Scale¶	Remarks

TEST OF COUNTERPOISE WEIGHTS

Denomination		Distinguishing Mark	Error	Tolerance Allowable	Within or Without the Tolerance	Remarks
Equivalent	Actual	(If several weights of one denomination give them distinguishing marks)				

Type of Scale	Date Installed	Information relating to previous tests, inspection, repairs and adjustment

Capacity of Scale, Nominal................................ Condition of Parts. Of Other Parts
On Sliding Poise................................ Office..............
On Counterpoise Weights................................ Poise Weights....
Size of Platform................................ Knife-edges.....
Material Weighed................................ Bearings.....
Length of Beam, Fulcrum to Trig-loop................................ Checks.....
Play in Trig-loop................................ Levers.....
If Notched Beam——Notches in——inches................................ Pit.....
Multiplication of Scale................................ Foundation.....
.... Drainage provision

Machinery

* Record actual value, not equivalent value.

† Record check mark if normal center balance and the words "high" or "low" if extreme balance is used for determining sensibility reciprocal.

‡ The fourth column value multiplied by nominal multiplication of scale, to which is added the fifth column value.

¶ Total reading minus value of test load.

Making Cartridge Cases on Bulldozers and Planers

Douglas T Hamilton

THE manufacture of cartridge cases described in the December number of MACHINERY is carried on by means of power presses of the crank and flywheel type, but many manufacturers who had orders for this work could not get deliveries on machines of this type and consequently had to resort to other methods of handling the work. The amount of ingenuity shown in this direction is remarkable. One good example of the application of car-shop equipment to this work is described in the following. All the cupping, redrawing and tapering operations are accomplished on bulldozers and frog and switch planers which have been fitted up for doing this work. The only special machine that had to be purchased to complete the cartridge case, with the exception of the machining operations, was a hydraulic heading press. The order of cupping and redrawing operations is shown in Fig. 3, and also in the accompanying table, which includes all the data—machines used, production, scleroscope readings, etc.

Cupping

In the plant where this information was obtained the blank is obtained of the correct size and thickness, and in the annealed condition. The first operation, therefore, is cupping, as shown in Fig. 1 and at *A* in Fig. 3. For this work, a Niles-Bement-Pond bulldozer is used. The die is held on the cross-head and the punch on a fixture attached to the bed of the machine.

This particular machine is fitted up for accomplishing both the cupping and first redrawing operations, the punch shown at *A* performing the cupping and that at *B* the first redrawing. In this way, two men can operate the machine and thus turn out a cup and perform the first redrawing operation at each stroke of the machine. A lubricant known as "Viscosity" and made by the Cataract Refining Co. is used for lubricating the die and punch.

Annealing

Following the cupping operation, the cases are annealed in a Quigley oil furnace as shown in Fig. 2. The cases are held in a sheet iron pan having a wire bottom and are brought to the furnace on a truck as shown, the platform of which is provided with rollers. As soon as the pan carrying the cases is brought in line with the door of the furnace, the air jack shown is operated, forcing the pan into the furnace. The door is then closed and the cases annealed. This furnace is kept at a constant temperature of between 1100 and 1140 degrees F. and holds seven boxes, each box carrying 140 cases. It requires thirty-five minutes for one lot of cases to

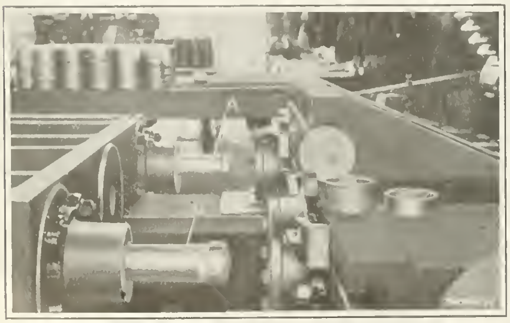


Fig. 1. Performing Cupping and First Redrawing Operations on a Niles-Bement-Pond Bulldozer

Fig. 2. Annealing Cartridge Cases in a Quigley Oil Furnace for Thirty-five Minutes

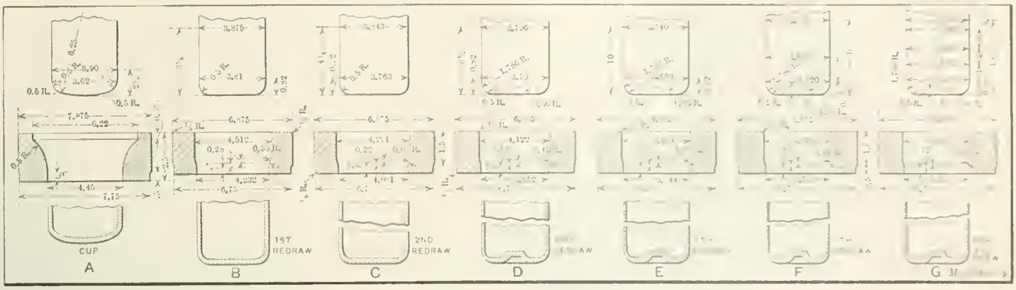
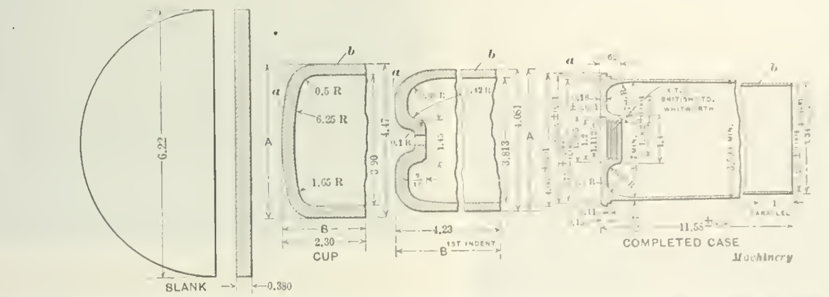


Fig. 3. Punches and Dies used and Sequence of Operations followed in producing British 18-pound Cartridge Cases on Frog and Switch Planers

pass completely through the furnace, so that one box is taken out and one put in the furnace every five minutes. As the pan of cases is removed from the unloading end of the furnace, see Fig. 4, it slides on a platform operated by an air jack in a similar manner to an elevator. This arrangement is located over a cooling bath and is operated to immerse the cases in the cooling bath. When cool, the platform raises the pan of cases, which is then rolled out onto the truck and carried over to the pickling bath shown to the right of the illustration. Here the pan is again picked up by an air jack

DRAWING, HEADING AND MACHINING OPERATIONS ON 18-POUND BRITISH CARTRIDGE CASE



No. of Operation	Character of Operation	A Inches	B Inches	Machine Used	Lubricant	Furnace Used	Temperature of Furnace, Degrees F.	Bath	Scleroscope Reading	Production Per Hr
1	Blanking	......	......	Punch Press	......	......	......	......	15	
2	Cupping	4.45	2.30	Bulldozer	Viscosity	......	......	......	a, 15, b, 50	300
3	Annealing for 35 Minutes	......	......	......	......	Oil Furnace	1100 to 1140	Water Cooling Acid Wash	15	300
4	1st Redrawing	4.232	3.45	Bulldozer	Viscosity	......	......	......	a, 15, b, 50	300
5	Annealing for 35 Minutes	......	......	......	......	Oil Furnace	1100 to 1140	Water Cooling Acid Wash	15	300
6	2nd Redrawing	4.081	4.6	Bulldozer	Viscosity	......	......	......	a, 40, b, 45	300
7	Annealing for 35 Minutes	......	......	......	......	Oil Furnace	1100 to 1140	Water Cooling Acid Wash	15	300
8	1st Indenting	4.081	4.23	Bulldozer	Viscosity	......	......	......	a, 18, b, 15	300
9	3rd Redrawing	3.952	6.25	Bulldozer	Viscosity	......	......	......	a, 18, b, 45	300
10	Annealing for 35 Minutes	......	......	......	......	Oil Furnace	1100 to 1140	Water Cooling Acid Wash	a, 13, b, 15	300
11	4th Redrawing	3.844	7	Bulldozer	Viscosity	......	......	......	a, 35, b, 45	300
12	Annealing for 35 Minutes	......	......	......	......	Oil Furnace	1100 to 1140	Water Cooling Acid Wash	15	300
13	2nd Indenting	3.844	6.875	Bulldozer	Viscosity	......	......	......	a, 18, b, 15	300
14	Drill Hole in Primer Pocket	......	......	Vertical Drilling Machine	......	......	......	......	......	175
15	Trimming and Burring	3.844	6.25	Toledo Trimmer	......	......	......	......	......	200
16	5th Redrawing	3.789	9.75	Frog and Switch Planer	Vaseline	......	......	......	a, 20, b, 40	180
17	Annealing for 35 Minutes	......	......	......	......	Oil Furnace	1100 to 1140	Water Cooling Acid Wash	a, 20, b, 16	[illegible]
18	6th Redrawing	3.738	13.35	Frog and Switch Planer	Vaseline	......	......	......	a, 20, b, 45	180
19	Trimming	3.738	11.875	Toledo Trimmer	......	......	......	......	......	200
20	Heading	3.738	11.750	350 ton, C. P. R. Hydr. Press	......	......	......	......	a, 40 to 50, b, 50	100
21	Annealing Mouth for 35 Seconds	......	......	......	......	Oil Burner	800	Cool in Air	a, 40 to 50, b, 25 to 35	80
22	1st Tapering	3.347	11.875	Bulldozer	Dry	......	......	......	a, 40 to 50, b, 35 to 40	300
23	2nd Tapering	3.328	11.95	Bulldozer	Dry	......	......	......	a, 40 to 50, b, 35 to 45	300
24	Machining Mouth and Head	......	......	Bullard Case Machine	Mystic	......	......	......	......	40
25	Hand Tapping	......	......	Bench Fixture	......	......	......	......	......	80
26	Reaming	......	......	Bench Fixture	......	......	......	......	......	80
27	Inspecting	......	......	Various Gages	......	......	......	......	......	80
28	Stamping	......	......	......	......	......	......	......	......	80

Machinery

Fig. 4. Immersing Cases in Cooling and Pickling Baths following Annealing

and dipped in the weak sulphuric acid solution used in removing the scale. Following this, the cases are immersed in a hot-water solution.

First, Second and Third Redrawing and Indenting Operations

After annealing and washing, the cases are taken back to the Niles-Bement-Pond bulldozer shown in Fig. 1, and the first redrawing operation is performed as previously described. They are again annealed, washed, etc. Following this, the second redrawing operation is performed. This operation is handled on a Williams & White bulldozer, where the punch

Fig. 5. Third Redrawing Operation on Williams & White Bulldozer

and die are held in the same manner as for the first redrawing operation. Annealing, washing, etc., follows the second redraw. The head end of the cartridge case is now indented in a Williams & White bulldozer, where the base end is formed to the shape shown at *D* in Fig. 3, and is then given the third redrawing operation without annealing as shown in Fig. 5. Here the operator removes the case from a tank which is filled with a lubricant—"Viscosity"—and places it on the punch, as illustrated, when the cross-head is on the backward stroke. The shape of the case after this operation is shown at *D* in Fig. 3.

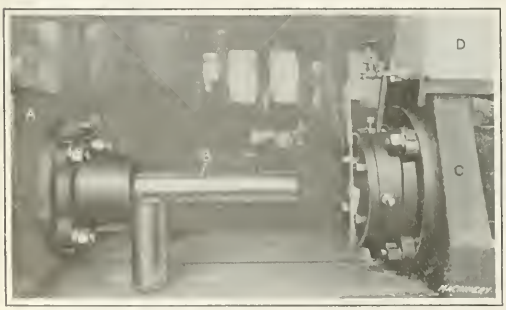


Fig. 6. Performing Fifth Redrawing Operation on a Frog and Switch Planer

Following the third redrawing operation, the case is again annealed, washed, etc., and is then taken to the Williams & White bulldozer, where the fourth redrawing operation is accomplished. The diameter and length of the finished case after this operation are given in the accompanying table. After the fourth redrawing operation, the case is annealed, and then taken to the second indenting operation. This is accomplished in a Williams & White bulldozer at the rate of 300 per hour.

At this point in the sequence, an operation is performed that is not general practice. This consists in drilling a 1/4-inch hole through the primer pocket. In attempting to form the head of the cartridge case with the primer pocket solid, it was found that the metal in the proximity of the pocket was much harder than at the rim. This is just the reverse of what is

Fig. 7. Heading Cartridge Cases on a C. P. R. Heading Machine

required. In other words, the rim must be much harder than the center of the head. To overcome this difficulty, a hole was drilled through the pocket, and in heading, this allowed the metal to flow freely to the center, and thus prevented "packing" and subsequent hardening. Following the drilling of the hole in the primer pocket, the case is taken to a Toledo

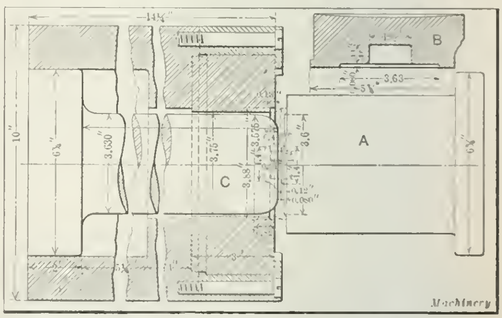


Fig. 8. Diagram showing Dies and Heading Tools used in Machine shown in Fig. 7

case trimmer, where the open end is trimmed, removing the ragged edge from the mouth of the case.

Fifth and Sixth Redrawing Operations

The fifth and sixth redrawing operations are handled on a frog and switch planer as shown in Fig. 6. In order to perform these operations on the planer, the entire cross-rail was removed and a large casting *A* serving as a punch-holder was fastened to the uprights. The redrawing punch *B* is therefore held stationary. The redrawing die, on the other hand, is held in a holder retained on casting *C* that is bolted to the planer table. The method of operating is to place the case on the punch when the planer table is on the return stroke.

Fig. 9. Mouth-annealing Cartridge Case in an Improvised Annealing Furnace

The punch and die is lubricated by a lubricant held in box *D* which, of course, travels with the die. The case, in being forced through the die, slides down a trough into a box.

After the fifth redraw, the case is annealed, washed, etc.,

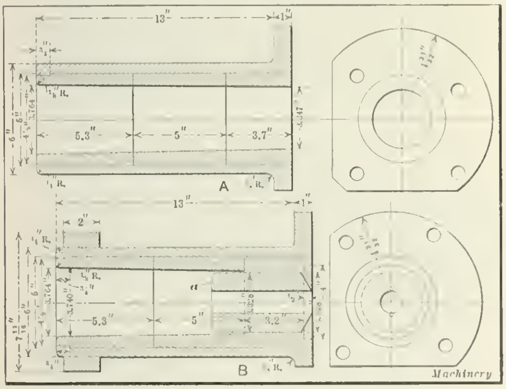


Fig. 11. Dies used for First and Second Tapering Operations on Cartridge Case

and is then given a sixth redraw which is accomplished in a similar manner to the fifth. The mouth of the shell is again trimmed on a Toledo case trimmer and from here is taken, without annealing, to the heading press.

Heading

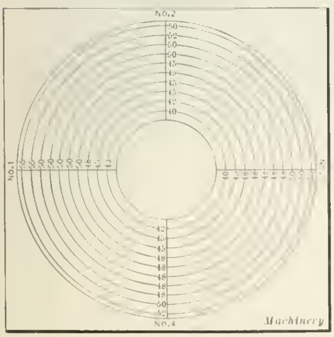


Fig. 12. Diagram showing Representative Scleroscope Reading taken on the Head of a Cartridge Case

The heading operation is now performed in the 350-ton press shown in Fig. 7, which is built by the Canadian Pacific Railway. This machine is provided with a table of the indexing type which carries four sets of dies, shown in detail in Fig. 8. In heading, the case is given two blows; the first is delivered by punch *A*,

Fig. 10. Testing Hardness of Cartridge Cases with the Scleroscope

which fills in the primer pocket. Punch *B*, which is held on a rod as shown in Fig. 7, is then placed over the case and a flattening blow is delivered. While these operations are being performed the case is supported by punch *C*, Fig. 8.

Mouth-annealing and Tapering

The next operation is mouth-annealing. This is accomplished in a simple furnace shown in Fig. 9. It comprises a stand which supports an air drill, a spindle *A*, fitted into the driving socket of the drill, and a table attached to this as shown. The case is supported on this table and rotated by the air drill. The annealing is done with an oil burner. The case is allowed to rotate for thirty-five seconds and is heated to a temperature of 800 degrees F. for a distance of about $4\frac{1}{2}$ to 5 inches from the mouth of the case.

After mouth-annealing, the cases are allowed to cool off in the air, and when cool are taken to a Williams & White bulldozer. Two tapering operations are necessary to bring the case to the correct shape and size. The dies used for this purpose are shown in Fig. 11. The first tapering die is shown at *A*, and, as will be seen, is made in three pieces. For the first tapering, the mouth of the shell is not supported, as the reduction is carried along the entire body. In the second ta-

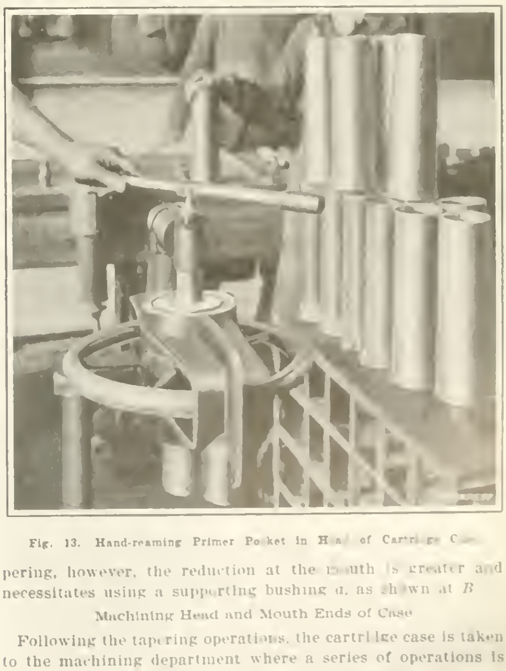


Fig. 13. Hand-reaming Primer Pocket in Head of Cartridge Case

pering, however, the reduction at the mouth is greater and necessitates using a supporting bushing *a*, as shown at *B*.

Machining Head and Mouth Ends of Case

Following the tapering operations, the cartridge case is taken to the machining department where a series of operations is performed on the head and mouth ends. These operations are

performed on a Bullard facing, chamfering and trimming machine in the manner described in the December number. The order of operations is: first, rough-drill and counterbore; second, face, trim and chamfer head; third, finish-chamfer and face; fourth, under-cut primer seat; fifth, finish-counterbore; sixth, tap with collapsing tap; seventh, trim and chamfer mouth.

The case is now taken to a special reaming fixture shown in Fig. 13, where the primer pocket is finish-reamed. Hand tapping of the primer pocket follows this and is accomplished in a similar fixture. The case then passes through a series of inspection operations, consisting in gaging the diameter and thickness of the head, depth, diameter, etc., of the primer pocket; overall length, diameter of mouth, etc. Another inspection is to look through the case, from the head end, to detect whether any free spelter is present or not. The cartridge case is then stamped on the head end in a Noble & Westbrook stamping machine. This finishes the machining and inspection operations on the case.

Testing for Hardness

As has been previously mentioned the hardness of the metal is tested before and after each annealing and redrawing operation, and for this purpose the scleroscope is used. Fig. 10 shows an inspector taking a series of readings on the head of the cartridge case. About one per cent of the daily production is inspected in this manner, and Fig. 12 shows a representative reading. The body of the case is also tested for hardness at the points indicated in the illustration accompanying the table. This table also includes the scleroscope readings obtained before and after every annealing and redrawing operation. For taking a reading on the body of the case, it is placed on the horn *A* shown in Fig. 10. Final inspection, packing, etc., finishes the operations on the case.

* * *

SPEED OF BAND SAWS

In reply to an inquiry for the most suitable speeds for band saws, we are informed by the Berlin Machine Works, Beloit, Wis., that this firm advises the following speeds for both band saws and circular saws for the materials given below:

For cutting the softest materials, such as unseasoned pine, bass wood, etc., a maximum speed of 10,000 feet per minute is recommended.

For seasoned soft wood, and unseasoned comparatively hard wook—oak, gum, etc.—a speed of 9000 feet per minute is recommended.

For seasoned comparatively hard wood and unseasoned hard wood, such as maple, hickory, etc., a speed of 8000 feet per minute is recommended.

For seasoned hard wood and unseasoned exceedingly hard wood, a saw speed of 7000 feet per minute is recommended; such exceedingly hard wood would be frozen unseasoned maple, for example, which is cut extensively in the mills of northern Wisconsin and Michigan.

The Defiance Machine Works, Defiance, Ohio, recommend in the operation of the band saws built by them a speed of 5000 feet per minute.

The Curtis Saw & Sawmill Machinery Co., St. Louis, Mo., advises that for small band saws, that is, two-inch and smaller, a linear speed of about 4700 feet per minute is recommended. These saws are usually run over a wheel three feet in diameter, having a speed of 500 R. P. M.

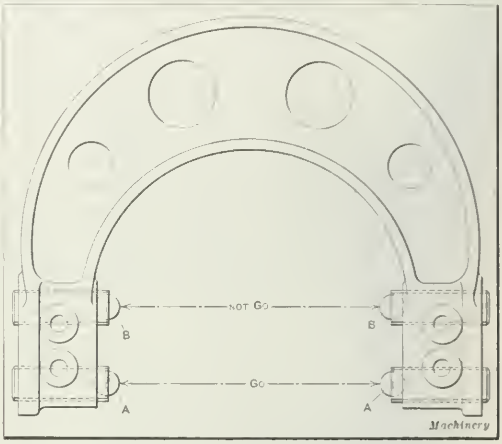
J. A. Fay & Eagan Co., Cincinnati, Ohio, states that when sawing wood the speed of band saws may be from 8500 to 10,000 feet per minute, depending upon the size and type of the saw.

* * *

One of the large automobile manufacturers publishes a bulletin for the benefit of his men. The bulletin is published mainly in the interest of safety, and is an excellent little publication; but from it we glean how completely dehumanized is the plant, for we are told that B 6073, D 8549 and A 416 offered suggestions last month. How much better Jones, Brown and Smith would have felt if their *names* had been mentioned instead of their *numbers!*

LIMIT GAGE WITH BALL CONTACT POINTS

A limit gage of British design made by Smith, Barker, Willson & Co., Halifax, England, is shown in the illustration, in which hardened steel balls are used for the contact points. The balls are seated in plugs to a depth slightly greater than a half diameter and are peened in place. The advan-



British Limit Gage with Ball Contact Points

tage of the ball contact points is cheapness of construction. The balls are hard and true, and when worn can be quickly and cheaply replaced. The plugs in which they are seated are adjustable, of course. Standard end measure gages are used to set them to the required "go" and "not-go" sizes.

* * *

ASSEMBLING PLUG AND RING GAGES OF SAME DIMENSIONS

It is well known among toolmakers, inspectors and users of accurate gages that plug and ring gages of the same diameter may be assembled by an expert, and the plug will move freely within the ring so long as it is kept in motion. But the moment the plug is allowed to come to rest the ring will grip it tightly, and much force will be required to push the plug out. The question is, how is it possible to put a plug measuring say exactly one inch into a ring gage measuring exactly one inch with an oil film between the opposing surfaces? The theory advanced by one concern that has made accurate gages for many years is elasticity of the plug and ring. The ring is supposed to stretch and the plug to compress when assembled, sufficiently to provide the necessary space for the intervening oil film. The theory is apparently borne out by the fact that as long as the plug is kept moving in the ring the gages fit smoothly, but the moment movement is stopped the oil is squeezed out and they freeze together.

Another theory advanced to account for the phenomenon is that the surfaces of the plug and ring even though highly finished, are quite irregular when viewed under the microscope, and that the irregularities act much the same as fur on an animal when smoothed by the hand. Under pressure, these minute excrescences are pressed down, giving way before the pressure of the oil film, but as soon as motion between the opposing parts ceases these irregularities tend to return to their original positions, thus interlocking and causing seizure. When measuring a plug or ring, the measurement, of course, is from the tops of these molecular hills.

* * *

High-speed steel has worked many wonders and it is not surprising that some ridiculous specifications have been made by those unfamiliar with its real qualities. One enterprising railway official, thinking he could facilitate the movement of cars on sidings, requested high-speed steel pinch bars!

GEAR TEETH WITHOUT INTERFERENCE OR UNDERCUTTING

DESIGNING NON-INTERFERING GEAR TEETH AND GENERATING THEM WITHOUT UNDERCUT FLANKS

BY JOHN EDGAR*

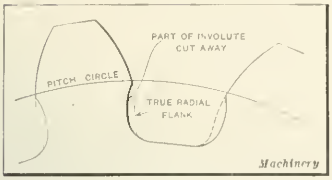


Fig. 1. Way in which Undercutting Action takes Place on a Twelve-tooth Pinion of 14½-degree Pressure Angle

Undercutting and interference of the teeth are to be avoided in all types of gearing, and to avoid one condition without having the other is a problem that must be given considerable attention. The tendency to produce undercut teeth is the one disadvantage of the processes of generating gear teeth from a tool shaped with straight sides similar to those of a rack, the undercutting being encountered in all cases where the pressure angle is less than 30 degrees and the addendum of the rack is the reciprocal of the pitch number. It appears in all gears of less than thirty-two teeth with the standard 14½-degree pressure angle. This undercutting is caused by the interference of the point of the tool in rolling out of the tooth, causing it to cut into the flank of the tooth and also to destroy a portion of the involute curve below the pitch line. The involute form at the point where the undercutting takes place is of proportionately greater value than at other points along the tooth face, as here the actual rolling action of the teeth on one another is attended with more sliding action than that which takes place above the pitch line, so that less wear will occur, greater pressure may be exerted, and the tooth will retain its shape better when this bearing surface is not lost by undercutting.

Undercutting is a serious matter in the standard 14½-degree involute system when gears of the smaller sizes and numbers of teeth are to be generated. To overcome trouble from this source, the use of the 20-degree pressure angle has been advocated; and as the undercutting action of the tool does not extend beyond the seventeen-tooth pinion, and is present in those gears with smaller numbers of teeth in a much less degree, the 20-degree pressure angle has much that can be said in its favor and is widely used in the case of generated gears. The stub-tooth which is now generally used in the case of the automobile transmission is usually of the 20-degree pressure angle type, which does away with undercutting almost entirely. But there are reasons why the 14½-degree tooth is to be preferred in many cases, and on that account the 14½-degree system will be considered in the present article, the examples being taken from gears of that pressure angle. It will be obvious that the treatment is universal in its application, and that the methods can be as easily applied to any system of involute teeth that may be under consideration. As previously mentioned, the undercutting action of the tool will occur in the case of gears of less than thirty-two teeth with the standard addendum. The actual undercutting increases as the number of teeth becomes smaller and is of a very undesirable nature in the case of a twelve-tooth pinion, as will be realized from an examination

* Address: 509 N. Church St., Rockford, Ill.

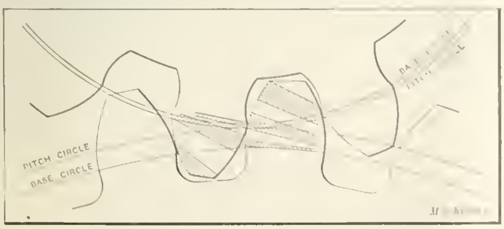


Fig. 2. Relative Sliding Action of Gear Teeth on each other

of Fig. 1, while pinions with less than twelve teeth will be so badly undercut as to be of little value in the transmission of uniform motion. In addition to affecting the wear of the teeth and their proper action, undercutting also weakens the teeth considerably.

A method of overcoming trouble from undercut teeth, which is now commonly used in automobile drives, is to make the pinion with long addendum teeth, thus avoiding the interference of the teeth and also the undercutting of the flanks. The long addendum is now almost exclusively used in the case of bevel gears; but there is no reason why it may not be employed in spur gears produced by the generating process, and even in the case of spur gears cut with a formed milling cutter. In the latter case, the involute can be made of the theoretical shape, because no correction will be necessary for the undercutting, as with the teeth of standard generated type; neither will the points of the teeth have to be thinned to avoid interference, as there will be no tendency for the teeth to interfere in properly designed gears. The modified radial form of the flanks of the teeth below the pitch line will allow of free milling, which is impossible with the pinions of standard generated tooth proportions.

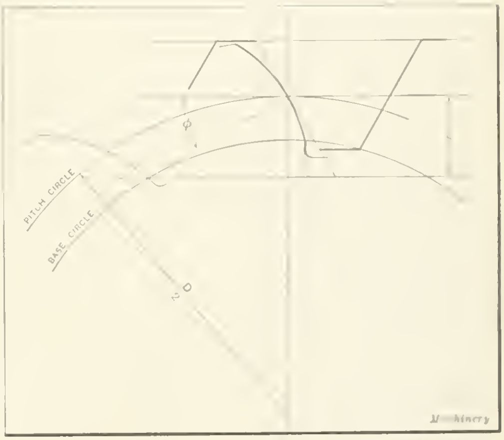


Fig. 3. Diagram Illustrating Derivation of Formula for Maximum Addendum S

Compactness of design makes it necessary to use pinions with small numbers of teeth when large ratios are to be employed. In designing the gears with long addenda, the fact that must be kept in mind is that the wear of the tooth increases as the point of contact nears the tip of the tooth, so that the aim should be to keep the addendum down to the minimum in order that the contact shall be confined to the region of the pitch point. The pure rolling action of the teeth on each other takes place at the pitch point and is confined to a line at this point. This can be practically demonstrated by a pair of gears that have been run under load for a short time, in which the wear will show itself at the point of the tooth and at the region of the base line, while the area around the pitch line will show little evidence of wear. Of course in a pair of gears that have had hard service, the wear along the tooth will be marked so that the preceding observation may not seem to be quite correct; but if the gears have been in use for only a short time, the evidence will bear out this assertion.

Were it not for the sliding action of the teeth, gears would last indefinitely, as the rolling of the teeth on one another would compress the metal and eventually produce a hard glazed surface. The wear due to this sliding action is more in evidence in the case of small pinions than in gears of com-

paratively large size; and the teeth of the pinion being proportionately longer than those of the gear have a greater percentage of this sliding action. Therefore, the addendum of the pinion must only be lengthened by an amount which is sufficient to do away with interference of the teeth, and to give a proportion that can be generated with little or no undercutting. Fig. 2 illustrates the extent of the sliding action. It will be seen that the tooth curves are divided into proportional spaces, the dividing lines being drawn tangent to the base lines, and they will coincide with the pressure line when the teeth come into contact at these points. The difference in the length of the space on one tooth and the corresponding space on the mating tooth is the amount of sliding action that occurs while the gear is rolling through an angle equal to that between the lines; and the sliding action is distributed over a wider area in the teeth of the gear.

To avoid undercutting in the teeth of any pinion generated with a straight rack-shaped tool, the depth of the cut below the pitch line must not exceed an amount given by the formula:

$$S = \sin^2\phi \times \frac{D}{2} \qquad (1)$$

S = maximum addendum for the rack tooth;
ϕ = angle of the tooth;
D = pitch diameter, as shown in Fig. 3.

From the preceding formula we find that to avoid undercutting in the twelve-tooth pinion the tool should not cut deeper than 0.375 inch when the diametral pitch is 1; and a tool that extended only this distance below the pitch line would not cut into the radial flank shown dotted in Fig. 1. Also a rack with teeth projecting no further than 0.375 inch beyond the pitch line would roll perfectly with the type of tooth shown in Fig. 1 when made with the theoretical radial flank. Any extension of the teeth of the rack beyond this limit will cause interference between the teeth of the rack and the flanks of the teeth in the gear. However, the interference between the teeth in a gear of, say, twenty-four teeth when in mesh with a pinion with radial flanks as shown in Fig. 1, will not be so bad as between the rack and pinion; and the limiting addendum is not so short, being 0.45 inch in this case. This limiting addendum for any combination of gears is easily found, and an interference diagram may be drawn for a pair of gears as shown in Fig. 4. This limit is not so easily determined as in the case of a rack, but the values may be tabulated and a chart constructed that can be used with greater facility than is possible in solving the formula for each combination.

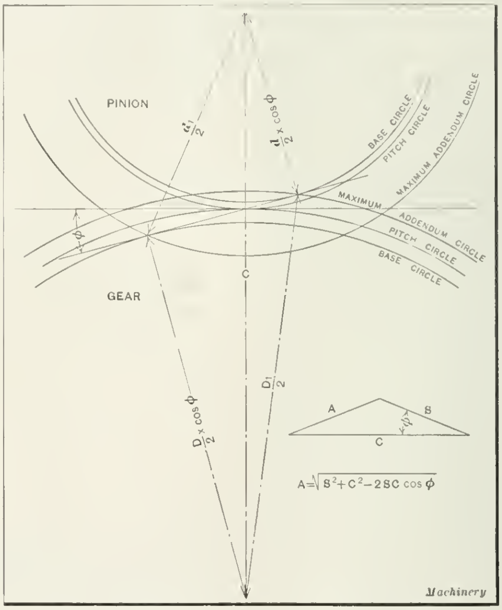


Fig. 4. Interference Diagram for a Pair of Spur Gears

The limiting factor in the case of the gears is the same as that with the rack, being the point of intersection of the addendum circle, the pressure line, and the base circle of the mating gear, the problem in each case being to find the length of the radial line $\frac{D_1}{2}$. An examination will show that this resolves itself into the problem of finding the side A of the obtuse triangle, the formula for which is:

$$A = \sqrt{B^2 + C^2 - 2BC\cos\phi}$$

The center distance C is given by the following formula:

$$C = \frac{D + d}{2}$$

where D = pitch diameter of gear;
d = pitch diameter of pinion.

$$\frac{D}{2} = \frac{R}{1 + R} \times C$$

where R = ratio of number of teeth in gear to number of teeth in pinion.

$$\frac{d}{2} = \frac{1}{1 + R} \times C$$

Using these values in the trigonometrical formula we get:

$$D_1 = 2\left[C^2 + \left(\frac{C}{1 + R}\cos\phi\right)^2 - 2\frac{C^2}{1 + R}\cos^2\phi\right]^{\frac{1}{2}} \qquad (2)$$

$\frac{D_1 - D}{2}$ is the addendum and the diametral pitch P is the reciprocal of this expression:

$$P = 2 \div 2\left[C^2 + \left(\frac{C}{1 + R}\cos\phi\right)^2 - 2\frac{C^2}{1 + R}\cos^2\phi\right]^{\frac{1}{2}} - D \qquad (3)$$

Substituting values for $\cos\phi$ we get for the 14½-degree system:

$$P = 2 \div 2\left[C^2 + \left(\frac{C}{1 + R}.968\right)^2 - \left(1.878\frac{C^2}{1 + R}\right)\right]^{\frac{1}{2}} - D$$

For the 20-degree system, the result is:

$$P = 2 \div 2\left[C^2 + \left(\frac{C}{1 + R}.939\right)^2 - \left(1.766\frac{C^2}{1 + R}\right)\right]^{\frac{1}{2}} - D$$

The values from the formulas have been calculated for 1-inch centers and the curves in Fig. 5 have been drawn, from which the limiting diametral pitch for any center distance and ratio up to 8 to 1 can be obtained. Since the pitch found in this way is based on the standard proportions of a tooth, the maximum value for any greater pitch is equal to the reciprocal of the pitch found by the use of the chart. Thus, if the maximum pitch found from the chart is 12, and the diametral pitch it is desired to use is 8, then the maximum addendum for the gear with the teeth cut to 8 pitch is the same as that for a standard 12-pitch gear or 1/12 inch long. The chart can also be used to obtain the minimum center distance for a pair of gears of a given ratio and pitch.

As an example to explain the use of the chart, suppose that a pair of gears of 5 to 1 ratio are to be run on 10-inch centers and we wish to have them mesh without interference; what diametral pitch can they be made? Find the ratio at the left of the chart and follow along until the line intersects the 14½-degree curve, then read down to the maximum pitch for a 1-inch center distance. The result is 90; divide this by the given center distance of 10 inches, which gives 9 as the required diametral pitch. As another example assume that a ratio of 4 to 1 is to be satisfied with gears of 5-pitch; what is the center distance that will give gears which will run without interference? Entering the chart from the left at the proper ratio line, as before, we find the maximum diametral pitch for a center distauce of 1 inch to be 73. Dividing this by the pitch we get 73 ÷ 5 = 14.6 inches as the required center distance. Again assume that it is desired to

have gears with 12 and 48 teeth of 5-pitch mesh without interference; what will be the proper addendum for the pinion? The ratio is 4 to 1, and the maximum diametral pitch from the chart is 73 for 1-inch centers. The center distance is $\frac{12 + 48}{2 \times 5} = 6$ inches, and the maximum pitch for 6-inch centers is $73 \div 6 = 12.167$. The maximum addendum is then 1/12 or 0.0888 inch. On the other hand, suppose we have to satisfy a ratio of 5 to 1 and desire to use gears of 10-pitch with standard addendum; what is the shortest center distance that can be used? From the chart, the maximum diametral pitch, corresponding to the ratio of 5 to 1, is 90; this is the pitch at a 1-inch center distance, so that the minimum center distance for 10 pitch is $90 \div 10 = 9$ inches.

The undercutting of the teeth in generating may also be avoided by using a tool of greater angle than that of the teeth that are being shaped, still making the teeth of the standard proportions. It is a well known fact that but one involute curve can be generated from a base circle of given diameter; and as the tool represents a tangent to the curve, corresponding to the position of the tool, a tool of any angle, within the limits of the portion of the curve of which the tooth is made up, can be used to generate the teeth by rolling the tool at the proper distance from the base circle. While the involute portion of the tooth curve will be the same, the flank, *i. e.*, that portion of the tooth below the base line of the gear, will be fuller as the angle of the tool is made greater. At this point it may be well to mention that it is impossible to generate a radial flank on the teeth of gears with a straight sided tool, the actual flank that is produced being either undercut or too full.

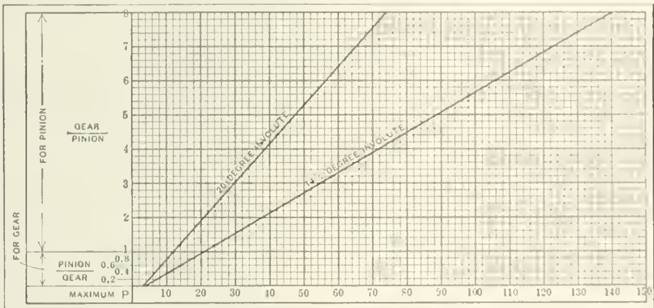
It will be found that the maximum addendum, according to Fig. 5, is the limiting depth that can be used in generating gears with a straight sided tool, and still produce gears with teeth which will not interfere, and which will not have undercut teeth. However, it is possible to generate teeth that have a minimum amount of undercutting by a compromise between the angle and depth of cut. This method is described in the following. From Fig. 6, we see that the minimum angle of a cutting tool to generate a gear tooth without undercutting is proportional to the ratio of the depth of cut to the radius of the base circle, the ratio being the versine of the angle ϕ. Thus:

$$\frac{\text{Depth below base line}}{\text{Radius of the base line}} = \text{versine } \phi^g. \qquad (6)$$

In the case of a twelve-tooth pinion of 14½-degree pressure angle and 1-pitch, we get:

$D = 6$ inches;
Radius of base circle $= 6 \times \cos 14\frac{1}{2}$ degrees $= 5.808$ inches;
Root radius $= 6 - 1 = 5$ inches;
Depth below base line $= 5.808 - 5 = 0.808$ inch;
Versine $\phi = 0.808 \div 5.808 = 0.1375$;
$0.1375 =$ versin 30 degrees 24 minutes.

The radius of the base circle is the pitch radius multiplied by cos ϕ. The roll radius is the base circle radius divided by cos ϕ^g. To distinguish between the pressure angle of the gear and the angle of the tool with which it is to be generated, call the pressure angle of the gear ϕ, and the angle of the tool ϕ^g. The radius at which a tool of 30 degrees 24 minutes angle must be rolled to produce the involute curve for the required pinion is $5.808 \div 0.863 = 6.73$ inches. The tooth shape is shown in Fig. 7. We will find, however, that a gear with twelve teeth cut in this manner will not mesh with any other gear without interference. This fact will be understood by referring to Fig. 7. By an application of the chart shown in Fig. 5, we will find that in the case of teeth with standard addenda for an even ratio of 1 to 1, gears with less than twenty-three teeth will not mesh without interference; and for a ratio of 2 to 1, the minimum number of teeth will be twenty-seven and fifty-four. At these ratios with less teeth in the gears, the teeth must either be undercut or the addenda made shorter. We will also find by applying Formula (1), that the teeth of the twenty-three and twenty-seven tooth gears will be undercut when generated with a straight sided tool of the same angle as the pressure line. This undercutting can be avoided by using a tool of 16 degrees 58 minutes angle, as found by Formula (6).



NOTE:—When the ratio of the gearing is an integral number, the maximum value of the pitch P at which interference begins applies only to the pinion; when the value of the ratio is a decimal, the maximum value of the pitch applies to the gear. Usually the pinion is the determining factor. The chart gives the maximum diametral pitch P which can be used without interference, for a given ratio of gearing and a center distance of 1 inch. To obtain the maximum diametral pitch for any required center distance, divide the value of the pitch obtained from the chart by that center distance. Similarly, to determine the maximum addendum for any required center distance and pitch, divide the given center distance by the maximum pitch obtained from the chart for a center distance of 1 inch. To get the center distance for any required ratio and pitch, divide the maximum pitch obtained from the chart for a center distance of 1 inch by the diametral pitch.

Machinery

Fig. 5. Chart showing Maximum Values of Pitch and Addendum without Interference of Teeth

It may not be convenient to use gears with as many teeth as the minimum for non-interference requires, according to the method of the preceding paragraph; and yet the undercutting of the twelve-tooth pinion may be undesirable. The extremely long addendum that would be necessary to avoid the undercutting action when a tool of standard angle is used may be considerably reduced by making it just the length required to avoid interference between the teeth of the pair of gears, as found from the chart for the desired ratio. Consider the 2 to 1 ratio with pinion of twelve teeth. The chart gives the maximum addendum as 0.45 inch for 1 pitch, by Formula (1) that of the rack-tooth or tool is 0.375 inch. If the tool is made to cut 0.45 inch below the pitch line and no undercutting is desired, the required angle of the tool is found from Formula (6) to be 16 degrees 51 minutes. If the depth of the space is to remain the same as for the standard tooth and equal to $2 \div P$, the depth of the space in the gear below the pitch line will be $2 - 0.45 = 1.55$ inch. We find by means of the chart that this is excessive, as the maximum addendum for a gear of twenty-four teeth and a ratio of 2 to 1, at 18-inch center distance, will be but 1.313 inch. The excess in depth is $1.55 - 1.313 = 0.237$ inch, and if the tool is made to cut to this depth undercutting of the teeth will result. (See Fig. 1 for typical case.)

The use of the standard tool is out of the question in this case, as the amount of undercutting would be excessive even when compared to the standard twelve-tooth pinion shown in Fig. 1. Even if the tool is made to an angle ϕ^g that would avoid undercutting at the depth of the maximum addendum, *i. e.*, 1.313 inch, for the twenty-four-tooth gear, the extra depth of cut would still cause a slight undercutting to take place. A practical method of compromise in this case would be to divide the amount of undercutting between the two gears so that the tool would be set to a depth below that required for the generating of non-interfering teeth, and divide the excess proportionally, *i. e.*, make the tool for the pinion at the angle required by Formula (6) and $0.45 + \frac{0.237}{3} = 0.529$ inch below

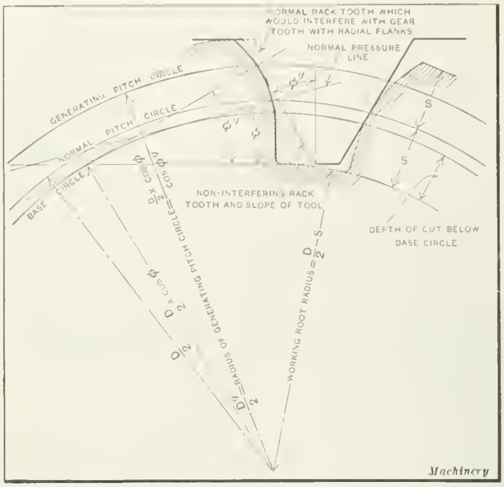


Fig. 6. Diagram illustrating Derivation of Formula for Angle of Generating Tool

the pitch line; that for the gear, $1.313 + \frac{2 \times 0.237}{3} = 1.471$ inch below the pitch line and at the required angle for a depth 1.313 inch, as found from Formula (6). The better way would be to make the total depth of the tooth equal to the sum of the maximum addenda for the gear and pinion, respectively, for reasons to be disclosed later. It would not do to make the tool for the gear to the angle corresponding to a depth of 1.55 inch, as the flank would then be too full and the teeth would interfere. The maximum addendum found by the chart is the limit at which the tool angle ϕ^g can be taken and still avoid interference. When we are considering the case of gears with standard addenda teeth, the preceding compromise can be applied and gear teeth obtained with a minimum amount of undercutting.

The foregoing methods are most easily applied in the case of the planer tool which is almost universally used in generating bevel gears; the only thing necessary is to grind the tool to the angle ϕ^g and measure the teeth in the usual manner. It is also applicable to the case of the hob, and where a quantity of gears of a single number of teeth are to be produced the use of a special hob with the angle made according to Formula (6) is to be recommended in place of the more universal method of avoiding undercutting by doctoring the tooth shape of the hob by applying a curved correction. The latter method is a compromise at best, and must be accompanied by a similar correction to thin the points of the gear teeth, resulting in a shortening of the arc of contact. In making the hob, the lead of the thread must be equal to the pitch of the teeth of the gear at the rolling radius corresponding to the angle ϕ^g and is given by the following formula:

$$\text{Lead of hob thread} = \frac{\cos \phi}{\cos \phi^g} \times P' \qquad (7)$$

where P' is the circular pitch of the standard gear.

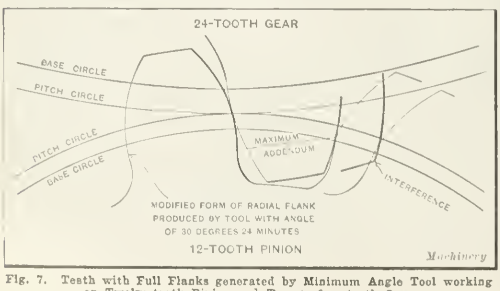


Fig. 7. Teeth with Full Flanks generated by Minimum Angle Tool working on Twelve-tooth Pinion and Twenty-four-tooth Gear

The thickness of the tooth of the hob must be such that the thickness of the tooth of the gear at the normal pitch line is equal to $\frac{P'}{2}$. This result can be obtained by making the hob tooth space equal to the thickness of the tooth of the gear at the rolling pitch line; and the thickness of the tooth at that point in the gear can be obtained by the method given in my article entitled "Plotting the Involute Curve," which was published in the February number of MACHINERY. The thickness of the hob teeth is taken at a depth equal to the depth of the space in the gear below the pitch line.

The tooth and space of the long addendum gears are, as a rule, not made of equal thickness. It is usual to make the teeth of such a thickness at the pitch line that they will be approximately of equal thickness at the mean depth. This would be the result if a standard hob were used to generate the teeth, as the thickness of the long addendum tooth would be that at the line $a - a$, the thickness of the short addendum mating tooth that at the line $c - c$, and the average thickness that at the line $b - b$, *i. e.*, the normal pitch line of the rack or hob. The pitch of the teeth in the rack or hob does not alter, no matter what location is taken for the pitch line, as with the gear teeth which increase or decrease in pitch with any shifting of the pitch line. To find the thickness of the teeth for the different addenda, we may solve the problem by proportion. If the sides of the rack teeth are

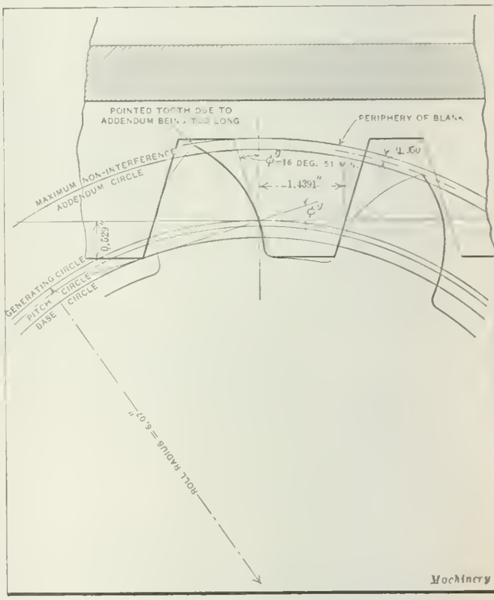


Fig. 8. Diagram showing Relation of Twelve-tooth Long Addendum Pinion and Hob

produced until they intersect each other, the space S'' from the normal position of the pitch line to the intersection of the sides, midway in the depth of the tooth, may be found by the formula:

$$S'' = \frac{0.7854}{P \tan \phi} \qquad (8)$$

where S'' has the value shown in Fig. 8;

P = diametral pitch;

ϕ = pressure angle of gear.

The thickness of the space at any location of the pitch line other than the middle position may be calculated from the formula:

$$T^n = \frac{S'' \pm a}{S''} \times T \qquad (9)$$

where T^n = thickness of rack tooth at any distance from normal pitch line;

a = distance pitch line is shifted from middle position;

T = normal thickness of teeth at line $b - b$.

The plus sign is used when the shift is outward from the normal position $b - b$, and the minus sign when the shift is inward toward the apex of the angle made by the sides of the teeth. The shift a is the same in both gears of a pair, the signs being opposite. As an example of what procedure to follow in finding the thickness of the hob tooth for a hob made with the teeth formed to the angle found by Formula (6) instead of the standard pressure angle, we will take the case of the long addendum twelve-tooth pinion previously referred to; the ratio is 2 to 1, the gears have twelve and twenty-four teeth, the addendum is $0.45 + \frac{0.237}{3} = 0.529$ inch, and angle of the tooth 16 degrees 51 minutes.

Normal pitch radius = 6 inches;

Root radius = 6 − 0.529 = 5.471 inches;

Base line radius = 5.808 inches;

Roll radius = 5.808 ÷ 0.957 = 6.07 inches.

The thickness of tooth on the pitch line is:

$S'' = 3.137$ inches;

$a = 1 - 0.529 = + 0.471$ inch;

$$T^n = \frac{3.137 + 0.471}{3.137} \times 1.5708 = 1.806 \text{ inch.}$$

The thickness of the tooth of the gear at the roll radius is found by the following method, as described in the article "Plotting the Involute Curve:"

One-half the angle of the tooth at the pitch line = $\frac{1.806}{2 \times 6} = 0.150$ radian;

b at ϕ is 0.00555 radian;

b' is $0.150 + 0.0055 = 0.155$ radian;

b' is one-half the tooth angle at the base line of the gear, and is expressed in radians:

b at $\phi^g = 16$ degrees 51 minutes is $\tan\phi - \phi$ (in radians);

ϕ in radians is $\phi \div 57.296 = 16.85 \div 57.296 = 0.294$ radian;

$\tan\phi = 0.30287$;

$b = 0.30287 - 0.294 = 0.00887$ radian;

½ angle of tooth at a radius of 6.07 inches is $0.1555 - 0.00887 = 0.14663$ radian;

Thickness of tooth at a radius of 6.07 inches is $2 \times 0.14663 \times 6.07 = 1.739$ inch;

The lead of the hob is $\frac{2 \times 6.07 \times 3.1416}{12} = 3.1783$ inches;

The thickness of the hob tooth at the depth of the roll radius or at $6.07 - 5.471 = 0.599$ inch from the end of the teeth, is then $3.1783 - 1.7392 = 1.4391$ inch. The hob and gear are shown in Fig. 8.

It will be noticed that the ends of the pinion teeth are pointed and shorter than the teeth of the hob, and consequently have a shorter addendum than was intended. This is a point that will have to be looked out for in the design of long addendum gears, especially in the case of pinions with few teeth, as the involute curve of the opposite sides of the teeth will overlap, which results in pointing the teeth and shortening the addendum. The limiting addendum obtained from the chart for non-interference will lie inside the point of the tooth, and had that been the limiting length for the addendum the teeth would not have been pointed. It is well when using extreme addenda on the teeth of small pinions to check up the tooth for thickness at the point in the same manner as has been done to find the thickness at the roll radius, and if the term b is equal to the term b' the tooth will be pointed; if b is greater than b' the tooth will be shortened. No attention has been paid throughout this article to the extra depth of tool required for cutting the clearance. This can be added to the proportions of the tool, and if the corner of the tool is made to a radius equal to the amount of the clearance, the extra depth will have no serious effect on the tendency toward undercutting; it can be disregarded in the calculations, if the tool is to be left sharp. It will rest with the designer to decide whether he wishes to go to such a refinement. Gears made with tools at the angle ϕ^g will not be interchangeable with the whole involute series and will not mesh without interference with gears of smaller numbers of teeth. Their application is therefore necessarily confined to the generation of gears for special trains and especially where quiet running gears are necessary.

* * *

PLANISH-BROACHING

A square-hole transmission gear of the kind illustrated in Fig. 1 is almost sure to close in when hardened. More than that, it is almost sure to close in unequally on account of the varying thickness of metal surrounding the hole at different points. For instance, this particular gear, in hardening, will close in but slightly at the thin end, but will close in considerably at the thick section, owing to the contraction of the heavier mass of metal at this end. The result is that the gear will not slide freely without being ground out to fit the shaft after hardening. This, of course, is a slow operation and not a very satisfactory one, so the American La France Fire Engine Co. of Elmira, N. Y., through whose courtesy this job is shown, decided to try planish broaching as a remedy. To this end, a planish broach was made approximately as shown on the Lapointe Machine Tool Co.'s broaching machine in Fig. 2. While there were no teeth on this broach, it was slightly relieved at certain points in order that the pull would not be excessive. All sections of the hole are reached by the broach, but not at the same time. The first section of the broach must enter the shrunken hole easily, the next section expands the hole in one direction, the third expands the hole in the other direction; and the last gives a final shaping to all four sides of the hole.

Fig. 1. Gear to be Planish-broached

It is necessary to expand the gears about 0.004 inch at the thick section in order to straighten the hole, but to maintain this expansion permanently the broach must be made so that it will compress the stock about 0.008 inch. This makes allowance for the springing back of the metal after being expanded. This operation is performed exactly the same as any other broaching operation, using a lubricant to prevent the broach from tearing the sides of the hole. C. L. L.

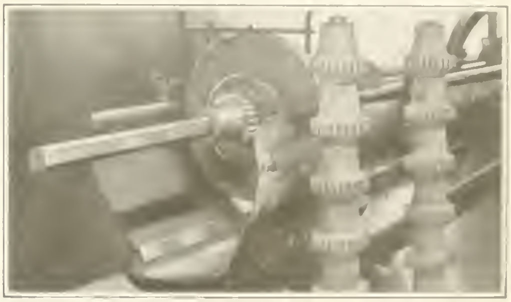


Fig. 2. Planish-broaching Operation

* * *

The manufacture of metal bodies for automobiles requires heavy presses of large capacity, especially if the largest parts are formed from one sheet. But in the majority of plants, the larger parts are made of two or more formed parts joined by autogenous welding that are afterward hammered smoothly into shape. The rough joint is ground off outside and is then hammered with the Pettengell post hammer to take out the wrinkles and roughness and to round off the curves to the desired radii.

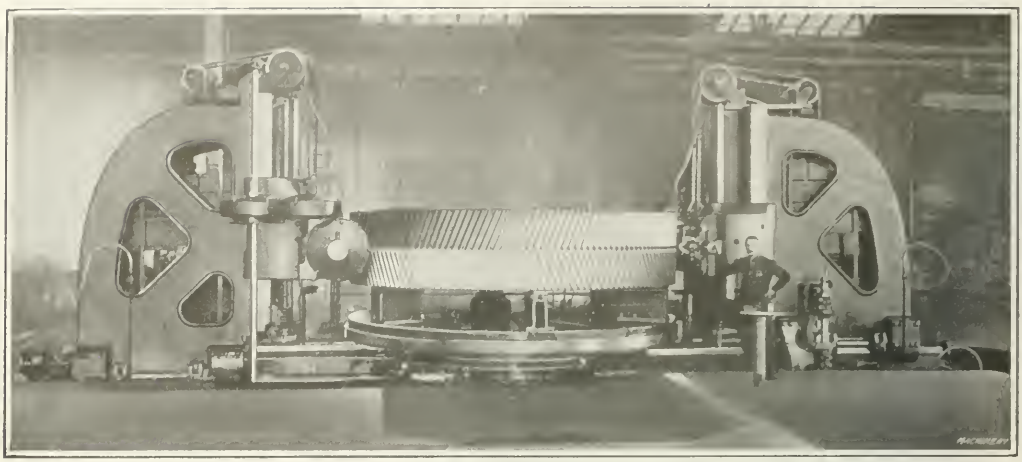


Fig. 1. General View of Falk Herringbone Gear Hobbing Machine working on a Large Gear

THE LARGEST HERRINGBONE GEAR HOBBING MACHINE*

A SPECIAL MACHINE DESIGNED AND BUILT BY THE FALK CO. FOR GENERATING WUEST TYPE OF HERRINGBONE GEARS

THE purpose of the following article is to describe what is believed to be the largest herringbone gear hobbing machine in the world; this is a special machine designed and built by the Falk Co., Milwaukee, Wis., for its own use in generating large herringbone gears. The capacity is for gears from 3 feet 2 inches up to 16 feet 3 inches in diameter, and up to 6 feet face width; teeth of all pitches up to ¾ diametral pitch can be cut. The floor space occupied by the machine is 43 feet long by approximately the same width, the height 16 feet, and the weight 150 tons.

Gears generated by this machine are almost invariably cut from steel castings, and the expense involved in building a machine for service of this kind is such that only a firm engaged in the manufacture of gears would have enough work for the machine to be able to earn a reasonable return on the investment. Hence, the term "special" gear hobbing machine is employed. At the present time a herringbone pinion generating machine is in course of construction, which has a capacity for cutting pinions from 13 inches up to 9 feet in diameter, and in face widths up to 6 feet. This machine will cut the teeth of pinions which are integral with shafts up to 22 inches in diameter.

It will be evident from the illustrations of the machine shown in Figs. 1 and 3 that it is equipped with two hobs carried by heads located at opposite sides of the table on which the work is mounted. One of these hobs starts cutting at the top of the gear blank and the other at the bottom, the desired angle for the herringbone gear teeth being obtained by employing a differential speed mechanism to transmit motion for rotating the work-table, and for feeding the cutter-heads on which the hobs are carried.

General Features of the Machine

The work-table on which the gear blank is mounted occupies a fixed position at the center, and the housings which support the cutter-heads at each side of the machine are mounted on ways which provide for sliding them back and forth to bring the cutter-heads into the proper positions for hobbing gears of various diameters within the range of the machine. Adjustment of the housings is obtained by means of very accurate lead-screws which were made for this purpose by the Boye & Emmes Machine Tool Co., Cincinnati, Ohio; these screws were furnished under a guarantee that the error in the lead of the thread should not exceed 0.001 inch per foot of length. Traversing of the housings is done by means of a 7½-horsepower auxiliary motor provided for this purpose, and the fine settings are made by hand. The housings are brought to approximately the required position by means of graduations on the bed, and dials are provided on the lead-screws to facilitate making the final accurate settings.

The cutter-heads are mounted on vertical bearings on the face of the housings, and the vertical feed is obtained by lead-screws made by the same manufacturer and having the same degree of accuracy as those employed for traversing the housings on the bed. It will be seen that the cutter-heads are counterweighted by means of weights located inside the housings; in the case of the hob which starts cutting at the top of the gear blank, the counterweight slightly exceeds the weight of the cutter-head, while in the case of the hob which works from the bottom of the gear blank, the counterweight is slightly less than the weight of the cutter-head. The reason

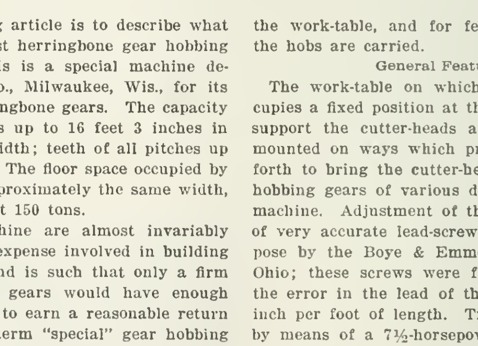


Fig. 2. Close View of Section of a Wuest Herringbone Gear

* In the February, 1915, number of MACHINERY a description was published of a herringbone gear hobbing machine built by the Fawcus Machine Co., Pittsburg, Pa. This machine has a capacity for hobbing gears up to 15 feet in diameter, making it a close competitor for the honor of being the largest herringbone gear hobber in the world.

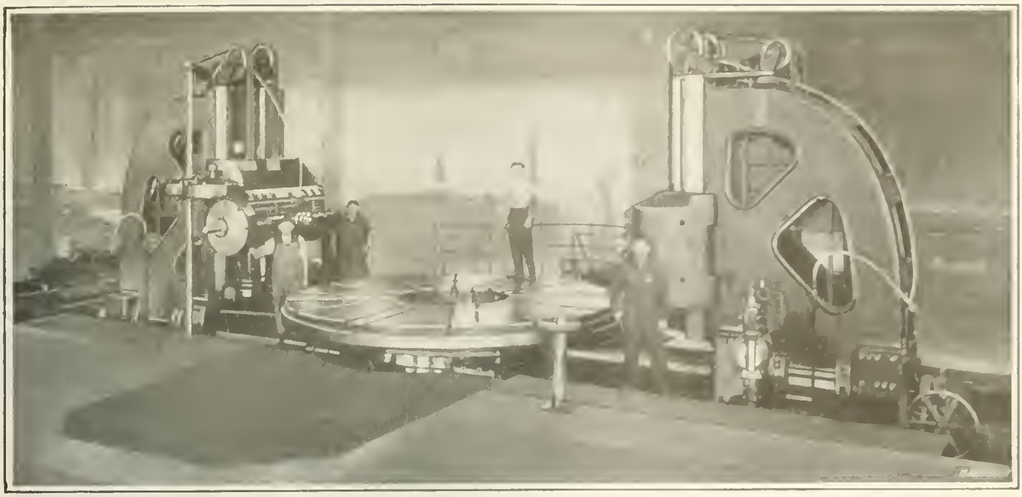


Fig. 3. Machine with Work removed from Table—Attention is called to Pit at Far Side of Machine in which All Driving Mechanism is located

for this is that it is desired to take up any lost motion between the lead-screw and nut in the same direction for both the cutter-heads, and also to have both of the lead-screws in a condition of tension. The arrangement of the feed mechanism will be described in a subsequent paragraph. The guides for the cutter-heads on the housings are of the narrow type, and the same is true of all guide bearings on the machine.

Arrangement of the Driving Mechanism

The main driving motor and the mechanism for making speed and feed changes are located in a pit on the opposite side of the machine from which the photographs reproduced in Figs. 1 and 3 were taken. The railing surrounding this pit can be seen in Fig. 3. The machine is driven by a 30-horsepower motor which transmits power to the arbors in the cutter-heads through a change-gear box that provides ratios of 1 to 2 or 1 to 4; after leaving the gear box the motion is transmitted through a train of bevel, spiral and worm gears to the cutter-arbors. A vertical shaft which carries the power up to one of the cutter-heads can be seen at the left-hand side of the machine in Fig. 1; and there is a similar shaft at the opposite side of the machine, which transmits power to the other cutter-head. In working out the design, care was taken to have the drive symmetrically arranged in order that torsional strains in the shafting would be equal for both of the cutter-heads. Further provision for accurate driving was made by employing the hunting tooth principle in the gears which transmit the motion to the cutter-heads; it may be mentioned that hunting tooth gears are also used at all points on the machine where the occurrence of wear would affect the accuracy of the results obtained.

Power for rotating the table and for feeding the cutter-heads up and down, respectively, is taken from the main driving shaft which transmits motion to the cutter-arbors. The drive to the table is carried through a differential gear box and thence through herringbone change-gears to two worms meshing with worm-wheels that drive the table. In order to take full advantage of the benefits resulting from the use of herringbone gears, it is of the utmost importance to have extreme accuracy in the spacing of the teeth. Provision is made for obtaining the required degree of accuracy in the spacing of teeth of gears generated on the machines used by the Falk Co. by a patented mechanism that automatically compensates for any error which may exist in the spacing of the teeth of the worm-wheels which drive the table. Means are also provided for taking up lost motion between the worm-wheels and driving worms, so that a degree of accuracy is obtained which appears to be as high as human ingenuity can make it.

Power for the feed motion of the cutter-heads on their respective housings is taken from the table driving shaft and transmitted through the feed box; from this box it is carried back through the differential gear box and thence to the feed shaft which transmits the motion to the lead-screws. This gives the proper relation between the table speed and rate of feed to obtain the required angle for the herringbone teeth of the gear. Change-gears are pro-

Fig. 4. Steel Casting for a Herringbone Gear—notice the Large Shrink Heads

Fig. 5. Rough Casting of a Pinion Blank

vided outside the differential gear box to provide for using different hobs, and spiral change-gears are employed to give the proper table speeds for hobbing gears with various numbers of teeth. An auxiliary 7½-horsepower motor is provided for traversing the cutter-heads on the housings when setting up the machine or returning the heads to the starting point after the roughing cut has been completed.

Setting up the Work on the Machine

The gears made on this machine are of the Wuest herringbone type, and it is customary to employ a roughing and finishing cut in generating the teeth. In hobbing gear teeth of the coarser pitches, experiments have been made with roughing hobs having the sides of the thread stepped in a way similar to that employed with stocking cutters on gear cutting machines. This practice has given very satisfactory results. A close view of several teeth of a Wuest herringbone gear is illustrated in Fig. 2, where it will seen that the ends of the teeth at one side of the gear come opposite the spaces at the opposite side.

In setting up the machine for generating a gear, it is obvious that the cutter-heads at opposite sides of the machine must be so adjusted that the hobs are in the proper relation to each other and to the work. A hand-wheel is provided at the end of each cutter-head for the purpose of adjusting the position of the hob in relation to the work. The preliminary setting is made in this way for taking the roughing cut, and after this cut has been completed, a gage is employed for ascertaining the relation of the teeth on one side of the gear to the spaces on the opposite side. This test will generally show that a slight discrepancy exists in the relative positions of the teeth, and before starting to take the finishing cut, the position of one of the cutters must be adjusted so that the finishing cut will result in bringing the ends of the teeth at one side of the gear exactly opposite the spaces on the opposite side.

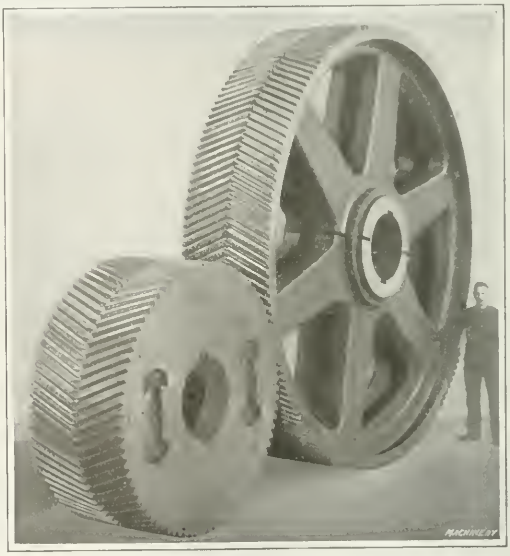


Fig. 6. Finished Pair of Herringbone Gears; Pinion is in Two Pieces connected with Shrink Keys

Casting the Gear Blanks

In addition to its business in the manufacture of gears, the Falk Co. operates one of the most completely equipped steel foundries in the country; and this has placed the concern in an exceptionally advantageous position for manufacturing large herringbone gears, which are generally cut from steel. Figs. 4 and 5 show the rough steel castings; and Fig. 6 shows the finished pair of gears. The gear is said to be the largest ever hobbed from a solid blank; it is approximately 14 feet in diameter by 35 inches face width, and the teeth are of 1 diametral pitch. The pinion is approximately 7 feet in diameter and of the same face width and pitch as the gear; it is made in halves for attachment to the engine crankshaft, and held together by shrink keys. These gears are required to transmit a peak load of 7000 horsepower with the gear running at 30 revolutions per minute. From the illustration of the castings, it will be evident that unusually large shrink heads are provided, the purpose being to supply an abundance of molten metal to feed into the mold as the steel cools and contracts.

After the cutting of the teeth on the gears has been completed, they are set up on a testing machine on which they are "run in" to give the teeth a good bearing surface before the gears are shipped. Large gears are treated with a mixture of oil and emery while they are being run in; and the accuracy of the bearing surface obtained is tested with red lead to be sure that the required degree of accuracy has been obtained in the tooth bearings. In the case of small gears, experience has shown that certain other forms of abrasives give more satisfactory results for the running-in operation.

Advantages of Herringbone Gears

The chief advantage claimed for gears with herringbone teeth is that they transmit the motion with great uniformity, that there is not such a tendency towards the development of wear as in the case of other types of gearing, and that the development of vibration and noise is reduced to a minimum. These features make the application of herringbone gears particularly advantageous for use on all types of machinery where the service is of such a character that the development of shocks or vibration in the gearing is likely to cause the breakage or premature wearing out of machine parts, discomfort to employes resulting from excessive noise, or imperfect work as the result of vibration. Rolling mills used in steel works, heavy-duty pumps of the class employed in municipal pumping stations, and masticators used in rubber factories may be mentioned among the classes of equipment in which the application of herringbone gears

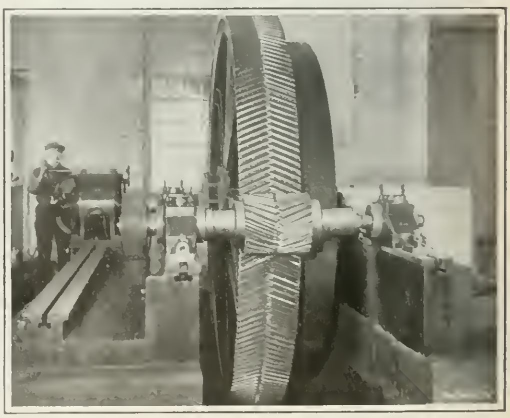


Fig. 7. Running in and testing a Pair of Herringbone Gears

has been a notable success. Advantages resulting from the application of this type of gearing are lost, however, unless a high degree of accuracy is obtained in cutting the teeth. Realization of this necessity led the Falk Co. to improve upon the gear hobbing machines which it has had in use for the generation of Wuest herringbone gears; the machine which forms the subject of this article has now been running for a long enough time to demonstrate its ability to produce extremely accurate work; and in this connection it is noteworthy that accuracy of the product is coupled with an extremely satisfactory rate of production. The operation of the machine is fully automatic and it can be run day and night until the job on which it is working has been completed. E. K. H.

* * *

MATHEMATICS IN ENGINEERING

In an address by Prof. Ernst J. Berg, of Union College, Schenectady, N. Y., before the American Society of Swedish Engineers, at the December meeting in Brooklyn, on "Differential Equations in Engineering" attention was called to the importance of mathematics in many engineering problems which are now solved by "cut-and-try" methods at great expense. It was stated that all real or actual engineering problems can be reduced to such a form that they may be solved by the application of one of six fundamental differential equations. While there are many other mathematical problems leading to differential equations of other forms, these are not of interest to the engineer, as he deals only with things that are *real*, while the mathematician may construct problems that may involve variables of an imaginary character, that is, those that lead to mathematics for mathematics' sake. The engineer, however, is not concerned with these problems, but his problems can all be reduced to six fundamental differential equations that may be said to be the basis of all mechanical and electrical phenomena. The young engineer was advised to acquire the mathematical knowledge necessary to apply and solve these differential equations. Examples were quoted of engineers who had spent a couple of weeks in plotting curves in attempting to obtain some specific engineering information which the mathematician of engineering training had solved in a few minutes. Mention was also made of the fact that the six fundamental equations of engineering apply equally, and have the same form, whether they relate to dynamics in mechanics, to electricity, or to thermodynamics. In fact, the universal laws that underlie all phenomena in physics become apparent first when differential equations are applied to them. Chemistry also has of late been reduced to a mathematical science, and the chemist-mathematician of today can predict with accuracy results that in the past were found only through experiments and careful measurements.

While pointing out that mathematics is by far more important and valuable to the engineer than the average engineer is inclined to believe, Prof. Berg intimated that there was a great deal in mathematics that was entirely useless in engineering, and that it was important to study those things that would find direct application; and the most important of all to the engineer who wants to go beyond the elementary domain of mathematics, is, therefore, differential equations. It was also stated that, with proper teaching, any young man can become a reasonably proficient mathematician, there being no such thing, according to Prof. Berg, as a normal mind inherently unfitted for mathematical studies. He mentioned that in his experience of fifteen years of engineering, and a number of years as professor at the University of Illinois and Union College, Schenectady, he had found young men, who apparently could study mathematics only with the greatest difficulty, but who had, when properly taken in hand, developed into remarkably brilliant students of the subject. He intimated that the average engineering graduate did not know how to use his mathematical foundation, and stated that if he would give an average of fifty hours of concentrated study to the application of differential equations in engineering, using any one of a number of good text-books on the subject, he would acquire a fund of knowledge and a commercial asset which would be worth a great deal to him in increased earning power. While, according to the speaker, mathematics, in itself, was so delightful a study that the trained mathematician would rather read a new good book on the subject than he would a novel, and would read it with the same sense of interest and eagerness, yet the engineer must also look upon the commercial side, and the study of mathematics, when properly applied to engineering, could easily be valued in dollars and cents. Hence, he concluded that all young engineers should take pains to become proficient in the practical application of engineering mathematics.

* * *

RESTRICTED IMPORTATION OF MACHINE TOOLS INTO GREAT BRITAIN

Considerable uneasiness was caused in machine tool trade circles by the publication of a note in the December 6 number of *Commerce Reports*, the daily issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., as follows:

> A royal proclamation published November 30, 1915, prohibits, after December 21, the importation into the United Kingdom of all machine tools and parts thereof except small tools. A further exception is made in favor of machine tools and parts thereof imported under the license of the Board of Trade and subject to conditions and provisions of such license.

This statement seemed to be of ominous significance to American machine tool builders, but dealers in England and the Washington authorities made it clear that the British government was simply restricting the importation of machine tools to licensed importers, the aim being to discourage speculation and irresponsible dealings. British importers of machine tools must obtain licenses from the Board of Trade which, in cooperation with the War Munitions Board, restricts the disposition of such articles and regulates profits. There appears to be nothing in the proclamation to give serious uneasiness to legitimate trade interests. It seems to be aimed at the largely speculative trade activity, as pronounced in Great Britain as in America—the business of irresponsible agents or brokers who act as "go-betweens" and play the customer and the manufacturer against each other in order to make fat commissions with little risk. The result of the license requirement will be to concentrate the importation of machine tools into the United Kingdom in the hands of responsible, established machinery dealers.

* * *

PRIMARY MERCURIAL RESISTANCE STANDARDS

The fundamental units of electrical measurement are the ohm, (the unit of resistance) the ampere, (the unit of current) and the volt, (the unit of electromotive force). These units were defined by the International Congress on Electrical Units and Standards, London, 1908, and have since been internationally adopted. The Bureau of Standards, Washington, D. C., has recently issued a publication, Scientific Paper No. 256, dealing with the construction of four standard ohms. This unit was defined by the London Congress as the electrical resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grams in mass, of a constant cross-sectional area and of a length of 106.300 centimeters. The Bureau of Standards has constructed four material standards representing the unit in the form of mercury columns in glass tubes. The work involved measurements of the highest accuracy of the length, the departure from uniformity of the cross section, and the mercury content of each tube, as well as in the comparison with the working standard. All measurements had to be made at the temperature of melting ice prepared from [illegible] purified water which was used in order to avoid any temperature uncertainty due to possible impurities in the ice. Electrical comparisons of the four standards showed the average deviation of their individual value from their mean value to be less than 0.00001 ohm.

HELICAL SPRINGS UNDER CENTRIFUGAL ACTION

SPEED LIMIT DEVICE WHERE THE WEIGHT OF THE SPRING IS AN IMPORTANT FACTOR

BY JOHN S. MYERS*

In these days of the "Safety First" agitation most high-speed machinery—particularly turbine driven units—is required to be equipped with a speed limit device. Such safety stops are constructed in various ways, but their action usually depends upon a spring being deflected by the centrifugal force of a rotating weight. For low speeds, the centrifugal force of the spring, due to its own weight, is of little moment since it represents but a small percentage of the total weight causing the deflection; but since centrifugal force varies as the square of the velocity, the weight of the spring becomes of considerable importance at even moderately high speeds. For instance, if the spring in a device operating at 1000 revolutions per minute is 5 per cent of the operating weight, a similar device designed to operate with equal force at 4000 revolutions per minute would have an operating weight of $\frac{1000^2}{4000^2} = 1/16$ that of the first weight. The weight of the spring is necessarily as great as before since it must sustain the same load, and hence the spring now constitutes $16 \times 5 = 80$ per cent of the total operating weight. As a result of these conditions, there arises an interesting problem of the influence of the centrifugal force of a spring upon its action. The most usual case of such a device is mathematically

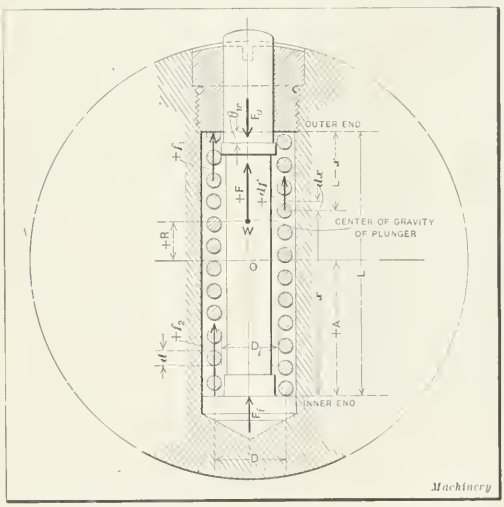


Fig. 1. Safety Speed-limit Device where Spring is acted upon by Centrifugal Force. The Center of Rotation is at O

treated in this article, and as the formulas derived are for the most part general in their form, the same treatment may be applied to other devices where helical springs are subjected to the action of centrifugal force acting in directions parallel to their axes.

Fig. 1 shows the type of device which has been selected for the purpose of making an analysis of the effect of centrifugal force on the action of the mechanism. The following notation is used, all values being in pounds and inches:

W = weight of plunger;
w = weight of spring;
N = R. P. M. of device about center O;
F = centrifugal force of plunger;
f_1 = force at outer end of spring due to centrifugal force of spring;
f_2 = force at inner end of spring due to centrifugal force of spring. (If f_2 is negative in value, it acts toward the inner end of the spring);
K = centrifugal force constant = 0.0000284;
d = diameter of wire from which spring is wound. (Care should be taken not to confuse d used to represent the diameter of the wire with d used to indicate the differential of a variable);
D_1 = inside diameter of coils;
D = mean diameter of coils = $D_1 + d$;
n = number of effective coils, usually taken as the whole number of coils minus 1.5;
F_s = safe load of spring;
θ = deflection of spring;
θ_w = working deflection of spring, *i. e.*, the amount the plunger moves from the inner to the outer position;
P = load required to produce a given deflection of spring under ordinary static conditions, when applied to one end and resisted at the other end;
S = safe transverse stress;
G = transverse modulus of elasticity;
M = modulus of the spring = Pn for $\theta = 1$, *i. e.*, M = deflection per coil, per pound, divided into 1;
L = length of spring in place under its initial strain;
A = distance from center of rotation to inner end of spring, as shown in Fig. 1. If the value of A is negative, it means that the inner end of the spring does not extend beyond the center of rotation. (Since there is ¾ coil on each end of the spring which is dead, the value of L should be reduced from the actual measurements to allow for this condition. The value of A should be similarly reduced, and this ¾ coil at the inner end should be considered as part of the plunger when figuring its weight W and locating its center of gravity. The weight of the spring w should be calculated for the actual number of coils minus 1.5);
R = radius from center of gravity of plunger to axis of rotation;
f = total centrifugal force of spring acting toward outer end = $f_1 + f_2$;
F_i = force acting on inner end of spring;
F_o = force acting on outer end of spring;
x = distance from inner end of spring to any element of the spring;
dx = infinitesimal element of the variable dimension x;
dw = weight of a portion of the spring having a length dx;
df = centrifugal force of a portion of the spring having a weight of dw.

Safe Load

For the safe load F_s of the spring, we have the following formula:

$$F_s = \frac{\pi d^3 S}{8D} \qquad (1)$$

For small steel springs, 80,000 may be taken as a safe value of the transverse stress S. Substituting this value in Formula (1) we have:

$$F_s = 31,416 \frac{d^3}{D}$$

$$d = 0.0317 \sqrt[3]{F_s D} \qquad (1a)$$

Deflection

For the modulus M of the spring, we have the following:

$$M = \frac{Gd^4}{8D^3} \qquad (2)$$

For steel we may take the transverse modulus of elasticity G as 11,500,000. Then we have:

$$M = 1,437,500 \frac{d^4}{D^3} \qquad (2a)$$

The deflection θ is then found to be:

$$\theta = \frac{Pn}{M} \qquad (3)$$

* Address: 4157 North 9th St., Philadelphia, Pa.

Centrifugal Force of Spring

In order to investigate the influence of the centrifugal force due to the weight of the spring itself, we first regard the spring as being without weight and then assign to an element of length dx, a corresponding element of weight dw. Then we construct formulas for the influence of this element of weight and by the methods of the calculus, summate the total effect when all of the spring has been given weight. Following this method of dealing with the problem, we have for the element of weight:

$$dw = \frac{w}{L} dx \tag{4}$$

The well-known formula for centrifugal force f takes the form:

$$f = KwRN^2.$$

We then have the following formula for the centrifugal force, resulting from the element of weight dw:

$$df = Kdw\,(x - A)\,N^2 = K\frac{w}{L}N^2 dx\,(x - A) \tag{5}$$

The infinitesimal force df is generated by the centrifugal action of the portion of the spring of length dx, and acts at a point located at a distance x from the inner end, and at a distance $L - x$ from the outer end of the spring. When the value of x is greater than that of A, the force df acts toward the outer end of the spring and is of positive sign. When the value of x is less than that of A, the force df acts toward the inner end of the spring, which will be shown by Formula (5) giving a negative sign. When the force df is of positive sign, it causes compression in that portion of the spring lying between its point of application and the outer end; and tension in the portion of the spring lying between its point of application and the inner end. When df is of negative sign, the converse is true. If the ends of the spring are not attached in such a manner that tension could be transmitted, the development of what would be tension simply reduces the external force on the spring (due to initial deflection or to the force F) by an equivalent amount. It is assumed that there is sufficient initial compression due to the force F so that the amount of any tension developed in the spring can never exceed the amount of compression. The amount of the force df which is sustained at the outer end of the spring is df_1 and it is transmitted over a length of spring $L - x$, through a number of coils equal to $n\left(\frac{L - x}{L}\right)$. Applying Formula (3), this is equivalent to a deflection at the point of application of df equal to:

$$d\theta_1 = df_1\frac{n}{M}\left(\frac{L - x}{L}\right)$$

The amount of the force df sustained at the inner end of the spring is df_2. This force is transmitted through $n\frac{x}{L}$ coils, and represents a deflection of:

$$d\theta_2 = df_2\frac{nx}{ML}$$

But these deflections both occur at a common point and hence are equal. Then:

$$d\theta_1 = d\theta_2$$

$$df_1\frac{n}{M}\left(\frac{L - x}{L}\right) = df_2\frac{nx}{ML}$$

$$df_1\,(L - x) = df_2 x.$$

$$df_1 = \frac{df_2 x}{L - x}$$

$$df_2 = \frac{df_1\,(L - x)}{x}$$

Since the force df is divided into two parts df_1 and df_2

$$df = df_1 + df_2$$

$$df_1 = df - df_2$$

$$df_2 = df - df_1$$

Substituting the value of df_2 previously obtained, in the equation for the value of df_1, we have:

$$df_1 = df - \frac{df_1\,(L - x)}{x}$$

Clearing the preceding expression of fractions and simplifying, we have:

$$df_1 = \frac{x}{L} df \tag{6}$$

Substituting the value of df_1 from Formula (6) in the formula for the value of df_2, we have:

$$df_2 = df - \frac{x}{L} df$$

Clearing the preceding expression of fractions and simplifying as far as possible, we have:

$$df_2 = df\frac{L - x}{L} \tag{7}$$

A minus sign in Equations (6) and (7) would simply indicate that the force df_1 or df_2 acted in a direction opposite to that indicated by the arrows in Fig. 1. Substituting in Formula (6) the value of df obtained from Formula (5) we have:

$$df_1 = Kw\frac{N^2}{L^2}(x^2dx - Axdx)$$

From the preceding expression, integrating between the limits of L and zero, we have:

$$f_1 = Kw\frac{N^2}{L^2}\int_0^L (x^2dx - Axdx)$$

$$f_1 = KwN^2\,(1/3\,L - 1/2\,A) \tag{6a}$$

Substituting in Formula (7) the value of df obtained from Formula (5) we have:

$$df_2 = Kw\frac{N^2}{L^2}(Lxdx - x^2dx - ALdx + Axdx)$$

From the preceding expression, we have by integration:

$$f_2 = Kw\frac{N^2}{L^2}\int_0^L Lxdx - x^2dx - ALdx + Axdx$$

$$f_2 = KwN^2\,(1/6\,L - 1/2\,A) \tag{7a}$$

The sum of f_1 and f_2 should equal the total centrifugal force of the spring f. Hence:

$$f = f_1 + f_2 = KwN^2\ (1/3\,L - 1/2\,A)\ + KwN^2\ (1/6\,L - 1/2\,A)$$

$$f = KwN^2\,(1/2\,L - A) \tag{8}$$

In Equation (8) the value of $\frac{1}{2}\,L - A$ is the distance from the center of rotation to the center of gravity of the spring. Hence the formula has the form of the usual one employed for centrifugal force, and thus constitutes a check on the accuracy of Equations (6a) and (7a).

Other Forces Acting on the Spring

When at rest, the load P acting on the spring is that necessary to produce the given deflection, and its value is given by the formula:

$$P = \frac{\theta M}{n} \tag{3a}$$

When rotating at a velocity sufficient to be operative, the centrifugal forces and the force due to the deflection of the spring must be in equilibrium. In other words, the plunger is floating freely upon the spring, the centrifugal forces being balanced by the condition of the internal stress in the spring. The centrifugal force F of the plunger is given by the following formula:

$$F = KWRN^2 \tag{9}$$

This is the only external force acting on the inner end of the spring; hence, $F_1 = F$. The internal forces balancing this are P and f_2 and, since f_2 (when of positive sign) acts in a direction opposite to that of P, their combined effect is $P - f_2$. The external forces being equal to the opposing internal forces, we have:

$$F_1 = F = P - f_2 \tag{10}$$

From Formula (10) the force P acting to produce deflection is seen to have a value of:

$$P = F + f_2 \tag{11}$$

The total external force F_0 acting at the outer end of the spring has a value of:

$$F_0 = P + f_1 = F + f_2 + f_1 \tag{12}$$

Care should be taken to see that f_1 and f_2 have their proper

signs as given by Formulas (6a) and (7a), for, when f_2 is of negative sign we have:

$$F = P - (-f_2) = P + f_2$$
$$P = F + (-f_2) = F - f_2$$

The spring should be made strong enough to safely withstand the action of whichever one of the two forces F_1 or F_o is the greater. To investigate which of these forces is the greater, we know that their difference is $F_1 - F_o$. Substituting and reducing, we have:

$$F_1 - F_o = KwN^2(A - \tfrac{1}{2}L) \qquad (13)$$

From Formula (13) it can be seen that if:

$$A = \tfrac{1}{2}L,$$
$$F_1 = F_o;$$
that if $A > \tfrac{1}{2}L,$
$$F_1 > F_o;$$
that if $A < \tfrac{1}{2}L,$
$$F_1 < F_o.$$

In other words, the longest end of the spring is subjected to the greatest load. Considering the actual load as equal to the safe load, we have for the case where $A > \tfrac{1}{2}L$ (for safety against failure) $F_1 = F_s$. Substituting and reducing to simplest terms, we have:

$$d = \sqrt[3]{\frac{8DKWRN^2}{\pi S}} \qquad (14)$$

For steel, this equation takes the form:

$$d = 0.000967 \sqrt[3]{DWRN^2} \qquad (14a)$$

For the case where $A < \tfrac{1}{2}L$, we have (for safety against failure) $F_o = F_s$, from which:

$$d = \sqrt[3]{\frac{8DKN^2}{\pi S}\,[WR + w\,(\tfrac{1}{2}L - A)]} \qquad (15)$$

For steel, Formula (15) reduces to the form:

$$d = 0.000967 \sqrt[3]{DN^2\,[WR + w\,(\tfrac{1}{2}L - A)]} \qquad (15a)$$

Making the constant in Formulas (14a) and (15a) equal to 0.001, for the sake of convenience, corresponds to employing a safe stress of about 72,300 pounds per square inch.

Deflection

Equation (11) gives the value of the force acting upon the spring to produce deflection. Substituting in this equation the value of F and f_2 from Formulas (9) and (7a), respectively, gives:

$$P = KN^2\,[WR + w\,(1/6L - 1/2A)] \qquad (16)$$

Substituting this value, together with the value of M from Formula (2), in Formula (3) for the value of the deflection, we have by using a modulus of elasticity G for steel of 11,500,000:

$$\theta = 198\,\frac{N^2 n D^3}{d^4}\,[WR + w\,(1/6L - 1/2A)] \times 10^{-13} \qquad (17)$$

Method of Procedure in Designing

The usual method of procedure in designing is as follows: First: decide upon the proportions of the plunger with an assumed size of spring, the working deflection of the spring θ_w, and the variation in the revolutions per minute N to produce this deflection. Second: calculate the weight W of the plunger and the distance R to its center of gravity. Third: calculate the centrifugal force F from Formula (9) for the outer position of the plunger. Fourth: if the distance A from the center of rotation to the inner end of the spring is equal to or greater than ½ the length of the spring L, when in place under its initial strain, then F is the maximum load on the spring. Hence, we either refer to a spring table, calculate the value of the safe load F_s on the spring from Formula (1) and the assumed dimensions, or calculate the value of the diameter d from Formula (14) to insure having a safe size of spring. If the value of A is a considerable amount less than the value of $\tfrac{1}{2}L$, the load at the outer end of tho spring must be investigated. To do this, calculate the value of w from the assumed sizes; then calculate the values of f_1 and f_2 from Formulas (6a) and (7a), and the value F_o from Formula (12); then refer to a spring table or calculate the value of d from Formula (15) or (15a). Fifth: being assured of the strength of the spring and having calculated the value of the centrifugal force F of the plunger for the outer position, we proceed to calculate the value of F for the inner position and of the centrifugal force f_2 of the spring

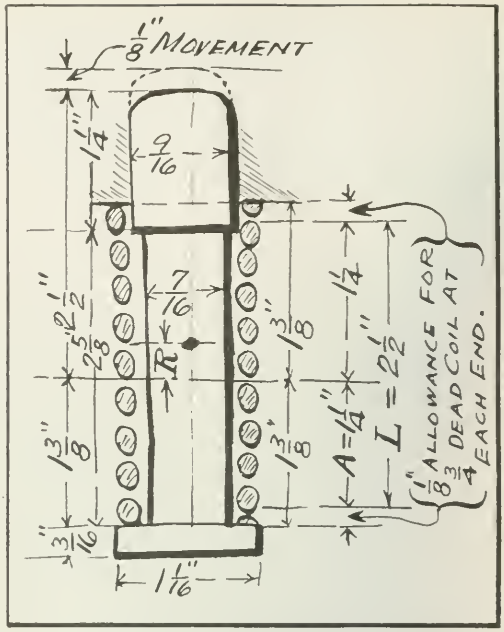


Fig. 2. Designer's Sketch of Plunger referred to in Example

for both positions, by applying Formulas (9) and (7a), respectively. Sixth: substitute these values in Formula (11) for the value of the force P acting to produce the deflection for the inner and outer positions. Substitute these values of P in Formula (3), and if the deflection is not close enough to the desired amount, modify the size of the spring until a sufficiently close value is obtained.

Example

For the plunger illustrated in Fig. 2, we have the following approximate values:

$W = 0.246$ pounds;
$R = 0.365$ inch radius at the inner position;
$R = 0.365 + 0.125 = 0.49$ inch radius at the outer position;
$\theta_w =$ movement of plunger $= 0.125$ inch;
$L =$ actual length of spring when in place under its initial strain $= 2\tfrac{3}{4}$ inches, or say the effective value of L is $2\tfrac{1}{2}$ inches. Assume the size of wire for the spring as No. 9 B. W. G. wire;
$d =$ diameter of wire $= 0.148$ inch;
$D_1 =$ inside diameter of spring $= \tfrac{5}{8}$ inch;
$D =$ mean diameter $= 0.625 + 0.148 = 0.773$ inch;
$N =$ R. P. M. for inner position $= 3150$;
$N =$ R. P. M. for outer position $= 3240$.

Applying Formula (9) for the centrifugal force at the outer position, we have:

$$F = 0.0000284 \times 0.246 \times 0.49 \times 3240^2 = 35.9.$$

For the inner position:

$$F = 0.0000284 \times 0.246 \times 0.365 \times 3150^2 = 25.27.$$

From Equation (1), the safe load F_s on the spring is found to be:

$$F_s = \frac{31{,}416 \times 0.148^3}{0.773} = 131.5 \text{ pounds.}$$

This is apparently a safe value. Assume the pitch of the coils of the spring when in place to be 0.2 inch. Then we have:

$$n = \frac{2.5}{0.2} = 12.5 = \text{number of coils.}$$

The volume of metal in the spring is:

$$\frac{\pi 0.148^2}{4} \times 12.5 \times 0.773 \times \pi = 0.521 \text{ cubic inch.}$$

Then the weight of the spring $w = 0.521 \times 0.283 = 0.147$ pound. For the outer position of the plunger, $L = 2\tfrac{3}{8}$ inches

and $A = 1\frac{1}{8}$ inch. Applying Equation (7a) for the outer position of the plunger we have:

$$f_2 = 0.0000284 \times 0.147 \times 3240^2 \times (1/6 \times 2\,3/8 - 1/2 \times 1\,1/8) = -7.3 \text{ pounds.}$$

For the inner position, we have:

$$f_2 = 0.0000284 \times 0.147 \times 3150^2\,(1/6 \times 2\,1/2 - 1/2 \times 1\,1/4) = -8.61 \text{ pounds.}$$

Applying Formula (11), we find that the force P producing deflection in the spring is for the outer position:

$$P = 35.9 + (-7.3) = 28.6 \text{ pounds.}$$

For the inner position we have:

$$P = 25.27 + (-8.61) = 16.66 \text{ pounds.}$$

The change in load is thus found to be:

$$28.6 - 16.66 = 11.94 \text{ pounds.}$$

This change occurs for a deflection of ⅛ inch. For the assumed sizes, for a steel spring, the modulus M is found from Formula (2a) to have the following value:

$$M = 1{,}437{,}500 \times \frac{0.148^4}{0.773^3} = 1490$$

From Equation (3), the number of coils n is found to be:

$$n = \frac{\theta M}{P} = \frac{0.125 \times 1490}{11.94} = 15.6 \text{ active coils, or } 15.6 + 1\tfrac{1}{2} = 17.1 = \text{ total number of coils.}$$

The length of the spring when completely compressed to bring it coil to coil would be:

Length of spring equals $17.1 \times 0.148 = 2.53$ inches.

Length of spring with plunger out $= 2\frac{5}{8}$ inches.

The sum of the clearance between the coils is thus seen to be $2.65 - 2.53 = 0.095$ inch, and the clearance per coil is $0.095 \div 17.1 = 0.00556$ inch.

The number of coils, as previously calculated, is $\frac{15.6 - 12.5}{12.5} \times 100 = 24.8$ per cent greater than the assumed number upon which the weight of the spring was based; and the value of f_2 is consequently 24.8 per cent greater, thus reducing the effective value of the force P. The clearance between the coils is also too small to allow of sufficient adjustment, so that the design of the spring or plunger should be slightly modified to meet these conditions. By recalculating with new assumed sizes, the resulting error should be extremely small.

* * *

ALUMINUM DIE-CASTING*

None of the die-casting alloys in general use, such as zinc, tin or lead base, exceed cast iron in tensile strength. It can therefore be seen that the foundation of the die-casting industry is based on economy. The cost of any die-casting must be less than the combined cost of producing that casting in cast iron and machining to a finished product equivalent to a die-casting. The cost of metal is a vital factor to the life of the die-casting industry, as prohibitive prices for raw materials must exclude die-casting from competition with other methods of production. The zinc market will serve as a good illustration. In 1914 approximately 85 per cent of the die-castings produced were made from zinc alloys consisting of a minimum of 85 per cent zinc, the other elements being tin and copper, which having a higher market value tend to raise the net cost of the average zinc die-casting alloy to approximately 5 cents a pound above the market price of zinc. For example, with zinc at 7 cents, copper at 16 cents and tin at 40 cents, which prices are about average, the cost of the average die-casting alloy is 12 cents a pound. This means that in order to compete with sand-casting the die-casting process must show a minimum saving of about 9 cents a pound on the machining cost of the casting since the cost of cast iron does not exceed three cents a pound. The cost of zinc, intermediate brand, on June 1 was 28 cents a pound which would bring the cost of the average die-casting alloy up to 31 cents per pound.

What this high metal-cost means to the die-casting industry can readily be understood by considering the fact that in order to compete, a three-pound die-casting must show a net saving on machining cost of at least 84 cents. Although there are numerous instances where die-castings show a saving even at this high price, the growth of the industry must of necessity be curtailed if such conditions are to prevail, unless a substitute for zinc is found. A careful study of the properties of the common metals reveals aluminum as the "hope" of the die-casting industry. The normal price of aluminum before the war was 8 cents which, considering the specific gravity, makes it the cheapest non-ferrous metal, and with aluminum at 35 cents a pound it exceeds only lead in cost.

The Doehler aluminum die-casting process, patented by H. H. Doehler, is the first that has been developed on a commercial basis in America or other countries. This process is no longer an experiment, having been in operation for more than two years, during which time castings have been turned out for use on many of the high-priced automobiles and other machines. At the present time, 150,000 pounds of aluminum are being converted into die-castings each month by the Doehler process. The alloy used in this process is aluminum copper, which term means that the alloy contains no tin, zinc or cadmium. The exact components of the alloy will not be published until the patents are granted.

The aluminum die-casting, although a commercial proposition, cannot economically replace zinc alloy die-castings where the latter are satisfactory, despite the lower cost of the aluminum alloy for the same bulk. The cause for this which, in fact, is the most serious drawback to the expansion of the industry lies in the life of the dies. A die for a zinc alloy casting will last almost indefinitely, whereas with aluminum alloys the best die material obtainable will not produce over 5000 castings without heat checking. Thus it will be readily seen that it must add largely to the cost of the casting if a new die is to be made for every 5000 castings.

* Abstract of paper read by Charles Pack at the annual meeting of the American Institute of Metals, September 28 to October 1, at Atlantic City, N. J.

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"AMPCO" BRONZES

The illustration shows a rude cold chisel made of "Ampco" bronze, which when used for chipping machinery steel held an edge as well as some chisels made of tool steel. These bronze chisels are being sent to the trade by the American Metal Products Co., Milwaukee, Wis., more as a curiosity, of course, than as practical working tools. They are intended to show some of the remarkable properties of "Ampco" hard bronze. Though not offered as a substitute for tool steel, it is claimed that this bronze in the form of cutting tools will serve not only as cold chisels but as lathe tools for turning

Cold Chisel made of "Ampco" Bronze, that cuts Iron and Steel

iron, mild steel and softer metals. It cuts aluminum without the use of a lubricant.

This bronze, which is furnished in different grades, contains no tin, zinc, lead or phosphorus and is non-corrodible, resisting diluted and strong sulphuric, hydrochloric and various organic acids, strong solutions of alkali carbonates and caustic alkali, sea water, various salt solutions, atmosphere, etc. It is cast in sand successfully and may be die-cast in iron or steel molds without causing rapid deterioration of the molds. In this respect, it differs radically from other brasses and bronzes containing tin, copper and zinc. Tin and zinc attack iron and steel at high temperatures forming alloys with the iron, and soon destroy the interior of iron and steel molds. It is claimed also that this bronze has the advantage of being very strong at high temperatures and is thus better able to withstand cooling stresses than ordinary bronzes used in die-casting. "Ampco" bronzes are furnished chiefly for bearings. Because of their hardness, it is claimed that their wear-resisting quality and frictional resistance is low. They are about 18 per cent lighter than brass, and annealing has no effect on the hardness.

OXY-ACETYLENE WELDING PRACTICE*

THE WELDING OF SHEET METAL AND BOILER WELDING BY THE FUSION WELDING METHOD

BY S W. MILLER†

SHEET metal is used in so many different forms and for such a variety of purposes that it is impossible to give any specific directions in regard to the methods to be followed in welding it. However, some general points can be noted, and the application to specific cases can often be derived from them. It should never be forgotten that in any welded piece there are likely to be strains due to contraction and expansion caused by the heating. In the case of brittle metals, such as cast iron, this strain will probably manifest itself by the piece cracking at some time during the operation or afterward. In the case of tougher metals, such as steel, the strain may not and probably will not so manifest itself, but it will be found instead that the piece will become distorted. The same general principles for taking care of strains in brittle metals apply in the case of tough metals. In other words, contraction must be allowed for in some way, either by preheating, separating the parts, or by expanding some part of the piece by heat or power, etc.

If a piece of steel plate 1/8 inch thick and 6 inches square be heated red-hot in the center with a torch, no particular change will be noticed during the heating, but on cooling off, while no crack will occur as it would if the plate were made from cast iron, the sheet will become badly warped. This warping can be remedied, as is done in every-day practice in boiler or tank shops, by laying the plate on an anvil or solid block of iron and peening it with a hammer until it is straight. This is an operation that requires considerable skill and experience, and is brought to its highest development probably in the case of large circular and band saws used for cutting wood. These have to be "hammered" to suit the speed at which they run and the conditions under which they operate. Without some experience, an attempt to straighten such a piece of steel will result in making it worse than it was originally, and while this process can be used, it is desirable to avoid it if possible. In the case of a small sheet, much of the difficulty can be overcome by heating it red-hot before welding, but in the case of a large sheet, this practice is not feasible, and it is generally difficult, if not impossible, to weld it neatly at the center. However, it is seldom necessary to make such an attempt, the majority of sheet welding being done along the edges, or in other places where the expansion due to the heating can be more readily controlled.

The welding together of short pieces of thin steel may be frequently accomplished nicely by preheating the whole piece along the edges to be welded. If there are many pieces of one kind to do, it will pay to make an arrangement by which a gas burner can be kept under the weld while it is made. In such cases the weld may be tacked at several points along the edges, and if it is kept red-hot by the gas flame it will give very little trouble, and in many cases the distortion will not be sufficient to cause any difficulty. On the other hand, in repair shops, it is not often that many pieces of one kind are done, it being generally odd jobs that are received. In cases where the weld is long, the best plan is to separate the sheets at one end by an amount equal to about 2½ per cent of their length, and just bring them together at the other end. If it is found that the contraction of the weld pulls the sheets together too fast, it will be necessary to hold them apart by clamping, wedging or some other method, forcing the contraction to take place in the weld rather than allowing the sheets to be pulled together. If, on the other hand, the sheets do not come together fast enough, stopping the welding process for a short time will generally correct the trouble, as the sheets cool off and do not again regain the same amount of heat.

It is not possible to clamp thin sheets so tightly that the edges may be brought absolutely together and all the contraction forced to take place in the weld. Even with very powerful clamps it is practically impossible to obtain the same pressure at all points along the edges, and, of course, where the pressure is less the contraction will be greater, the result being a buckling of the sheet and a wavy appearance on finishing the job. One of the easiest ways on odd jobs of this kind is to put a cross of ½-inch round metal between the sheets a considerable distance ahead of the torch, advancing it or moving it back from time to time as the contraction of the weld warrants. This of course has its limitations, because when the sheet is very thin, it will bend rather than force the contraction to take place in the weld; but if the sheets are ¼ inch thick or more, it is very satisfactory, particularly if clamps be placed across the sheet in several places, to keep the edges in line vertically.

Another objection to the use of clamps is that unless carefully designed, it is impossible to obtain the same pressure on the sheets twice in succession, and if it is found that a certain pressure with a certain amount of opening at one end will answer the purpose, it is evident that less pressure will cause the sheets to come together too fast and *vice versa*.

In the case of very thin material, such as is used for steel doors in railway passenger equipment, many ingenious jigs and clamps have been devised to hold the parts absolutely in line while welding. They all operate on the principle of forcing the contraction to take place in the weld. As they are special for each type of door manufactured, and as they are too expensive and generally not applicable for repair welding shops, no attempt is made to give any details of their construction, it being sufficient to say that the results obtained by their use are exceedingly satisfactory, and good results could not be obtained without them.

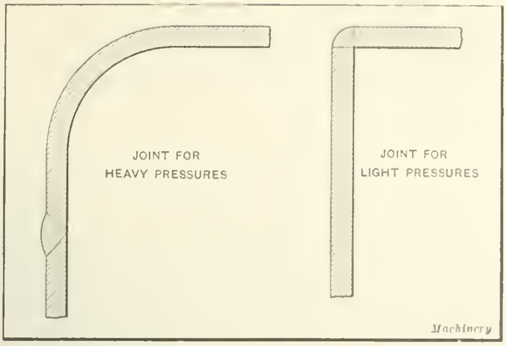
The methods outlined are applicable not only to flat sheets, but also to longitudinal seams of tanks such as range boilers, oil barrels, etc. In many cases automatic welding machines have displaced hand work on such articles and give a regularity of welding, uniform quality and appearance that is not obtained by hand welding. Light sheet welding by hand is really a special trade. The welder must have a steady hand and must keep in continual practice. While such welds made by an ordinary welder would appear to him very regular and uniform, they would seem to the expert sheet welder rather rough and irregular, although they might be perfectly sound. Such welds, if properly made, require very little finishing and result in as smooth a surface after grinding as the original sheet, and also have no buckling or other defects. The thicker the sheet is, the less is the trouble from buckling, and it is generally possible to make a nice appearing and sound weld in such sheets by keeping the wedge of metal between the sheets some distance ahead of the torch as previously explained.

Welding Copper and Aluminum Sheets

The welding of sheets of flat metals other than steel is only done in exceptional cases, and while the same principles apply, other metals are generally more ductile, and the strain can be more readily taken care of. It should not be forgotten that all such welds are castings, and except in the case of aluminum, the weld will not be as strong, nor can it be hammered or otherwise worked as safely as the original sheet. Pure rolled sheet aluminum or aluminum sheet with but little alloy can be welded with excellent results, if a satisfactory flux is used, and the resulting weld will be as malleable as the original sheet. Such work is done every day in the case of carriage and automobile bodies, and the metal is afterward beaten over the forms without any difficulty. In the case of copper and brass, proper annealing will help the brittleness of the weld very much, but this cannot always be done, and therefore care should be exercised in subjecting the weld to hammering, rolling, etc.

* For information on oxy-acetylene welding practice previously published in MACHINERY, see "Oxy-acetylene Welding Practice," November, 1915, and articles there referred to.

† Address: Rochester Welding Works, Rochester, N. Y.



Methods of making Joints for Heavy and Light Pressures

Welding Heads of Tanks

In the manufacture of steel tanks, there is no special difficulty in welding in the heads. There are, however, a number of precautions that should be observed in the preparation of the pieces, the principal one of which is that they should be so designed as to avoid anything except tensile strain in the weld; that is, no design should be made in which there is any chance of a bending strain occurring due to internal or external pressure. Two examples are given in the illustration showing good construction, and as these are economical as well as safe, it is not necessary to show examples of objectionable ones, it being safe to assume that constructions other than those shown will not give as good results. There are two principles to be followed in making such joints: first, that the included angle of the V should be at least 90 degrees; second, that the sum of the edges of the V should be as short as possible. Modifications of these principles may be allowable in special cases, but for all ordinary work they should be strictly followed. In making any welds in tanks subjected to pressure, care must be taken to have the weld made entirely through the sheet, so that there is no crack or remnant of the original edges of the sheet left unjoined.

Boiler Welding

The welding of boiler sheets is really a specialty, and should not, except in the simplest cases, be undertaken by a repair shop, unless the welder or the person in charge is thoroughly familiar with boiler construction and the ordinary repair methods. So much depends on the soundness of a boiler that only the very best work is justifiable. Such work can only be obtained from a thoroughly honest, competent welder, who will at all times do the best that lies in his power. Sound welds, free from burnt and oxidized spots and slag, cannot be obtained, even by the best welder, without a good torch; and for this work the best is none too good. It is also almost necessary that the person in charge of the shop be familiar with boiler construction and repairs, so that he, being responsible, may decide intelligently what is to be done, and how.

For these reasons, Henry Cave has proposed what he calls the "three license system," for boiler welding, by which the proper authorities would license the plant doing the work, the apparatus to be used, and the men actually doing the work, after proper examinations and tests had been made. There is much to commend this plan, although the details would have to be worked out carefully. It would appear that if those in charge of the operation of boilers are compelled to obtain a license for the protection of the public, those making repairs should also be compelled to adopt similar "safety-first" methods. The author believes that, in addition, the moral character of the welder should be carefully looked into. A man who drinks or dissipates has no moral right to make a boiler weld, as all the welder's facilities must be on the alert. It is difficult to obtain men with just the right qualities, of course, but it is not by any means impossible.

For such shops as are equipped to do this kind of work, the rules of the Federal government in connection with marine inspection, are an excellent guide as to what may be undertaken in the present state of the art. These rules are, of course, conservative, and in the case of marine work, must be closely followed. The Federal rules are given in the "General Rules and Regulations prescribed by the Board of Supervising Inspectors," copies of which may be obtained at any of the local officers of the Inspection Department, or from the Department of Commerce at Washington, D. C.

The boiler insurance companies must be consulted about the work contemplated in all cases when insurance is carried, as their inspectors would reject it unless the work met with their approval, and the insurance would lapse. As a matter of self-protection, a repair shop should be cautious about boiler welding, because if anything happened later to the boiler, even though it were not the fault of the welding, serious injury might result to the reputation of the shop doing the work.

On the continent of Europe, much greater progress has been made in the welding of boilers than in the United States, and much work is done there that is not yet permitted here. Hence, there is a vast field open to those who are willing to take the time and make the effort to become accomplished welders in this line.

The technique of boiler welding, except in the case of a few specialists is not yet developed to the point where any one except such specialists should make welds in sheets where the working stress is entirely tensile, such as the shell of any boiler or the roof sheet of a locomotive type boiler. Even the most competent welders, in the author's opinion, should never touch such places, because a crack there points very strongly toward poor design, unsatisfactory material, old age, or overstrain, especially if the defect is near a longitudinal seam and this seam is a single or double riveted lap joint.

There is probably no other important mechanical structure in which more accurate knowledge exists as to the actual stresses involved, and as to the strength of the various joints used than in boilers. This knowledge, however, is unfortunately not as widely disseminated as it should be, and the lack of it (and in some cases the desire to build boilers as cheaply as possible) has resulted in construction that is not good and is sometimes dangerous. These cases are not so common as they used to be, with the result that modern boilers generally give little trouble from defects, unless the boilers are badly treated, or carelessly repaired.

The chance of being called on to make repairs to a boiler, therefore, is generally in the case of one that is rather old. Under these conditions the author always makes a careful examination and if he thinks the boiler is unsafe, he refuses to do any welding at all on it. It is a safe plan for the owner of a defective boiler to have it inspected by one of the boiler insurance companies; and if they will insure it after the welding is done, of course the work can be proceeded with. If they will not insure it, the repairs should not be done.

Simple Boiler Repairs

There are a number of simple boiler repairs that can be readily made, in which the strength of the boiler is not particularly involved, such as welding flue sheet bridges, fire cracks in seams from the rivet holes to the edge of the sheet, etc. In all cases a V should be made entirely through the sheet, leaving the bottom of the V open at least 1/16 inch, so that the metal can be welded from the bottom up. The dirt and scale should be well cleaned off the inside of the sheet as well as the outside. It should not be forgotten that lime or any similar form of scale tends to make a brittle weld. Where one sheet laps over another, as in the case of a fire crack in a seam, the edges of the crack should be raised after beveling by heating somewhat with the torch and driving a chisel underneath. This permits of the weld being made entirely through the sheet. In taking care of the contraction after such work, great reliance can be placed on hammering of the weld just after it is made, to expand it, and in fact it is the only simple way with which the writer is acquainted. The hammering must not be continued too long, that is, below a blue heat, or the tendency will be to produce a crack.

Of course fire cracks and broken flue sheet bridges mean

short welds, and there is very little chance of leaving a strain in those cases. Where the weld is longer, much judgment must be used in hammering to avoid producing serious strains which may later result in cracking the sheet. Again, there are cases where sheets are corroded in spots. These can generally be built up with perfect safety and to good advantage. Frequently an expensive replacement may be avoided by doing this. However, in such cases, there will undoubtedly be a loosening of the rivets if there are any in the vicinity of the work, and these will have to be replaced or calked to overcome leaks. In some cases it pays to cut out the rivets and redrive them after the welding is done.

Another frequent and rather easy repair is the adding of sufficient metal to a worn calking edge to permit of the sheet being recalked. This can easily be done without welding to the sheet underneath. After the welding is done, the metal may be hammered down and chipped and calked as in the original construction. A small patch can be applied in the corner of a firebox quite readily, but the rivets should be removed for a distance of 8 or 10 inches to allow for contraction.

In a general way there is but little difficulty from contraction in doing welding where there is a change of direction in the surface of the sheet, for example, near a flange or similar bend, because by removing a few of the rivets, the contraction takes care of itself and the rivets can generally be replaced easily. However, in the case of a flat sheet, the problem is entirely different. The welding of cracks in fire-boiler furnaces or fireboxes requires a high degree of skill and knowledge, and generally necessitates the use of special appliances for confining the heat to a narrow zone. Such cracks do not develop singly, but are accompanied by parallel cracks for quite a distance along the sheet. These are frequent in locomotive boilers, and are due to the fact that under severe service the water is driven away from the sheets so that they become overheated. When they are hot, the pressure in the boiler tends to bulge them, causing cracks to appear on the fire side between the vertical rows of staybolts, and on the water side through the centers of the staybolt holes. In the course of time one of these cracks goes through and begins to leak. While there may be no evidence of any more cracks, the bulging of the sheet indicates that there are at least incipient cracks beside the one giving the trouble. Now if the leaky crack be welded, the shrinkage of the weld will open up one of the cracks somewhere in the vicinity, the weld being stronger than the rest of the sheet.

Instances have been cited where a large number of cracks of this kind were welded in one firebox, the result being that finally there was a considerable gap in the last crack that developed, this being, of course, approximately equal to the sum of the shrinkages of the welds. In such a case it may be possible to weld a crack, but the writer does not believe it advisable except for temporary purposes, and then with the distinct understanding that the job is not sound and further trouble will undoubtedly result.

In order to take care of the contraction, it is sometimes the practice to run streams of water or compressed air on the sheet on each side of the crack, about 4 inches from it, thus preventing to a large extent the expansion due to the heat of the torch and reducing the contraction.

The highest development of the welder's art is needed in the application of patches in the center of a stayed surface, such as a side or flue-sheet of a locomotive firebox. There is no particular difficulty about welding the first side or even the second, but the trouble comes on the third and fourth, particularly on the last one. It is always necessary to use a box patch, that is, one that is dished in the center, so that the dishing will take the strain. Such work, as well as the application of entire side sheets, and patches 12 feet long in large fireboxes, are perfectly possible, and in fact are done every day in locomotive boiler shops, but they are the work of men who are trained in that direction, and they should never be done by any ordinary welding shop. It is therefore unnecessary to give any detailed description as to how this work should be attacked, particularly as the appliances for doing it are special, and have to be modified to suit each case. There is one thing, however, that should always be done in case of any work inside a boiler, or other confined space. An extra man should be stationed at the tanks, which should always be kept outside of the space or boiler, so that in case the hose bursts and the acetylene catches fire, it can immediately be shut off, thus avoiding possible fatal injury to the men inside.

* * *

DIFFICULTIES OF SCIENTIFIC MANAGEMENT IN SMALL PLANTS*

The factory employing from a hundred to three hundred men is frequently owned by a single individual, or, if the company is incorporated, the management is dominated by the heaviest stockholder to such an extent that the result is the same. This man may not be actively engaged in the business of manufacture—quite frequently he is not—but nevertheless his influence is strongly felt in matters touching the general business policy, expenditures, and innovations of any sort.

The manager of the business, who may or may not have had manufacturing experience, is often the sales manager, in fact, if not in name, and presides over the general office of the company. He is looked to for results, but must keep well within the limits of the company's policy as laid down according to the doctrines of the dominant stockholder, and heresy of any kind on his part is likely to result in personal disaster.

One of the most firmly established tenets in the creed of the successful business man is that of insisting upon the utter extermination of unproductive labor. No one will dispute the soundness of the reasoning, provided the labor so designated assists in no way the process of manufacture. Too often, however, since the man whose brain only is active differs not greatly in appearance from the man who is loafing, the fact that an employe is neither rushing about nor actively engaged in manual labor causes him to be condemned as useless, and he is henceforth abolished. The heavy stockholder very often knows a good deal about bookkeeping, and, since he visits the factory to better it, he will readily attack any apparent excess of men in this department, while fear of showing his ignorance would cause him to hesitate a long time before criticising the number of men actually engaged in the work of manufacture. The manager and the superintendent must please their superior and so are extremely loth to sanction in any way an increase in "apparent unproductive labor." When lack of profits forces retrenchment, the clerical force is always the first to be attacked, and the efficiency of the executive is often badly impaired by the consequent lack of necessary assistants. Even some very successful business men go so far as to view with great alarm the acquisition of anything in the nature of office furniture by a superintendent, fearing that he may be tempted to loll in idleness when he ought to be rushing about among his men. They feel that they are getting their money's worth when he is wearing out shoe leather which he pays for himself, but they are not so sure of it when he is sitting at a desk working his brains and using paper and pencil which they pay for. This may seem to be an exaggeration, but nevertheless the two commonest criticisms applied to managers and superintendents are, "the business is too top heavy," or, "he has too many men standing around."

Human nature being what it is, and the successful owner having pretty definite ideas as to who is responsible for his success and as to just how it was obtained, what chance has the efficiency engineer of foisting upon the average small business the paraphernalia of staff and line, routing, dispatching, and time study, with their chief of staff, supervisors of study, of planning, of standards, of bonus, of analysis, etc., together with each one's clerks, messengers, etc.? How, then, is the small- or medium-sized enterprise to obtain the benefits which can unquestionably be obtained by the introduction of the principles of efficiency? That is the question.

* * *

It may take time to be careful, but it takes more time to look after injuries.

* From an article by Dwight T. Farnham in the "Engineering Magazine," October, 1915.

DESIGN AND CONSTRUCTION OF SPROCKETS*

IMPROVEMENT IN EFFICIENCY RESULTING FROM DETERMINATION OF SPROCKET DIMENSIONS BY EXACT MATHEMATICAL INVESTIGATION

BY B. D. PINKNEY†

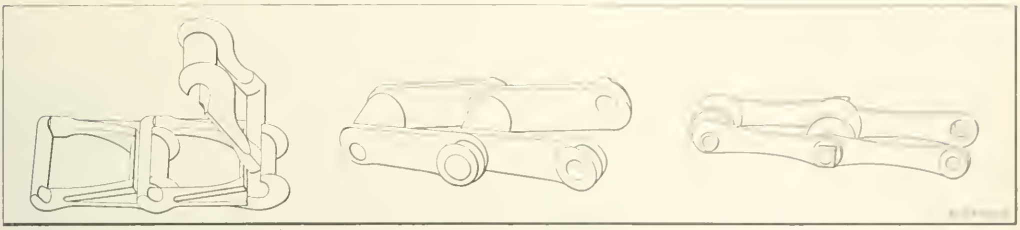


Fig. 1. Detachable Chain with Open Links Fig. 2. Pintle Chain with Closed Links Fig. 3. Cast Roller Chain

THE design and construction of sprockets, especially cast sprockets to carry chain of those pitches for which cutters are not regularly made, is an important branch of machine building. The design of such sprockets is generally carried out by cut-and-try methods without reference to geometrical construction or the use of rational formulas. The accuracy of sprockets designed in this way is more or less questionable, and they are only suitable for comparatively low speeds. The inaccuracy of the earlier types of cast chains was probably responsible for the adoption of this method of designing; but with the advent of the closed-link or pintle chain, and also the greater accuracy of the modern open-link or detachable chain, the lack of uniformity was reduced to such an extent that the development of rational formulas for the construction of sprockets for such chains became a mechanical necessity.

It is my intention to show that the design of sprockets lends itself readily to exact mathematical investigation; and that the combination of sprockets designed in this way, with a modern cast chain of accurate dimensions, naturally results in the production of a marked increase in the efficiency of the drive. Cast chain is divided into three general types, *i. e.*, detachable chain (open links) shown in Fig. 1, pintle chain (closed links) shown in Fig. 2, and roller chain shown in Fig. 3. The cast block chain shown in Fig. 4 is of the pintle type; and the chains shown in Figs. 5 and 6 are machined with great precision. Standard cutters are now made for machining sprockets, and the formulas for use in designing cast sprockets apply equally to sprockets with machined teeth.

* For other articles on the design of sprockets, chain-drives and allied subjects published in MACHINERY, see "Calculations for Roller Chain Drives," March, 1914; "Standard Sprockets for Detachable Link Belts," August, 1913; "Selecting the Number of Teeth for Gears and Sprockets," September, 1912; "Design of Dished Sprockets," October, 1911; and "Roller Chain Power Transmission and Construction of Sprockets," February, 1905.

† Address: 524 E. Third St., Newport, Ky.

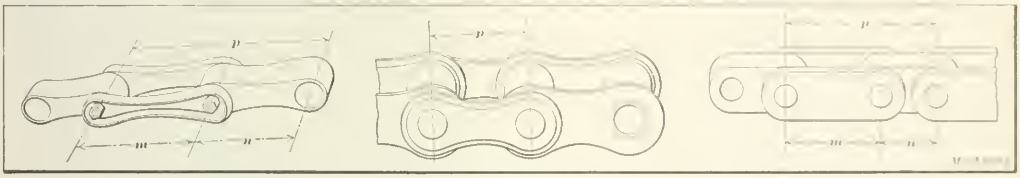


Fig. 4. Cast Block Chain Fig. 5. Machined Roller Chain Fig. 6. Machined Block Chain

In the early stages of the manufacture of detachable chain, which was invented in 1873 by W. D. Ewart, the lengths of equal numbers of links varied considerably, *i. e.*, the pitch was not constant. Neither did the links work together with a degree of satisfaction that would warrant their indiscriminate use; and the chain, when used for transmission purposes could not be made to work satisfactorily on a sprocket of uniform base diameter, if the sprocket had to be used both as the driver and the driven member.

In the year 1882, W. D. Ewart invented a sprocket with an improved tooth base, and one of his patent claims was for "a sprocket-wheel having the roots of the teeth of different depths at their opposite sides, so as to produce a differential pitch according to whichever of said sides may be made the working sides of the teeth." This sprocket is shown in Fig. 7. The driving sprocket, by putting the chain in tension, took up all lost motion in the links and made the chain of greater pitch, so that the chain would accommodate itself to the greater base diameter of the sprocket. The smaller base diameter was for a normally slack chain on a driven sprocket. Mr. Ewart, in his patent specifications, describes this as a novel construction "whereby wheels cast from the same pattern may be used as either driving wheels or driven wheels." As modern cast chains closely approach the accuracy of machined chains this differential feature is no longer necessary, and manufacturers have abandoned its use. Driving sprockets and driven sprockets are now made of exactly the same diameter.

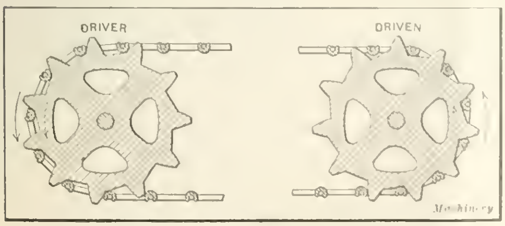
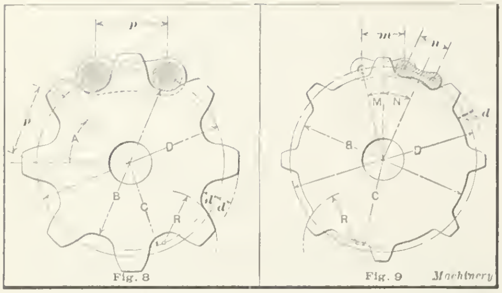


Fig. 7. Ewart Sprocket with Patented Differential Pitch

TABLE I. PITCH OF DIFFERENT SIZES OF SPROCKET CHAINS

No. of Chain	Average Pitch, Inches	No. of Chain	Average Pitch, Inches
25	0.902	77	2.[illegible]
32	1.154	78	[illegible]
33	1.394	83	4.000
34	1.398	85	4.000
35	1.630	88	2.609
42	1.375	95	4.[illegible]
45	1.630	95	3.967
51	1.155	103	3.075
52	1.506	108	4.720
55	1.6[illegible]1	110	4.720
57	2.308	114	3.250
62	1.651	122	6.050
66	2.013	124	4.063
67	2.308	116	6.150
75	2.609		

Machinery



Figs. 8 and 9. Diagrams used in deriving Formulas for Sprocket Diameters

Until a few years ago, the chain manufacturers gave the pitch of detachable chains in terms of an approximate number of links per 10 feet, and chains of equal length rating varied as much as 2 inches in 10 feet. Now that a greater degree of accuracy has been established, the average pitch of the chain is given. Table I gives a list of the "engineering detachable chains" which are extensively used in machine construction, together with their average pitch. But the important factor in sprockets is the base diameter, and not the pitch diameter, although the pitch diameter must first be calculated, after which the base diameter is determined from the measurement of the chain dedendum. The pitch diameter of sprockets is found by Formula (1), and the pitch diameter of sprockets for block chains is found by Formula (2):

$$D = \frac{p}{\sin \frac{1}{2} A} \qquad (1)$$

$$D = \frac{m}{\sin M} \qquad (2)$$

TABLE II. CONSTANTS FOR USE IN DETERMINING SPROCKET DIAMETERS (SEE FIG. 8)

No. of Teeth	Constant k	No. of Teeth	Constant k	No. of Teeth	Constant k
5	1.7013	25	7.979	45	14.336
6	2.0000	26	8.296	46	14.654
7	2.3047	27	8.614	47	14.972
8	2.6131	28	8.932	48	15.290
9	2.9240	29	9.249	49	15.608
10	3.2360	30	9.567	50	15.926
11	3.5490	31	9.885	51	16.244
12	3.8640	32	10.202	52	16.562
18	4.1790	33	10.520	53	16.880
14	4.4940	34	10.838	54	17.198
15	4.8100	35	11.156	55	17.517
16	5.1260	36	11.474	56	17.835
17	5.4420	37	11.792	57	18.153
18	5.7590	38	12.110	58	18.471
19	6.0760	39	12.428	59	18.789
20	6.3930	40	12.746	60	19.107
21	6.7100	41	13.064	..	......
22	7.0270	42	13.382	..	......
23	7.3440	43	13.700	..	......
24	7.6610	44	14.018	..	......

Machinery

$$\tan M = \frac{\sin N}{\frac{n}{m} + \cos N} \qquad (3)$$

where $D =$ pitch diameter;
$p =$ pitch of chain;
$m + n = p$.
For A, M and N see Figs. 8 and 9.

For conveniently finding the pitch diameter of any sprocket of 5 to 60 teeth, reference may be made to either Table II or Table III. Merely multiplying the constant k by the pitch of the chain gives the pitch diameter of the sprocket. For instance, the pitch diameter of a 35-tooth sprocket for No. 75 chain is:

$$11.156 \times 2.609 = 29.106 \text{ inches.}$$

The base diameter B (see Figs. 8 and 9) is obtained by Formula (4):

$$B = D - 2d \qquad (4)$$

As the manufacturers of cast chains do not give the dimension of the dedendum d, it must be measured from the chain. Machined chain manufacturers always give this dimension. Fig. 10 shows the construction of the sprocket teeth.

$$\text{Radius } C = 0.47\,D \qquad (5)$$

$$\text{Radius } R = 0.17\,D \qquad (6)$$

If radius R is less than $p - d$, use a minimum radius according to Formula (7).

$$\text{Radius } R \text{ (minimum)} = p - d \qquad (7)$$

$$W = 0.8\,L \text{ (except for roller chain)} \qquad (8)$$

The tooth width may be constructed as shown in Fig. 11 if the sprocket is of the webbed type, or as shown in Fig. 12 if the sprocket is of the spoked type, the additional width at E Formula (12), being necessary to strengthen the rim and prevent it from cracking while it is being cast.

$$T = 0.9\,S \text{ (see Figs. 13 and 14)} \qquad (9)$$

$$t = 0.6\,T \qquad (10)$$

$$F = d \text{ for roller chain and } 0.75\,d \text{ for all other chains} \qquad (11)$$

$$E = 1.25\,T + \tfrac{1}{8} \text{ inch} \qquad (12)$$

$$G = 0.08\,p \qquad (13)$$

TABLE III. CONSTANTS FOR USE IN DETERMINING SPROCKET DIAMETERS (SEE FIG. 9)

No. of Teeth	Constant k	No. of Teeth	Constant k	No. of Teeth	Constant k
6	1.935	24	7.646	42	13.373
7	2.249	25	7.964	43	13.691
8	2.565	26	8.282	44	14.009
9	2.881	27	8.600	45	14.327
10	3.198	28	8.918	46	14.645
11	3.515	29	9.236	47	14.964
12	3.832	30	9.554	48	15.282
13	4.149	31	9.872	49	15.600
14	4.467	32	10.191	50	15.918
15	4.785	33	10.509	51	16.237
16	5.102	34	10.827	52	16.555
17	5.420	35	11.145	53	16.873
18	5.738	36	11.463	54	17.192
19	6.056	37	11.781	55	17.510
20	6.374	38	12.100	56	17.828
21	6.692	39	12.418	57	18.146
22	7.010	40	12.736	58	18.464
23	7.328	41	13.054	..	......

Machinery

Note: $m = 0.6p$; $n = 0.4p$.

The formulas give a tooth with an angular chain clearance, or so-called "roundness" of 20 degrees, which I have found gives the best results. The smoothness with which the chain enters and leaves the teeth permits of employing a high chain velocity (900 feet per minute for cast chains and 1400 feet per minute for machined chains) and the action is free from jerks. In fact, the factor that limits the speed, as far as smooth running is concerned, is the inaccurate shape of the teeth. The old taper-flank teeth worked very well when a speed of 100 feet per minute was not exceeded, and as higher speeds were required, the experiment of rounding off the flanks was tried.

When the detachable chain makes a reverse bend, the open end of the link rides on the sprocket as shown in Fig. 15. As the addendum a (see Fig. 13) of the chain is less than the dedendum d, it is obvious that the base diameter of such a sprocket must be greater, the pitch diameter, of course, remaining the same. These sprockets are called "traction" or

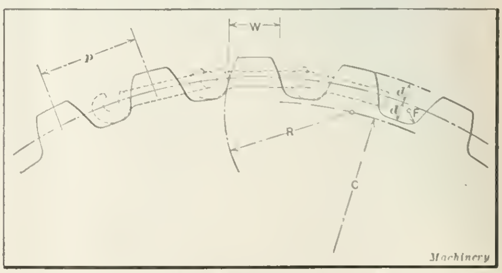
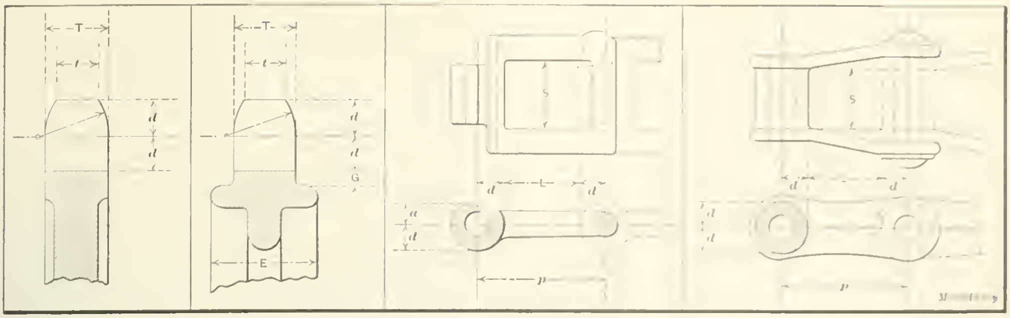


Fig. 10. Diagram showing Method of laying out Sprocket Teeth



Figs. 11 to 14. Diagrams showing the Important Dimensions of Sprockets and Sprocket Chains

"face" sprockets. Face-sprocket teeth are generally run to a point, as shown by the dotted lines in Fig. 15, to distinguish them from the standard sprockets.

There are some chains composed of such long links that the sprocket teeth would be unnecessarily large. Such a condition is shown in Fig. 16. A preferable construction is shown in Fig. 17, where two short teeth are used instead of one long tooth. In this case, if the sprocket has twenty standard teeth, there actually will be forty teeth, and the sprocket is said to be a twenty double-tooth sprocket. Some manufacturers place a web between the double teeth, as shown by the dotted lines in Fig. 17, but I have found it advantageous to omit this. For instance, in long pitch chains, you may have a tooth ratio of 15 to 21½, and to get whole numbers of teeth this would have to be increased to 30 and 43, where the large diameters would probably be objectionable. Omitting the web permits of using half-tooth ratios, and a sprocket could then have 21½ double teeth. The angle A applies to the pitch of the chain and not to the number of teeth, if there are more teeth than there are links.

For roller chain sprockets, the fillet F is made equal to d, which is the radius of the roller. This gives a smooth action to the chain as the roller bottoms on the sprocket. Fig. 18 shows the form of teeth for a roller chain sprocket. The distance h represents the roller clearance and is equal to 0.05 p. The reason that roller chains may be run at a higher velocity than other chains (except chains of the silent type) is due to the fact that as the roller chain stretches, and the pitch becomes greater, the rotary action of the sprocket throws out the chain and the rollers rise on the flanks of the teeth—automatically adjusting themselves to the larger pitch diameter. Non-roller chains offer too much resistance for this automatic compensation.

Another type of sprocket is the gap sprocket, shown in Fig. 19; and these gap sprockets are generally used for the reverse chain. When the chain is fitted with attachments for some specific purpose, and a reverse bend is made, the sprocket is provided with a gap or gaps to allow the attachment to pass. Fig. 20 shows one form of these attachments. Of course, where the projections are in the form of side wings, as shown in Fig. 21, the attachment will straddle the sprocket and a gap is not necessary. Cutting out the tooth that interferes with the attachment does not serve the purpose of a gap sprocket, for the attachment and the link will then be too loose, this variation being more and more noticeable as the number of teeth in the sprocket decreases.

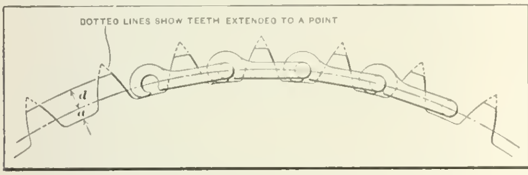


Fig. 15. Action of Detachable Chain in making Reverse Bend

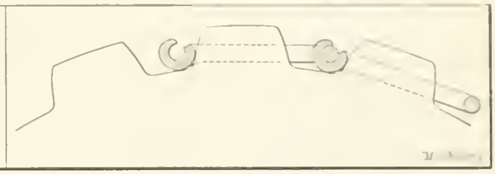


Fig. 16. How Long Links may make Sprocket Teeth too Large

The construction of gap sprocket teeth is shown in Fig. 22. The dotted chain links show the incorrect position which would follow if the normal pitch diameter were used. Therefore a new pitch diameter P_G, must be substituted for gap wheels. The value of P_G is found by geometrical construction, bearing in mind that a flat equal to $2p$ is required for each gap, the perimeter of the gap wheel pitch line (including the flat distances) being equal to the normal pitch circle derived from Formulas (1) or (2). The dotted points of the teeth show a preferable construction.

$$\text{Radius } C_G = 0.47\, P_G \qquad (14)$$

Hook-tooth sprockets are used to transmit power from a chain running in a straight or nearly straight line, and they are also sometimes used as idlers for returning a horizontal slack chain if the drive is intermittent and there is a tendency for the chain to jump off an ordinary sprocket. Not infrequently these sprockets have only three teeth. The engaging flank has a 10-degree reverse curve, the construction of which is shown in Fig. 23.

$$P_H = P - 2\,d \qquad (15)$$

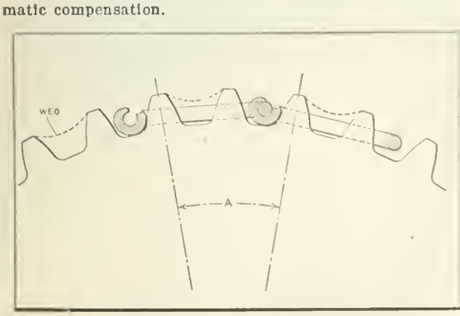


Fig. 17. Two Short Teeth used in Place of One Long Tooth

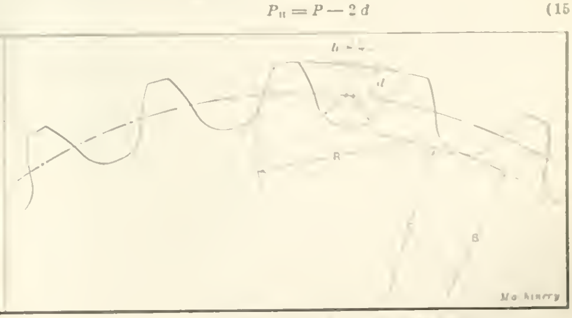


Fig. 18. Form of Teeth used for Roller Chain Sprocket

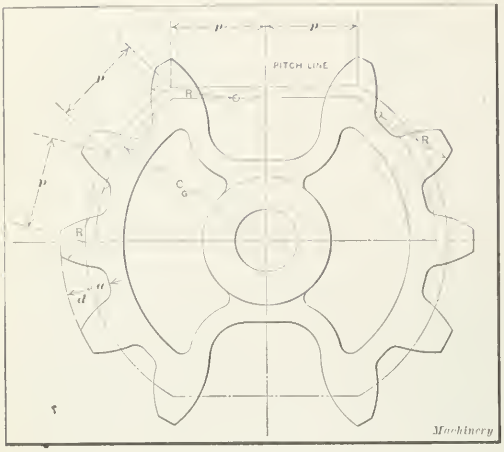


Fig. 19. Gap Sprocket used for Reverse Chain

$$\text{Radius } C_H = 0.47\, P_H \qquad (16)$$

$$\text{Radius } C_A = 0.49\, P \qquad (17)$$

The radius R_H is equal to radius R, Formula (6), except that the minimum radius R_H is found by Formula (18) instead of Formula (17):

Radius R_H (minimum) $= p + d$.

The tooth flanks are rounded at the ends to prevent interference as the chain enters and leaves the sprocket, as shown at X in Fig. 23. Hook-tooth sprockets cannot be used as drivers, as the wear is very great, due to one tooth doing all the driving; and, as the load is transferred from one tooth to another, there is a distinct jerk, due to the link slippage caused by the pitch of the sprocket being less than the pitch on the chain. When these sprockets engage the reverse side of the chain, no corrections are necessary, as in Fig. 15, because the corrected pitch diameter P_H already is smaller than the normal pitch diameter D.

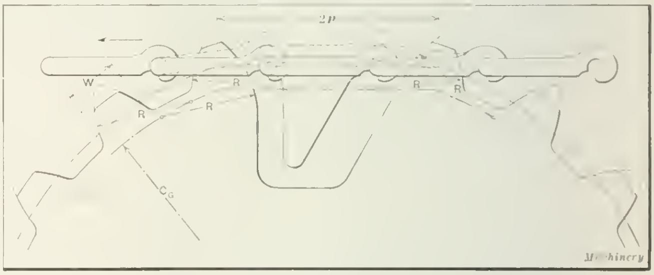
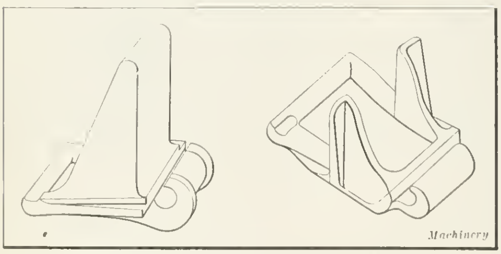


Fig. 22. Typical Layout for Gap Sprocket Teeth, showing Trouble that would follow if a Normal Sprocket Diameter was used

* * *

ALLOY OF NICKEL AND TANTALUM

The resistance of nickel to acids is considerably increased by an addition of tantalum. Ordinarily from 5 to 10 per cent may be added, but the resistance increases with an increasing percentage of tantalum. An alloy of nickel with 30 per cent of tantalum, for example, can be boiled in aqua regia or any other acid without being affected. The alloy is claimed to be tough, easily rolled, capable of being hammered, or drawn into wire. The nickel loses its magnetic quality when alloyed with tantalum. The alloy can be heated in the open air at a high temperature without oxidizing. The method of producing the alloy consists in mixing the two metals in a powdered form, compressing them at high pressure, and bringing to a high heat in a crucible or quartz tube in a vacuum. For general purposes, the alloy is too expensive.



Figs. 20 and 21. Attachments carried by Sprocket Chains

DIFFICULTIES IN MAKING BRASS DIE-CASTINGS

The successful results which have been obtained in making die-castings of white metal have naturally suggested the possible saving which would follow the development of a process for die-casting brass parts, instead of machining them from bar stock or casting them in sand and then finishing by machine work. Several manufacturers have done experimental work along this line and one or two are making relatively simple parts on a commercial basis; but up to the present time it has not been found possible to make brass die-castings on the scale that obtains in making white-metal die-castings.

One well-known manufacturer of die-castings, who has conducted extensive experiments with the view of determining the feasibility of die-casting various brass and bronze mixtures, has reached the conclusion that the idea is impractical. This is not due to the fact that satisfactory brass die-castings cannot be made, but rather that certain operating conditions appear to impose insurmountable difficulties in the way of making the castings at a price which would enable them to compete in the market with parts made by some other method. The chief difficulties which this manufacturer has encountered are as follows: The dies used for making die-castings are necessarily expensive, and in order to distribute the die cost so as to make it possible to sell the castings at a profit it would be necessary to produce not less than 10,000 parts before the dies were worn out. With white metal it is possible to produce up to 50,000 parts in a single set of dies, but with brass the number of castings produced frequently does not exceed 1000. The reason for this great difference in the life of the dies is that the temperature of molten brass is much higher than that of melted white metal and that the coefficient of expansion or contraction of brass is also much greater. The combined effect of high temperature and the strains imposed upon the die by the expansion and contraction stresses naturally results in its rapid deterioration. These conditions make it practically impossible to produce parts in which through holes or under-cuts are required, and where it is necessary to resort to drilling or machining to bring the die-castings to the required form they can be more cheaply made by other methods.

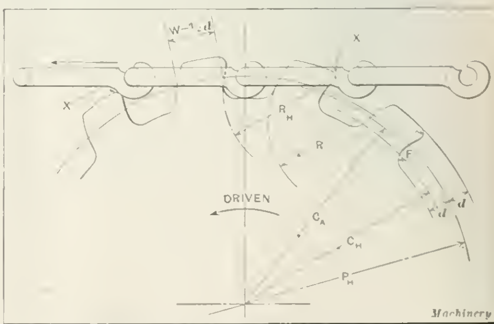


Fig. 23. Design of Hook-tooth Sprocket

The high temperature of molten brass makes it impracticable to use die-casting machines on which the metal is forced into the die by air pressure or by pressure supplied by a hand-operated plunger. The reason is that in such machines the molten metal is held in an iron pot, and the high temperature of the melted copper would result in the rapid destruction of the pot and contamination of the copper with iron which would give it undesirable properties. In the making of brass die-castings, the practice followed is to melt the brass in crucibles and then pour it into the dies. As the high cost of the dies makes it impracticable to have a large number, it is evident that the rate of production is slower than would be the case in pouring an entire crucible full of copper into a series of sand molds made by the match-plate method. This slow pouring of the molten metal, together with the high temperature, will result in the formation of a large amount of dross due to oxidization, and although this dross can be reduced in a reverberatory furnace it is not usually possible to recover more than 50 per cent of the copper content. As a result the loss of copper is a factor that must be taken into consideration.

The foregoing outlines difficulties that have practically decided one successful manufacturer of white-metal die-castings against entering into the manufacture of brass parts by the die-casting method. But the great advances which have been made in the scientific control of industrial work have shown numerous examples of seemingly insurmountable difficulties which can be overcome; and it is entirely possible that means may be found for the successful manufacture of brass die-castings. Few things are impossible, but manufacturers of die-castings who contemplate working in brass will do well to take advantage of the experience of the manufacturer referred to in this article, and conduct their experiments along lines which tend to overcome the difficulties referred to. Such a course would seem to be the means of saving expenditure of money on unsuccessful experiments. E. K. H.

[The foregoing review of the state of the art of making brass die-castings was submitted to the American Metal Products Co., Milwaukee, Wis., which is developing the manufacture of bronze die-castings.—Editor.]

BRONZE DIE-CASTINGS

BY PETER J. WEBER*

The conclusion of the manufacturer cited in the foregoing article is not wholly borne out by the experience of our company in the production of bronze die-castings. Our company has been successful in producing a limited number of bronze die-castings and has made sufficient progress in this field to warrant entering it on a commercial basis.

Our experience bears out the statement made in the foregoing article in the production of die-castings in brass or copper-zinc alloys. The particular difficulty encountered in working with copper-zinc alloys is the rapid deterioration of the dies, owing to the tendency of zinc to alloy with iron at high temperatures. This difficulty has been avoided by omitting zinc in the composition of the alloys used for die-casting, but even this course is not sufficient to prolong the life of the die. It was soon found that ordinary steels and cast iron do not resist the action of copper base alloys at the high temperatures at which they must be poured. It therefore became necessary to develop a special steel for the dies and cores. The steel which we are using will permit making from two thousand to five thousand castings from a die, depending on the shape and size of the casting, the number of cores, and the construction of the die mold.

Ordinary brass does not possess sufficient strength at high temperature to overcome the shrinkage strains set up in the castings when cooling in the die, and invariably die-castings made from copper-zinc alloys break or crack before they can be removed from the die. This difficulty must be overcome in a commercial die-casting alloy. Provision must also be made for reducing the time of shrinkage to a minimum so as to hold the castings to size. This has been accomplished by the development of a special power-operated die-casting machine which withdraws the cores, opens the die and removes the castings from the die in the shortest possible time and with the least labor involved.

There are many other details which cannot be overlooked in the successful production of bronze die-castings. The design and construction of dies to increase their life, promote ease of repair, reduce to a minimum the labor cost of production and operation are factors which determine the success or failure of each attempt. Many difficulties are encountered by local shrinkage in different parts of the castings of variable sections, and in the proper venting of the die mold so as to allow the rapid displacement of all air in the molds, by the molten metal entering the die. Some of these problems have been so intricate as to make it necessary to alter the design and construction of the die several times before a piece could be successfully produced. It is evident that the solution of these problems requires special application and concentration of thought on each piece, as each type of casting presents problems wholly different from those encountered in pieces of a different type.

It has been the experience of this company that bronze die-castings cannot be produced in competition with pieces which can be completely manufactured in automatic screw machines, whether in brass or steel. The die-casting process is only commercially feasible when difficult or numerous machine operations requiring a number of different settings in machine tools are thereby eliminated.

Copper base alloys which permit of being die-cast, must be of especially fine quality and great strength, and must be capable of maintaining a condition of stable equilibrium at all temperatures. The bronzes developed by this company have special qualities as to strength, elasticity, hardness and resistance to corrosion, and the fact that it is possible to vary these qualities between wide limits by varying the composition of the alloys renders them adaptable to a very wide variety of die-castings and sand-castings. It is necessary to have a large field in which to select pieces for die-castings of bronze because of the many limitations and difficulties which up to the present stage of development of the process have not been overcome. Because of their great strength, the bronzes produced by this company are capable of displacing iron and steel in the production of finished machine parts, such as die-castings, a field from which ordinary brass or bronze die-castings, if they could be made, are restricted. The bronze die-castings thus produced are stronger and more durable than steel castings. Within certain limitations it has been found possible to compete against iron and steel machine parts made from castings or drop-forgings, despite the great difference in the cost of material.

Owing to the many difficulties involved and the great amount of experimental work necessary, it has not been commercially possible for this company to limit its activities to the production of die-castings but it has also been pushing and marketing its bronzes in other forms such as ingots and sand-castings of bearings, bushings and castings where bronzes of special strength, toughness, hardness and resistance to corrosion are required. No reason is known why the difficulties should not be overcome by persistent efforts along the lines indicated. This company has been producing a number of bronze die-castings such as connecting-rods, bearings, valves, turbine blades, gears, cams and numerous other machine parts. Its process has been limited to the production of pieces of comparatively simple shape, weighing not less than one-half ounce nor more than three pounds and having no long small cores. The die-castings thus produced have been within a limit of accuracy of 0.005 inch from finished dimensions.

* President, American Metal Products Co., Milwaukee, Wis.

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DIE-CASTING ALUMINUM ALLOY

An aluminum alloy especially well adapted for casting under pressure in die-casting machines was patented May 5, 1914, by W. H. McAdams and contains the following ingredients, aluminum, 70 parts; zinc, 22 parts; copper, 3 parts; antimony, 5 parts, by weight. It is claimed that the alloy makes castings which are very strong and resilient and which possess a permanent superior luster.

TUNGSTEN—ITS IMPORTANCE IN THE MANUFACTURE OF ALLOY STEEL

BY ROY C. MC KENNA*

In the past year, the enormous demand created for high-speed steel by the acceptance in America of large orders for shrapnel shells and for war munitions, together with the prohibition of the exportation of tungsten ores from the British Colonies, has increased the price of tungsten ore to five times the normal. The greatest use of tungsten is as an alloy of high-speed steel; that is, tool steel to which tungsten and chrome have been added to impart the property of red hardness. In such steel, from 16 to 20 per cent of tungsten is used. Large quantities of tungsten are also used in magnet steel, but probably 90 per cent of all tungsten ore mined is used in the manufacture of high-speed steel.

Tungsten ore is mined in many parts of the world, but its production in the United States is recorded only since 1900. Before that date, the amount mined here was insignificant. There are four kinds of tungsten ore, known as ferberite, wolframite, hubnerite, and scheelite. All these are mined in Arizona, California, Colorado, Idaho, Nevada, New Mexico, South Dakota, Washington, and Alaska. The oldest and best known tungsten mines are located in Spain and Portugal, but the best grade of ore and the best producing mines are found in Boulder County, Colorado. Tungsten ore is also mined in Australia, India, Japan, Siam, Argentina, Brazil and Peru, but although tungsten ore deposits are found in so many sections of the world, there were produced in the year 1912 only 9654 short tons of 60 per cent tungsten trioxide concentrates, or less than 5000 short tons of pure tungsten.

Fig. 1. Ferberite, a Combination of Iron and Tungsten, mined in Bouldor County, Colorado

Fig. 2. Wolframite—Iron, Manganese, Tungsten—mined in Spain, Portugal, South America, Burma, Australia

Fig. 3. Scheelite, a Combination of Lime and Tungsten, mined in South America and Japan

Fig. 4. Ferro-tungsten, an Alloy of Iron and Tungsten, used in Manufacture of High-speed Steel

One of the least known and yet one of the most important of our new industries, established through necessity occasioned by the war, is the manufacture of ferro-tungsten. Formerly American users of this product bought their supply from foreign sources, and as ferro-tungsten is almost entirely used in making high-speed steel, it requires little imagination to understand the helpless position of American steel makers when foreign sources of supply are cut off by war. The United States government should recognize the great value of this new industry, which owing to the condition of mining will be greatly hampered when foreign competition is resumed. I believe that congress should provide a measure of protection to the capital already invested so that the tungsten ore producers may continue always to be independent and safe from the menace of foreign control.

* * *

FRENCH AND BELGIAN MARKETS

BY A. P. DAUTUN†

Many manufacturers now working on war orders seem to think that when the fighting is over, Europe, for lack of money, will no longer be able to buy anything from us. This is a greatly misconceived idea. England, being the wealthiest nation in the world, will always have a gold surplus, even after every other nation is exhausted financially; and she will always be able to pay cash. France and Belgium are not quite so fortunate in this respect. These two countries, to which I would like to draw particular attention, have a shortage of gold. To some this may appear serious, but when one considers the unlimited credit that these countries enjoy, their natural resources and, last but not least, the thrift and industry of the inhabitants, they make a highly satisfactory security. The industrial sections of Belgium and northern France are being sadly devastated, and before the war closes the ruin may be even greater. This may lead some to believe that these two countries will not be in position to do much business for a long time, but remember how Galveston and San Francisco were rebuilt—finer, larger and better in every way. The French people are so sure of themselves that they are now making extensive and thorough preparations for enormously increasing their commerce.

We have arrived at a stage where our production exceeds home demand and our surplus must find an outlet. France and Belgium are beginning to get acquainted with American goods, particularly labor-saving and time-saving machinery. These countries are planning to invest heavily in these lines, provided we, in turn, buy their surplus goods—things that we do not make ourselves. In other words, France and Belgium want to do business with us if we meet them half way. If Americans wish to take advantage of this market, they must see to it that our government makes the necessary changes in the tariff that will permit products peculiar to France and Belgium to enter this country without being heavily taxed. Clear, concise and adequate literature will be needed in the French language by American manufacturers who would take advantage of these great potential markets. No amateur translations can be tolerated.

Actual representatives will be more favorably received than mere agents, as the French and Belgians like to deal directly wherever possible. These representatives should know the language. They should study genuine courtesy and forget the glad hand and the loud vest. It will be highly satisfactory to all concerned if our American manufacturers could organize and place their headquarters in one locality. A permanent exhibition managed by an efficient force and conducted on a high business plane has been suggested. Preparations will have to be made to insure prompt, accurate and thoroughly satisfactory deliveries. The importance of these matters regarding packing, crating, shipment and delivery cannot be too strongly emphasized. Another important consideration not to be forgotten is the possible competition of Germany. The year before the war France imported nearly three times as much general machinery from Germany as from the United States. The French and Belgian hatred of everything German will, of course, be to our advantage, but if we cannot make satisfactory terms, one of the best markets in the world will be lost to us.

France and Belgium are to be modernized to the last degree. Many machine tools will be needed; also factory equipment, contractors' supplies, transportation and conveying machinery, plumbing conveniences, electrical equipment and modern mill machinery of all kinds will be wanted in great quantities. Cash registers and office specialties will be in demand; and in fact every conceivable device needed to facilitate business and enable a nation to become highly productive, even though many of its inhabitants have been lost or crippled, will be required.

* President, Vanadium-Alloys Steel Co., Pittsburg, Pa.
† Address: Freehold, N. J.

HOLDING DEVICES FOR TAPERED WORK*

METHODS OF HOLDING EITHER ROUGH OR FINISHED WORK WITH EXTERNAL OR INTERNAL TAPERS

BY ALBERT A. DOWD†

THERE are many instances when it is necessary to hold a piece of tapered work during the various machining operations. Sometimes the work is tapered on the outside, while in other cases the tapered surface is on the interior. The piece may be either in the rough state, and therefore somewhat uneven, or it may have been partially finished in a previous operation. In the case of a rough tapered surface which is to be gripped, it is evident that the inequalities of the surface must be taken into consideration; while in the event of the surface having been finished, care must be taken to obtain accurate location and provision for driving. The work may be very small or it may be of large size, and the material may be either a casting or a forging, while the tapered surfaces may be at an acute angle with the center line or somewhat obtuse. There may be instances which will permit the addition of holding lugs or their equivalent, while other cases may be susceptible to chucking by means of special jaws.

All of these points have an effect on the method of holding and must be considered when designing holding devices, while the type of machine on which the work is to be done is also an important factor. There is nothing much easier to hold than a small bushing having a shallow internal tapered surface which has been previously machined, and there is nothing much more difficult (under certain conditions) than a large shell of thin section having an outside tapered surface with a rather obtuse angle. The greatest care must be exercised in the design of holding devices for tapered work, and a few of the points to be considered are noted herewith. Specific cases will further be cited and attention called to important points during the progress of this article.

Points in Design

1. Size of the work. This is the first point to be considered, for the selection of the machine is somewhat dependent upon it. It is important to start with the size of the work and decide on what machine it is to be handled.

2. Number of pieces to be machined. If the production is large, every effort should be made to design the holding devices in such a way that broken or worn portions can be readily replaced, and convenience and rapidity of operation must be carefully studied. If but a few pieces are to be machined, the fixtures should be designed as cheaply as possible, yet with the idea of producing the work as rapidly as seems to be feasible. It does not necessarily follow that because a fixture is cheaply made, it must be slow and clumsy in operation, for it is often possible to work out the design so that it will be both cheap and capable of rapid manipulation.

3. Method of holding and driving. Both of these points should be carefully considered and as several methods are nearly always possible, it is well to make up rough sketches of the various schemes and then analyze them to see which offers the most advantages.

4. Accuracy required in the finished product. This is an important point and should influence the design to a considerable extent. For instance, it would be absurd to make up a fixture with all kinds of compensating devices and adjustments for keeping it in perfect alignment, when the work to be done on it was a large boiler nozzle or some such part requiring a tolerance not closer than 0.010 to 0.015 inch. On the other hand, a lack of these refinements on an extremely accurate job such as a piece of gun work, would indicate poor judgment on the part of the designer.

5. Rigidity. This must be considered both in regard to the inherent strength of the fixture itself, and also in respect to the overhang from the spindle if the fixture is designed for use on a horizontal type of machine. A lack of rigidity means the possibility of vibration, resulting in chatter, which is absolutely fatal to good workmanship or accuracy.

6. Angularity of tapered surfaces. This point is of great importance because if the angle is rather small and the work is to be held only by the tapered portion, there is a strong probability that it will slip out of its seat if a slight irregularity is encountered during the machining. I have seen an instance of this kind in a piece having a 10-degree included angle, which persisted in slipping out of jaws formed to the same angle. It is difficult to give a hard and fast rule regarding the angle which can be safely held without chance of slipping, for the direction of the cutting action on the work makes a great difference. Speaking generally, a piece of work requiring no facing or back cutting, and having an included angle of not more than 12 degrees, can be safely held in a set of properly formed grooved jaws. It is always better to be on the safe side and provide additional means of holding when there is the least doubt about the matter.

Methods of Holding Tapered Bushings

Undoubtedly the simplest form of tapered work is a bushing having a cylindrical exterior and a conical interior, and the simplest method of holding work of this kind is by means of various adaptations of the lathe mandrel or arbor. The design of the arbor is dependent, to a considerable extent, on the angularity of the tapered surface and the amount of machining required on the exterior of the bushing. Several examples and methods of holding are shown in Fig. 1. The work D, shown in the upper portion of the illustration, is a simple steel bushing having a previously machined internal tapered surface L which makes rather an acute angle with the center line. The outside of the work and the two ends H and G are to be machined concentric and square with the tapered portion. The arbor A represents the simplest form of holding device which can be devised for work of this kind. It is flattened on both ends at J so that a dog can be applied in either place, and it is centered at K so that it can be used on the centers of a lathe. In using an arbor of this kind, the outside of the work can be turned without trouble and the end G faced. When it comes to the facing of the end H, there is a possibility of the work loosening up unless it has been driven pretty firmly onto the arbor. For this reason light feeds should be used at this point.

The work E is a bushing of a similar nature to that just mentioned, but the tapered portion is much less acute and the wedging action of the arbor A would not be sufficient to hold it in position. In this instance the arbor B is flatted for a dog at S and centered at each end for the lathe centers. The work is drawn back onto the taper M by means of the nut R and the U-collar Q. In this connection it is well to note that the outside diameter of the nut is smaller than the inside of the bushing, so that as soon as the pressure is removed from the U-collar, it can be slipped out of the way and the work drawn off over the nut without interference. In operation, the outside turning is done first, then the end O is faced, and finally the collar is released to permit the facing of the end P, the pressure of the cut being sufficient to hold it in position during this operation.

The lower view in Fig. 1 shows a bushing F which has an internal tapered surface at a very slight angle with the center line. The angle in this instance is so small that the wedging action on the tapered portion of the arbor would, under ordinary circumstances, make the use of an arbor press necessary in order to remove the work after it had been machined. The two ends of the arbor C are flatted at Z and centered in the regular manner; and a nut W with a U-collar V is used to force the piece onto the taper N, as in the preceding instance. After the outside turning and the facing of the two ends U and T has been done, the knurled collar X

* For articles on work-holding devices previously published in MACHINERY see "Methods of Holding and Machining Thin Work" in the August, 1914, number and articles there referred to.

† Address: 7909 Ridge Blvd., Brooklyn, N. Y.

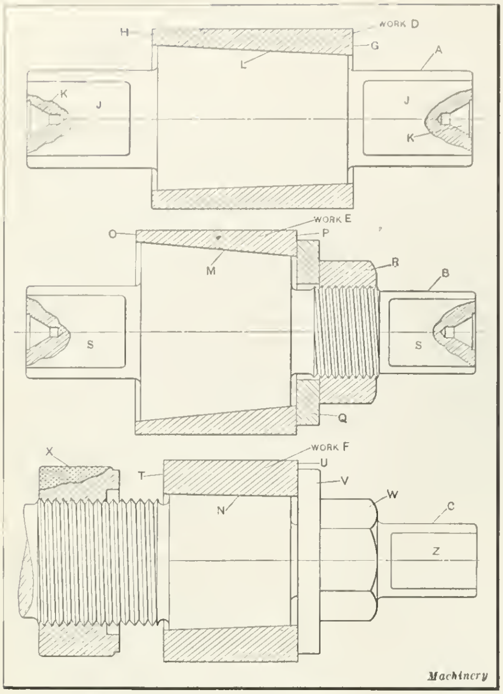

Fig. 1. Methods of holding Work with Cylindrical Outer Surface and Tapered Hole

is spun up against the end T to start the work off from the taper. Obviously the U-collar is removed before this is done. An arrangement of this kind makes the use of an arbor press unnecessary, and results in the saving of considerable time.

Holding Device for a Small Tapered Forging

The work shown at A in Fig. 2 is an example of a piece which could not be held securely by ordinary methods. The piece was a small steel drop-forging having a tapered portion B, the included angle of which was 10 degrees. This tapered part was unfinished and was naturally subject to slight variations. The upper part of the illustration shows

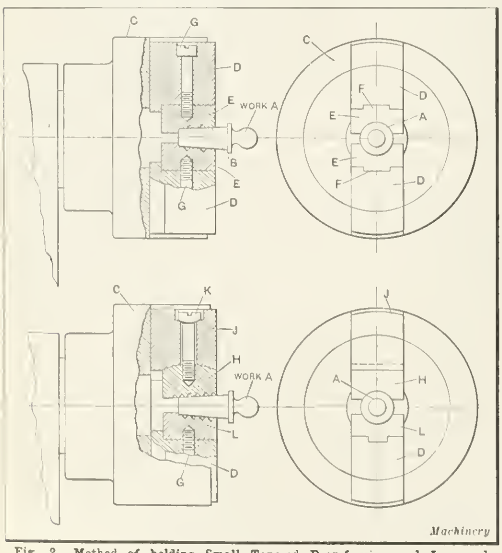

Fig. 2. Method of holding Small Tapered Drop-forging and Improved Method which compensates for Variations in Size

the method by which an attempt was made to hold the work, that was entirely unsuccessful. A two-jawed chuck C was equipped with a set of inserted jaws E which were formed to the taper B of the work, and these jaws were held in position in the main jaws D of the chuck, by means of the screws G. The jaws E were tongued at F to fit the main jaws D. It was found that any attempt to machine the ball-end portion of the work resulted in a loosening of the hold upon the tapered end so that the work came right out of the jaws, no matter how tightly they were set up.

Occasionally a piece would remain in position long enough to allow the machining to be done, but the greater part of the pieces could not be held. Another method was therefore devised, making use of a swivel jaw in order to compensate for the variations in the rough forgings. The lower part of the illustration shows the construction of the device, the same two-jawed chuck C being provided with a set of special jaws, one of which L was of the same construction as in the preceding instance, while the other jaw H was convexed on one side to fit a corresponding surface in the special chuck-jaw J. Provision was made around the screw K for a limited amount of "float" so that the jaw H could adapt itself automatically to the varying contours of the forging. As the jaws were set up on the work, jaw H swung sufficiently to

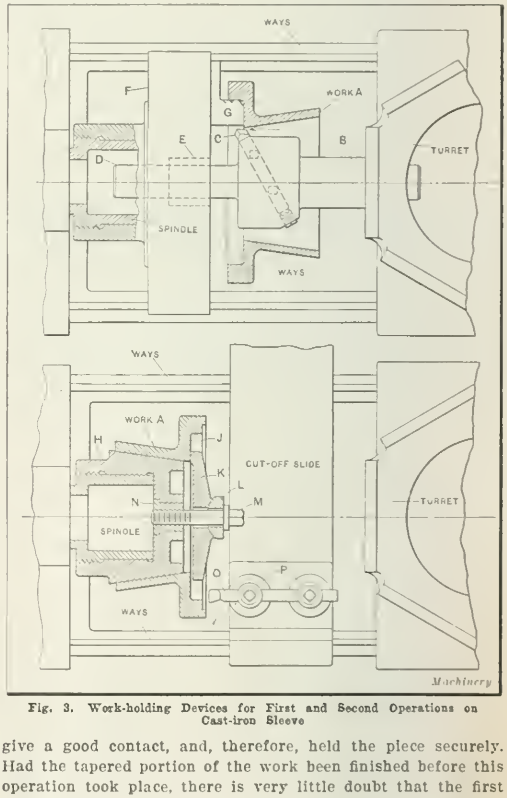

Fig. 3. Work-holding Devices for First and Second Operations on Cast-iron Sleeve

give a good contact, and, therefore, held the piece securely. Had the tapered portion of the work been finished before this operation took place, there is very little doubt that the first method would have given satisfactory results.

Holding Devices for a Tapered Cast-iron Sleeve

The work shown at A in the upper part of Fig. 3 is a cast-iron sleeve on which no machining has been done, and which is to be faced on both ends, tapered and recessed as indicated. For the first setting the jaws G in the three-jawed chuck F are used to grip the work by the inside of the flange, and they are so proportioned that they do not interfere with the action of the boring tool C which is piloted at D in the bushing E in the chuck body. The boring tool C is simply used to generate a true running surface for the taper tools which follow it, in order that they may not be influenced by

irregularities in the casting. The shank of the bar B is held in the turret hole in the usual manner.

The second setting of the work is shown in the lower portion of the illustration, and the machining to be done during this setting was the facing and recessing of the flange end, to bring it square and concentric with the internal taper. A special steel tapered "nose piece" H was screwed onto the end of the spindle to receive the finished part of the work A. A steel bushing N was set centrally in the face of the nose piece and tapped out to receive the screw M. The work was drawn back onto the taper by the clamp K which was made to obtain a three-point bearing on the rough surface J of the casting, the collar L being interposed between the head of the screw and the clamp in order to provide a spherical bearing and neutralize the stresses on both the work and clamp. The facing of the work is done by the tool O on the cut-off slide; and attention is called to the method of setting up this tool in two toolposts P in order to give rigidity. The sizing of the recess is done by a special tool in the turret. A valuable point in the construction of this device is its compactness and the fact that it is practically built up on the spindle itself, so that there is very little overhang.

External Holding Device for a Tapered Cast-iron Flange

The method shown in Fig. 4 is somewhat out of the ordinary because a piece of this kind would naturally be held by

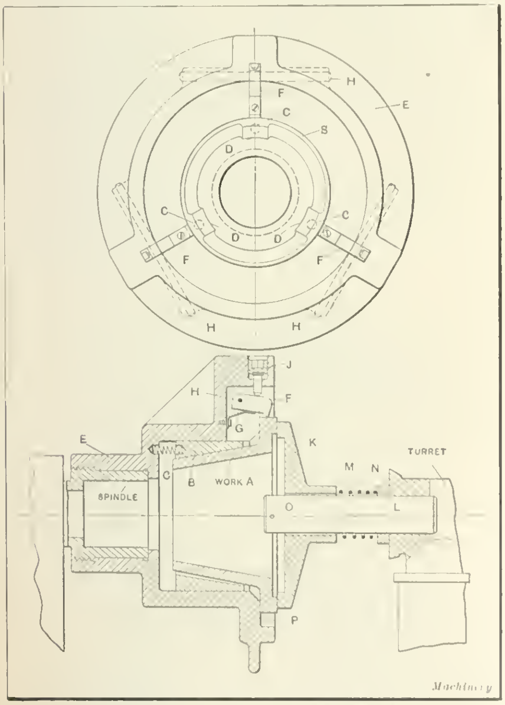

Fig. 4. Method of holding a Thin Tapered Piece so as to afford Adequate Support and prevent Distortion

the outside of the flange in a three-jawed chuck. In this instance, however, the tapered portion being somewhat thin, it was decided that it needed some sort of support in order to lessen the possibility of chatter, so that the chuck-jaw method was deemed unsuitable. The fixture body E was made of cast iron and screwed to the end of the spindle. It was provided with a sliding sleeve B which was forced outward by three coil springs C which were pocketed in both the body and the sliding member of the fixture. In setting up the work, it was placed in the taper bushing and then the turret was brought up until the floating clamp K bore against the face of the flange and carried it back against the finished seat P. This clamp was a loose fit on the stem L which entered the hole in the turret and was provided with a stiff

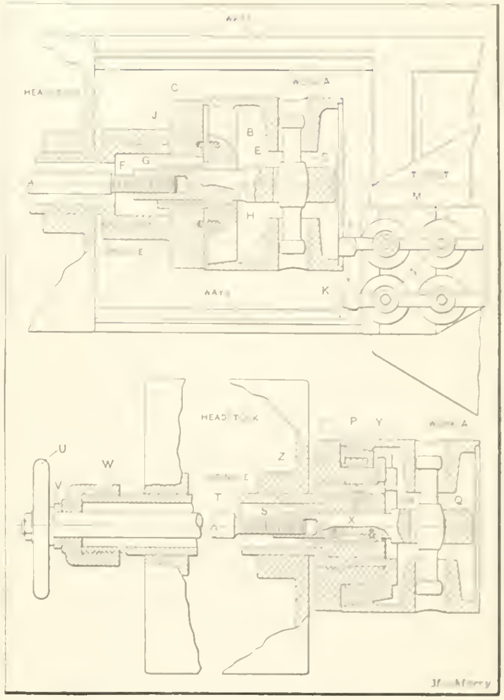

Fig. 5. Fixture for holding Pump Piston, and Later Design which avoids Excessive Overhang from Lathe Spindle

spring M thrusting against the back of the clamp and the collar N on the stem. The pin O prevented the clamp from being forced off the stem by the action of the spring. While

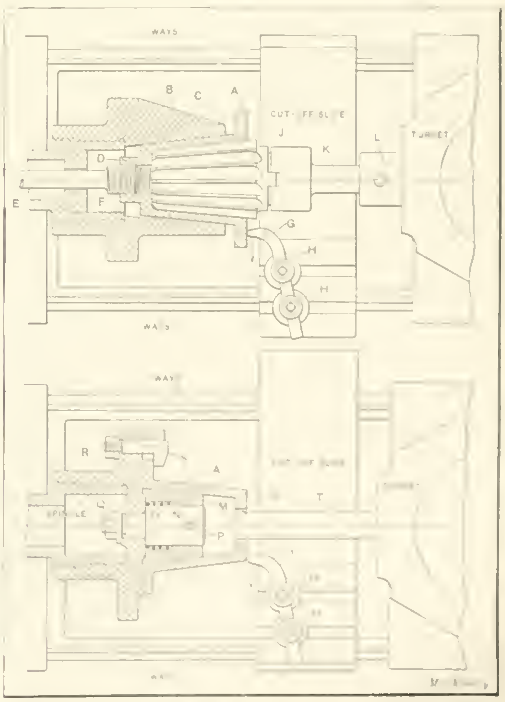

Fig. 6. Fixture for holding Tapered Hub Casting while finishing Inside Surface and facing Ends

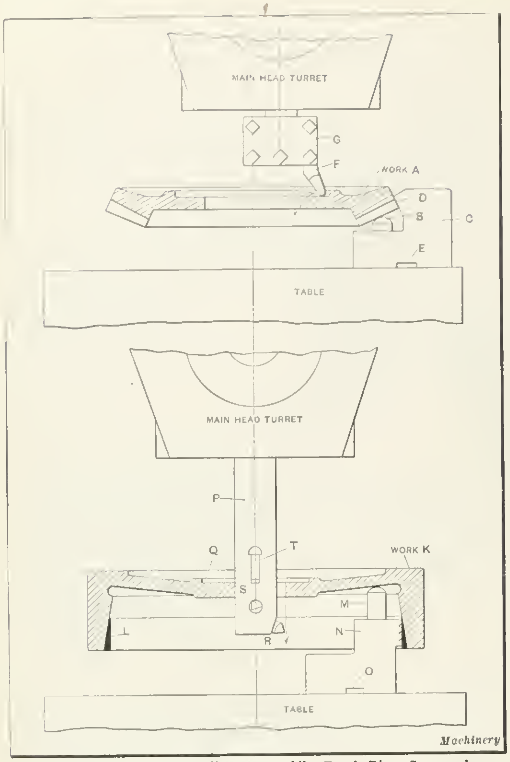

Fig. 7. Methods of holding Automobile Bevel Ring Gear and Automobile Flywheel

the clamp was held firmly against the face of the flange, the swinging dogs *F* were forced into the edge of the casting by the hollow set-screws *J*. Attention is here called to the position of the pins *H*, these being set well back beyond the flange so that as the dogs swing they have a tendency to hold the work back against the surface *P*. The flat springs *G* serve to return the dogs to a normal position. After the work is located in the fixture, the clamp *K* is withdrawn and the turret tools brought into operation.

Two Methods of Holding a Pump Piston Casting

The casting *A* shown in Fig. 5 is part of the piston for a power pump, the tapered portion of which has been machined and the end faced in a previous setting. The upper view shows the original design for the fixture, while the lower view shows a much superior construction which was adopted in place of the original device. In the upper view, the work *A* is located from the previously finished tapered surface, by the spring-actuated floating plug *B* which is a running fit in the body of the casting *C*, the latter being screwed to the spindle. There are four small coil springs *J* let into both the body casting *C* and the plug *B*. and a key *G* prevents the plug from turning. The forged steel link *E* is square at the forward end and bored out transversely to take the pin *D* which enters the wrist-pin hole in the piston. This pin is rounded at all bearing points so that the pressure is distributed, and the casting is drawn back firmly against the finished face of the fixture body casting *C*. The link *E* is prevented from turning in the plug *B* by means of a Woodruff key *H*. The rod *F* is threaded to fit the end of the link *E*, and passes completely through to the rear end of the spindle where it is operated by a handwheel, as illustrated in the lower view. Two tools *L* and *K* are used to face the end of the casting and cut the recess, these tools being held in four toolposts *N* on the tool-holder *M*. The turret lathe used for this work has a turret of the flat variety, with a cross-feed movement, allowing facing and recessing to be done from the turret.

It was thought that the overhang from the spindle was entirely too great in the preceding design, so the one shown in the lower part of Fig. 5 was adopted in its place. It will be noted that in this case the entire fixture is built around the spindle in such a way that excessive overhang is avoided, and a much better design made possible. The body casting *O* of the fixture is screwed to the spindle and the sliding taper sleeve *P* is mounted upon it as far back toward the head as possible. The coil springs *Z* are used to force the sleeve into the tapered part of the work *A*, while the pin *Y* simply prevents too great a movement of the sleeve. A plug *S* is fitted to the inside of the spindle and held in position by the screw. This plug is splined to receive the key *X* in the link *R* which is of similar construction to that previously described. The pin *Q* is the same as that in the upper view; the draw-back rod *T* is threaded with a coarse-pitch left-hand thread at the forward end and serves to draw the pin *Q* back, through the medium of the link *R*, until the end of the work comes against the finished face of the body *O* of the fixture. The collar *W* is threaded to the rear end of the spindle and the rod *T* passes through it and is keyed to the handwheel *U*. The thrust washer *V* is of hardened steel and is interposed between the hub of the handwheel and the collar. It will be noted that although the taper portion of the work is used as the locating point to center it, still the work is drawn back firmly against the squared up end of the fixture so that the longitudinal location is assured.

Fixtures for Holding a Taper Hub Casting

The work shown at *A* in Fig. 6 is a hub casting which is provided with a boss *D* for holding purposes. This boss has been drilled and tapped in a previous operation so that it is approximately concentric with the body of the casting. The fixture body *B* is of cast iron, and is screwed to the spindle in the usual manner. This casting has three shallow internal ribs *C* which are bored to the taper of the outside of the work, the remainder of the inner surface being relieved. The draw-rod *E* is threaded at the forward end to fit the tapped

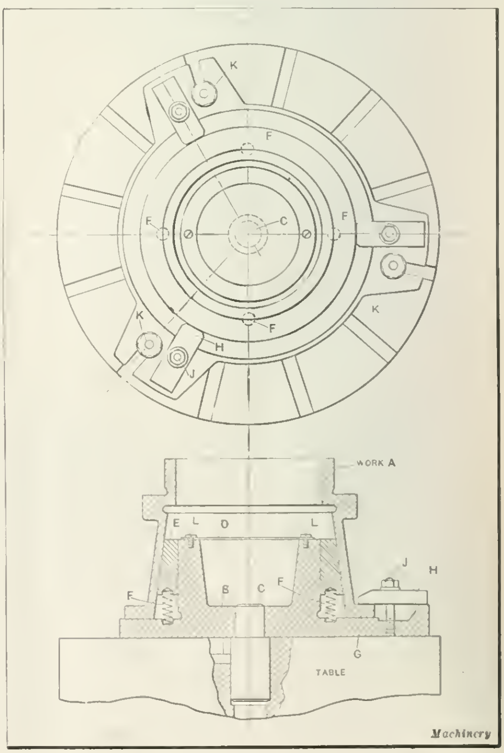

Fig. 8. Simple Fixture for holding Work with Internal Tapered Surface

out portion of the hub on the work, which is drawn back into the fixture by means of a handwheel at the rear end of the spindle, as in the instance previously described. The rod E passes through a bushing F in the spindle, which serves to hold it approximately central so that it will enter the threaded part of the casting without trouble. There is a clearance of 1/16 inch in the hole to allow for variations in concentricity. A series of stepped tools and reamers are used in the interior work, one of these reamers being shown at J mounted on the shank K which is hung in the floating holder L in the turret. The tool G carried in the two tool-holders H on the front of the cut-off slide, is used to face the flange while the turret tools are working on the interior, a similar tool at the rear of the slide being used for finish-facing.

The second setting of the work is shown in the view in Fig. 6, the previously machined internal taper and the face of the flange being used as locating points. The body of the fixture R is made of cast iron and screwed to the end of the spindle. It is provided with a central plug P which is drawn back against the finished pad by the nut and washer at Q. On this plug a tapered bushing M is mounted, this bushing being of hardened steel, ground to the correct taper and arranged so that it is a nice sliding fit on the plug P. The coil spring O forces the bushing outward so that it is always in position in the taper of the work, and the pin N limits its movement according to the length of the slotted hole. Three hook-bolts S are provided in the face of the body casting 120 degrees apart, and these serve to draw the flange back into position against the face of the fixture, thus insuring longitudinal location, while the tapered bushing centers the work. The boring-bar T is used to true up the hole and the tool G is used for facing. A cutting-off tool on

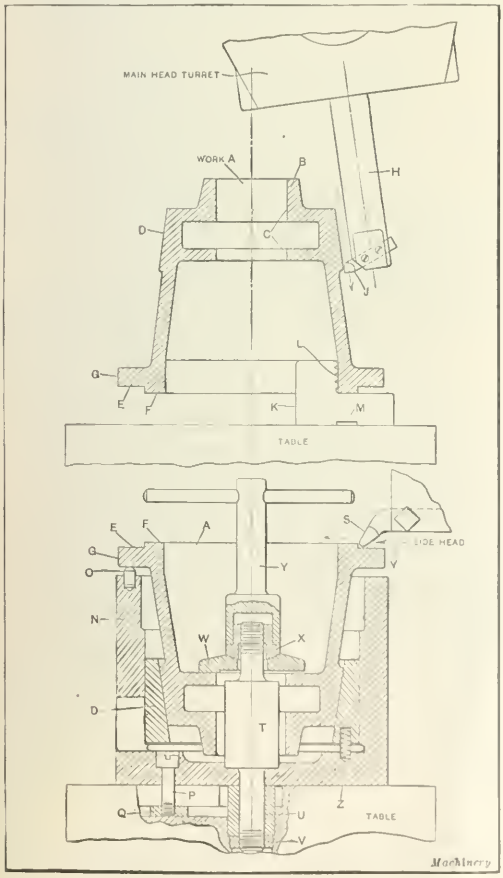

Fig. 9. Two Settings of Work for machining Surfaces B, C, D, E, F, and G

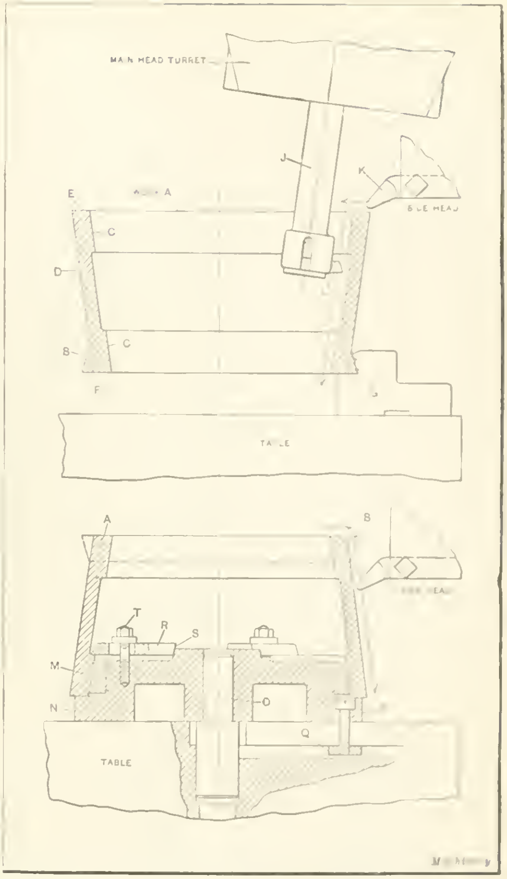

Fig. 10. Another Chucking Application for holding Tapered Work

the rear of the cut-off slide removes the superfluous part of the hub before the facing operation takes place. This tool is not shown in the illustration.

Method of Holding a Bevel Ring Gear

The work A shown in the upper part of Fig. 7 is a ring gear for an automobile, the blank being an alloy steel drop-forging on which no machining has been done. A set of special chuck jaws is used to hold the work and the machine used is a Bullard vertical turret lathe. It is well to note that fixtures and holding devices designed for use on this type of machine must be proportionately heavier than those designed for use on the horizontal type of machine, as the machine itself is heavier, more power and heavier tools are used in machining, and the work is generally of a much more massive character. The work is set up on three round pointed raising buttons B which rest in the screw holes of the jaws. The jaws C are formed at an angle D corresponding to that on the outside of the forging, and this angle has a tendency to draw the gear blank down on the pins B in the jaws to give an excellent three-point support. The jaws themselves are keyed at E to the sub-jaws in the table. The tool F is held in a regular tool-holder G in the main head turret and is used to bore the hole and face and cut out the recess in the blank.

Method of Holding an Automobile Clutch Flywheel

The work K shown in the lower portion of Fig. 7 is a good example of a piece of taper work which would be very difficult to hold unless provision were made in the casting. In this case a chucking ring L is added to the casting, thus providing a straight surface which can be readily grasped in the chuck jaws N. These jaws are of special design, being cut

away so that the rim of the wheel can be faced or under-cut with this setting of the work. The jaws are keyed to the sub-jaws of the table at *O*. The work is supported, as in the former instance, on the three raising buttons *M* which strike against the web of the wheel. A special three-cutter bar *P* is used to bore and ream the center hole in the wheel. The tools *R* and *S* are used for boring, and the flat cutter *T*, having a floating action which allows it to follow the previously bored hole, does the finishing. The shoulder *Q* is also machined at this setting, and is used for locating the work when machining the other side of the wheel and the clutch taper. A chucking ring may often be applied to a casting to facilitate the holding of tapered work, providing a great number of castings have not been made up previous to the designing of the holding devices. This is an excellent example of the value of forethought in design.

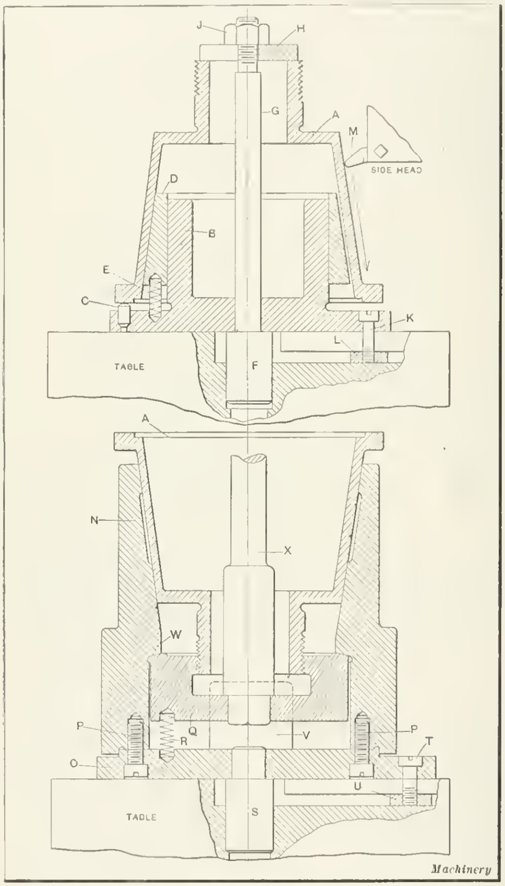

Fig. 11. Fixtures for holding Large Tapered Piece with Thin Walls, which afford Adequate Protection against Distortion

Fixture for Holding a Piece of Electrical Work

The piece shown at *A* in Fig. 8 has been partially machined in a previous setting, but the work remaining to be done must be concentric and square with the tapered portion. The fixture base *B* is made of cast iron and it is centered on the table by means of the stud *C* which enters the central hole in the table. The fixture is held down by means of three T-bolts *K* which enter the slots in the face of the table. These are clearly shown in the upper view. The work locates on the sliding taper sleeve *E* and the flange is clamped down onto the finished pad of the fixture by the three clamps *H*. Attention is called to the fact that the studs *J* are screwed tightly into the base of the fixture and a nut and washer provided at the upper end so that wear of threads cut in cast iron is eliminated. There are four coil springs *F* which are so proportioned that they but little more than hold up the weight of the tapered sleeve, so that when the casting is placed on the fixture the weight is sufficient to bring the flange down on the pad *G*, thereby facilitating the clamping. A sheet steel plate *D* is held in place by the two screws *L* and simply acts as a cover to keep the chips from accumulating in the pocket of the casting. This is an excellent example of a simple fixture for handling work having an internal tapered surface.

Method of Holding a Tapered Electrical Part

The work *A* shown in Fig. 9 is to be machined at *B*, *C*, *D*, *E*, *F*, and *G*, and it is held for the first setting in the jaws *K* by the straight inner surface *L*. These jaws are keyed at *M* in the usual manner. The outer taper *D* is machined by setting over the main head to the correct angle and then turning with the tool *J* held in the bar *H*. The methods of machining the surfaces *B* and *C* in this setting are obvious. In the second setting of the work, the piece is dropped down into the pot casting *N* until the flange strikes the three pins *O* in the upper edge. These pins are equally spaced and serve as a three-point support for the flange. The taper sleeve *D* is supported in the base of the casting by three springs *Z* which are so proportioned as to barely support the weight of the sleeve. The pot casting *N* is centered on the table by means of the bushing *U* on the stud *T*, the latter being clamped down by the nut *V*. The entire fixture is held down on the table by the screws *P* which draw up on shoes *Q* in the table T-slots. The work is clamped by the collar *W* in which the nut *X* has a spherical bearing. The collar *W* is relieved so that it bears on three points on the rough inner casting. A socket wrench *Y* is provided to tighten the clamp. In machining, the tool *S* held in the side head is utilized to cut the recess and face and turn the flange.

Method of Holding a Taper Pot Casting

The pot casting *A* shown in Fig. 10 is another example of a piece of work to which it was necessary to add a chucking ring in order to hold and machine it to the best advantage. In this case the piece was to be machined on the faces *C*, *D*, *E*, and *F*, *i. e.*, all over with the exception of the internal relieved surface which was left in an unfinished state. The chucking ring *B* was cast to an angle of 20 degrees from the perpendicular, and the jaws *G* were made to a corresponding angle so that they drew down on the pot while centering it at the same time. The boring-bar *J*, having a tool *L* at its lower end, was used to machine the inside tapered surface *C*, the head being set to the proper angle; and the tool *K* in the side head faced the end *E* at the same time. In the second setting of the work, the base *N* is centered on the table by means of a plug *O* and is held down by the screws *P* which enter shoes *Q* in the table T-slots. It will be noted that in this fixture there are no projections beyond the casting which is being machined, so that it presents a very clean and neat appearance.

The method of clamping this piece is somewhat out of the ordinary, there being very little surface on which to gain a bearing. The relieved portion on the inside of the casting was only 1/4 inch thick. The inner hub on the fixture body casting *N* was machined to a slight angle and the end of the clamp *R* was tapered at *S* to correspond. It will be seen that when the nut at *T* is set up, the tendency of the clamp is to crowd outward into the relieved portion of the casting so that there is no danger of its slipping off the offset. The clamps are slotted in order to permit rapid removal. The ring *M* is a loose piece in this instance, and is slipped into the casting before it is placed on the fixture. In this operation the side head turns the taper, removing the chucking ring *B* at the same time. The taper is generated by means of a side-head forming attachment described in a previous article.

Method of Holding a Thin Taper Casting of Large Size

The work *A* shown in Fig. 11 is of considerable size and its sections are somewhat thin, requiring careful handling in order to avoid distortion. The body *B* of the fixture is

centered on the table by means of the plug *F* which extends up through the body of the fixture and is threaded at its upper portion *G* to receive the nut *J*. A U-washer *H* is thereby brought down onto the top of the hub. The work is located from the internal tapered surface on the sleeve *D* which is ribbed at three points to take care of the inequalities of the casting. There are three springs *E* which support this sleeve. A three-point support for the flange is provided by the hardened steel pins *C* in the base of the fixture. The screws *K* hold the fixture down on the table by means of the shoes *L* in the table T-slots. The tool *M* in the side head is used to generate the outside taper by means of a forming attachment, while the thread is cut on the hub by the thread chasing attachment of the main head.

The method of holding the piece for the second setting is somewhat out of the ordinary, the outside taper being used as a locating point in the internal tapered portion of the fixture casting *N*. This piece is fastened to the base *O* of the fixture by the screws *P*, a shoulder being provided on the former casting in order to make the location positive. The centering stud *S* locates the fixture on the table and the screws *T* hold it down by means of the shoes *U* in the table T-slots. The threaded collar *Q* is supported by three coil springs *R* and has a spherical bearing at *W* in the interior of the fixture. After the work has been dropped down into the pot, the socket wrench *X* is inserted in the square hole of the nut *Q* and the piece drawn down into its taper seat. The spherical bearing at *W* is designed to equalize variations between the thread and the tapered portions. Openings *V* are provided in the outer wall of the fixture so that chips may be readily removed. It will be noted that in both the first and second settings of this piece, the fixtures are so designed that they support the walls of the casting against the pressure of the cut and thereby tend to eliminate distortion and chatter.

* * *

The Electric Power Club, which met at Hot Springs, Va., November 8 to 10, inclusive, has amended its constitution so as to include as members manufacturers of transformers and industrial control apparatus. Five companies manufacturing this class of apparatus were elected to membership, making the membership thirty-four companies in the electrical industry. In the work of standardization of motors and generators, a number of changes in existing commercial ratings were made to bring them within the limits established by the new rules of the American Institute of Electrical Engineers. The allowable variation in voltage at which motors will operate successfully was fixed at 10 per cent above or below the rated voltage. The starting torque for continuous duty polyphase induction motors with full voltage applied was standardized as not less than 150 per cent of full load torque for two-, four- and six-pole motors, 125 per cent for eight-, ten- and twelve-pole motors; and 100 per cent for fourteen-pole motors. The maximum torque for such machines shall not be less than 200 per cent of full load torque. For direct-current motors, the variation of speed from full load cold to full load hot was fixed as not to exceed 10 per cent, based on the full load speed hot. No change was made in the present basis of rating for continuous duty motors and generators used for general purposes, *viz.*, 40 per cent centigrade rise in temperature at full rated load with a 25 per cent overload temperature guaranteed for two hours.

ALIGNING THE PROPELLING SHAFTING OF SHIPS

BY N. I. MOSHER*

In the following article a plan view of the shafting of a twin-screw ship is shown in Fig. 1, which illustrates the crankshafts, thrust bearings, line and propeller shafts. The position of the forward bulkhead is shown at *A* and the after engine room bulkhead at *B*. The spring bearings of the lineshafts, located in the shaft alleys, are indicated at *C* and *D*; *E* shows the inboard bearing of the stern tube; *F* shows the outboard bearing of the stern tubes; and *G* shows the after strut bearings. The bearings *E*, *F* and *G* are in contact with the water and are ordinarily lined with Lignumvitae wood. This article, with the aid of the illustrations, shows a method of establishing shaft centers for the aligning of the propeller and lineshafts of ships. There are a number of methods used in doing this work and any of them will give satisfactory results if carefully carried out.

For the most part the lining up of shafting and machine tools in and about shops is accomplished by the use of piano wire, its use being preferable for this kind of work owing to its high tensile strength which enables it to be drawn very tight without breaking. A test on the Riehle testing machine indicated a breaking strain of 130 pounds on piano wire 0.020 inch in diameter, or 24 gage wire. Fig. 2 shows a small wire winch that is made especially for setting lines; and the construction of this winch is such that the wire can be adjusted while under tension. This device has proved its usefulness many times in shop work, more especially in lining up combined air and circulating pumps, engines, planer beds, shafting, etc.

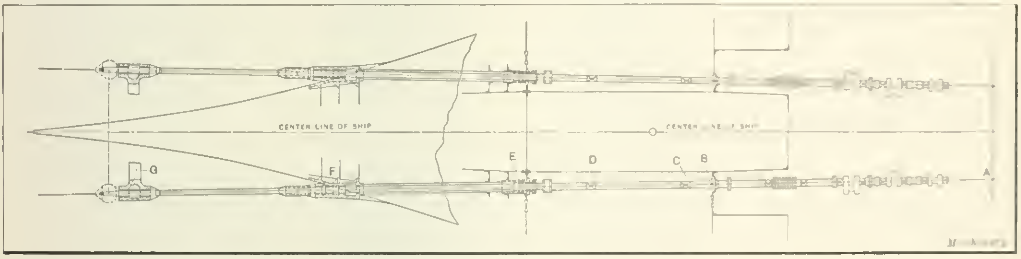

Fig. 1. Plan View of Propelling Shafting of Twin Screw Ship, showing Crankshafts, Thrust Bearings and Propeller Shafts

The writer will endeavor to illustrate and explain two methods that are practiced at the present time in lining up shafting in ships' hulls. In the construction of the hull, the main engine foundation is built to the height and angle laid down in the drawings, and from this foundation the crankshaft centers will be figured. Having determined these centers, a line can be set at the proper distance from the ship's center line. In twin-screw ships the propeller shaft usually runs at a slight angle to the center line of the ship, and these angles must be carefully taken into consideration when setting the crankshaft center line. After setting the line carefully, which line will be secured to the fore-and-aft bulkheads of the engine room, a small hole will be drilled in the fore-and-aft bulkheads, which represents the center of the crankshaft. Around this center will be cut a hole large enough for the installing of the after bulkhead flange, but care must be taken before cutting out the center to scribe a circle on the bulkhead and mark it conspicuously with a center punch, so that the original center can be found if it is necessary.

Having established the shaft center on the engine room bulkheads, the next consideration will be the centering of the after strut bearings. The strut and stern tube castings are usually roughly machined in the shop to within $\frac{1}{4}$ inch of the finished size. These castings are first set in place and secured to the hull by the ship-fitters, the location to be determined by the plan of the shafting laid down in the ship drawings, as shown in Fig. 1. After having found the

*Address 15 James St., Winter Hill, Mass.

center of the rough-bored hole in the strut, a parallel strip about 1½ inch square is secured to the end of the strut casting, as shown in Fig. 3, this parallel piece being leveled in a horizontal plane and its top edge set ¼ inch above the actual center of the shaft, so that a center point can be sunk into the parallel to receive the compass point.

Now that the shaft center has been determined in the after strut, a parallel piece of the same dimensions will be secured to the after engine room bulkhead in the same manner as the strut, and over it will be an electric light with a reflector, as shown in Fig. 3. By this method the transit can pick up the parallel edges very accurately, and the work may be performed at night as well as by daylight. After having established the two end centers, as described, the same type of parallel pieces will be secured at as many intermediate points as the occasion demands, assuming one at each end of the stern tube casting, which will also be assumed to be secured the same as the strut, fairly close to the dimensions given on the shaft plan. Having placed as many of the parallel pieces as required, the next operation will be to paint their edges red, white, blue, green or any other striking color that may be on hand; and by setting up the surveyor's transit in a position just aft of the strut bearing, the operator can pick up the extreme aft-and-fore parallels, and the intermediate parallels can be adjusted to line up exactly with them.

The object of the different colors on the parallel strips is to make them more noticeable to the eye of the transit operator. Now that the line on the horizontal plane has been established we turn to the work of the vertical line, which may be accomplished in the following manner: Set the transit to pick up the center line on the after strut and engine room bulkhead parallel pieces, then take a square white card, say 3 by 6 inches in size, and draw a vertical pencil line in the center square with the base. Then place the card on the parallel piece already set in the stern tube, and move the card until the transit operator can pick up the black pencil line. Next carefully scratch a line on the parallel piece to correspond with the pencil line. Continue this operation at each of the parallel pieces and you will have established a line in the vertical plane; and from these points with the square, scratch a line across the face of each of the parallels. Then with the hermaphrodite calipers set at ¼ inch, you will scratch the point ¼ inch below the parallel face, which gives the shaft centers, and from these centers the dividers will scribe a circle for setting up a boring-bar.

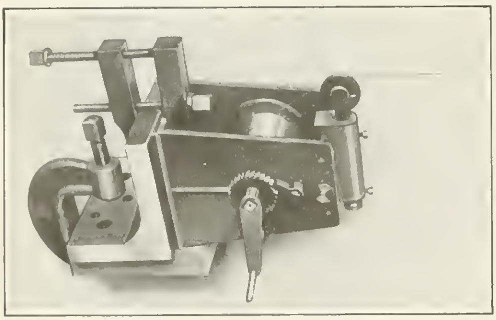

Fig. 2. Small Wire Winch used for setting Wire Lines

After having set the portable boring-bar carefully to the circle, the bar is ready for boring the struts or stern tube, as the case requires.

The aligning of the spring bearing may be taken from a piano wire set up to the center mark in the stern tube and the engine room bulkhead center marks; and the spring bearings, which are finish-bored in the shop, are adjusted to the line. Where it is not practical to use a surveyor's transit, the following method is recommended: Establish shaft centers as above described, and measure the distances between the strut bearing and the engine room bulkhead; then stretch a piano wire between two fixed centers on the floor of the mold loft or the machine shop, which will be spaced equal to the distance between the engine room bulkhead and strut, and attach a weight of, say, 100 pounds to the piano wire, allowing the wire to run over a sheave about 4 inches in diameter or over the wire winch shown in Fig. 2. Set the wire level at each end with the aid of the transit, and on the floor of the shop lay out the points where the bearings and stern tube bearings will come. At these points, use the transit to measure the amount of sag in the line, setting the amounts down carefully for reference when the line is re-set in the ship's hull.

Care must be taken to use the same weight that was applied in determining the sag of line in the shop set-up. The method of establishing the center mark from the wire

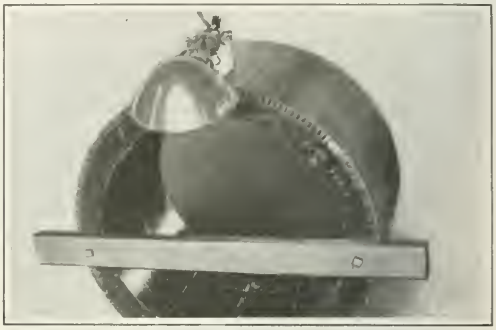

Fig. 3. Rough-bored Hole in Strut with Parallel Strip secured to End of Casting

can be done with the hermaphrodite calipers by setting the radius to the required dimensions and establishing trial centers, just ticking the line from four positions. After actually establishing the center marks, scribe a small circle around each mark so that it may be picked up at a glance. The ordinary portable boring-bar, with a special spider casting for securing the bar to the strut and stern tube castings, can be used for this work. Great care must be exercised in setting up the bar to the center marks already established.

The shafts installed in ships before launching are the propeller shafts and lineshafting that extends through the stern tube bearings. This installation is completed and the stuffing-boxes are packed and glands secured; but it may be advisable to re-align the shafting after the ship is in the water, as it has been found that an alignment may be perfect when the ship is in dry dock and askew when in the water, so that in all cases the alignment should be checked up after the ship has been launched. This can be done by breaking the coupling joints and testing the opening between the faces of the coupling with feelers, as no more positive proof is needed than to know that the faces of the shaft flanges are parallel with each other before bolting them together, since the faces of all shaft couplings are squared up on centers and carefully tested before leaving the machines.

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LUBRICANT FOR THREAD CUTTING

The Geometric Tool Co., New Haven, Conn., publishes a periodical called *Threads*. In the August number the following receipt for the "best lubricant" for general threading is given: 40 gallons of water; 10 gallons of mineral lard oil (of such quality as Union Petroleum Co.'s); 2½ pounds soda ash (no more nor less); and 10 ounces borax. Take a barrel of about fifty gallons' capacity and have it steamed and washed free from all deposits of glue and other residue. Tap the barrel at the bottom for a spigot, and elevate it about eighteen inches from the floor. Weigh the 2½ pounds of soda ash (caustic soda or caustic potash will not do). Thoroughly dissolve this, with the ten ounces of borax, in a bucket of hot water. Place in the mixing barrel. Then fill the barrel about three-quarters full of water, and after agitating this mixture of water and alkali, allow it to stand at least thirty minutes. Then add the ten gallons of mineral lard oil. Upon slight agitation the combination of oil and alkali water will turn white, resembling milk.

ANNUAL MEETING OF THE A. S. M. E.

The thirty-sixth annual meeting of the American Society of Mechanical Engineers was held at the Engineering Societies Bldg., New York City, December 7 to 10, inclusive. A large attendance was registered and many papers of engineering interest were presented and discussed.

President Brashear's address at the opening session Tuesday evening was "Science in Its Relation to Engineering." Dr. Brashear, in a very charming way, showed the interrelation of science and modern engineering and how engineering has been benefited by some of the researches of scientists that to the layman might appear to be of little practical value.

Wednesday morning, following the reports of the committees, a memorial service was held in memory of the late Frederick W. Taylor, past president of the society, notable for his scientific management work. Henry R. Towne presided.

The machine shop session Wednesday afternoon was well attended. The two papers, "Automatic Mechanical Control of Lathes and Screw Machines," by L. D. Burlingame, and "Electric Operation and Automatic Electric Control for Machine Tools," by L. C. Brooks, were of much general interest, as was shown by the lively discussions.

David S. Jacobus, president of the A. S. M. E.

The entertainment features, as usual, were well carried through. Following the president's address Tuesday evening, was the reception of the members and their friends by the newly elected president, Dr. Jacobus, the retiring president, Dr. Brashear, the secretary, Calvin W. Rice, and past-president F. R. Hutton, and ladies. The remainder of the evening was given over to social intercourse and dancing. On Wednesday evening a departure was made from the usual Wednesday evening lecture by holding a smoker. A short vaudeville entertainment was given by some excellent talent. On Thursday evening, the annual reunion, dinner and dance was given at the Hotel Astor. The excursions at this meeting differed from those of previous years in that there were a few of exceptional interest rather than many of ordinary interest.

The following officers were elected for the year: D. S. Jacobus, president; W. B. Jackson, J. Sellers Bancroft, and Julian Kennedy, vice-presidents; John H. Barr, John A. Stevens, H. De B. Parsons, managers; W. H. Wiley, treasurer.

The professional papers presented are given below:

"Design of Fire Tube Boilers and Steam Drums," by F. W. Dean.

"A Novel Method of Handling Boilers to Prevent Corrosion and Scale," by Allen H. Babcock.

"Gas Producers with By-Product Recovery," by A. H. Lymn.

"Modern Electric Elevator and Elevator Problems," by David Lindquist.

"The Application of Engineering Methods to the Problems of the Executive, Director and Trustee," by Hollis Godfrey.

"Turbines vs. Engines in Units of Small Capacities," by J. S. Barstow.

"The Connors Creek Plant of the Detroit Edison Co," by C. F. Hirshfeld.

"Proportioning Chimneys on a Gas Basis," by A. L. Menzin.

"Higher Steam Pressures," by Robert Cramer.

"Heating by Forced Circulation of Hot Water in Textile Mills," by Albert G. Duncan.

"Relative Value of Private and Purchased Electric Power for Textile Mills," by Frank W. Reynolds and Dan Adams.

"The Engineer and the Business of Fire Insurance," by Joseph P. Gray.

"Automatic Mechanical Control of Lathes and Screw Machines," by L. D. Burlingame.

"Electric Operation and Automatic Electric Control for Machine Tools," by L. C. Brooks.

"Report on Safety Code for the Use and Care of Abrasive Wheels."

"Operation of Parallel and Radial Axles of a Locomotive by a Single Set of Cylinders," by Anatole Mallet.

"Four-Wheel Trucks for Passenger Cars," by Roy V. Wright.

"The Heat Insulating Properties of Commercial Steam Pipe Covering," by L. B. McMillan.

"Performance and Design of High Vacuum Surface Condensers," by George H. Gibson.

"Circulation in Horizontal Water Tube Boilers," by Paul A. Bancel.

"Unique Hydraulic Power Plant at the Henry Ford Farms," by Mark A. Replogle.

"The Flow of Air Through Thin-plate Orifices," by Ernest O Hickstein.

"Elasticity and Strength of Stoneware and Porcelain," by James E. Boyd.

"Foundations," by Charles T Main.

"Oil Engine Vaporizer Proportions," by Louis Illmer

"Standardization of Safety Principles," by Carl M Hansen.

"Modern Movement for Safety from Standpoint of Manufacturer," by Melville W. Mix.

"The Attitude of the Employer toward Accident Prevention and Workmen's Compensation," by W. H. Cameron.

"Industrial Safety and Principles of Management," by W. P Barba.

* * *

DAVID S. JACOBUS

David Schenk Jacobus, the newly elected president of the American Society of Mechanical Engineers, was born in Ridgefield, N. J. in 1862. He was educated in a private school, then in the Stevens Preparatory School, Hoboken, N. J., where he won by competitive examination a free scholarship in the Stevens Institute of Technology. He graduated with the degree of mechanical engineer from the Institute in 1884 and was appointed associate professor of experimental mechanics, in which capacity he served until 1897 when he was appointed full professor of experimental mechanics and engineering physics, retaining the chair until 1906. From 1900 to 1906, he was also in charge of the Carnegie Laboratory of Engineering, which had been built and equipped for carrying out a course of instruction to supplement class room work by practical experiments made by the students.

Dr. Jacobus developed at Stevens Institute original apparatus for the illustration of physical law and for the testing of various mechanical devices, and he raised the course of experimental mechanics to a high plane by developing a greater degree of participation by the students in practical demonstrations. He is still connected with the Institute as a trustee and special lecturer in experimental engineering. The honorary degree of doctor of engineering from the Institute was conferred upon him in 1906. Since 1906, he has been actively associated with the Babcock & Wilcox Co., maker of water-tube steam boilers, at the head of its engineering department in the position of advisory engineer

Dr. Jacobus is regarded as one of the foremost American authorities on steam engineering He has written numerous scientific papers on this subject, many of which have been included in the transactions of engineering societies of this country and published in the engineering periodicals. He was admitted to membership in the American Society of Mechanical Engineers in 1889; he was a manager of the society from 1900 to 1903 and vice-president from 1903 to 1904.

He is a member of American Institute of Mining Engineers, American Institute of Electrical Engineers and the Society of Naval Architects and American Engineers, and a fellow of the American Association for the Advancement of Science. He was president of the American Society of Refrigerating Engineers in 1906-1907. He is a member of the American Mathematical Society, the American Society of Promotion of Education and the Franklin Institute.

GRINDING DIES ON THE BRYANT CHUCKING GRINDER

The grinding machine manufactured by the Bryant Chucking Grinder Co., Springfield, Vt., has been used for several years for internal grinding operations, but recently means have been developed for using this machine for form-grinding dies and similar parts on which it is required to finish a tapered or curved internal surface. In order to explain the method of dealing with work of this kind, we will refer briefly to the way in which the machine operates, so that those readers of MACHINERY who are not thoroughly familiar with the Bryant chucking grinder may understand the efficient manner in which this machine is capable of handling die-grinding operations.

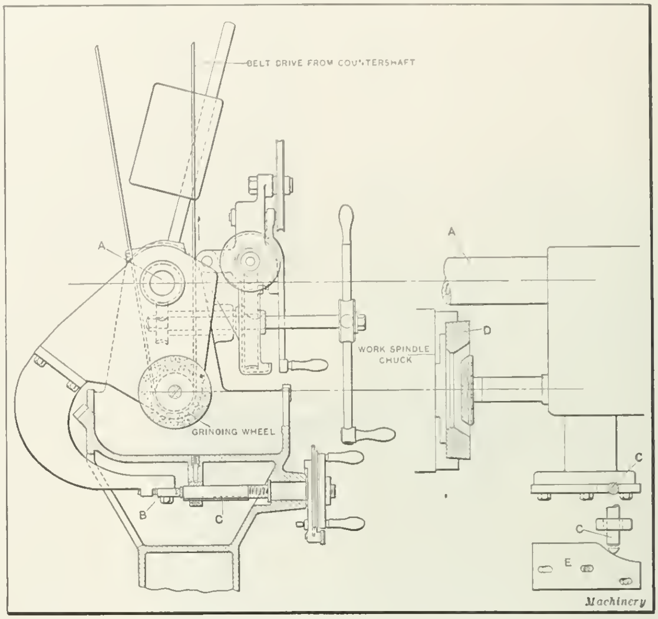


Fig. 1. Bryant Chucking Grinder equipped with Formed Control Plate for the Performance of Die-grinding Operations

Fig. 1 shows a transverse cross-section through the machine and a partial front view. The grinding wheel slide swings about the supporting bar *A*, and a control plate *B* on the slide engages the feed plunger *C* to govern the size of hole to be ground. Screwing in the feed plunger, by means of a handwheel at the front of the machine, results in bringing the grinding wheel into the cutting position ready for operation. The provision which has been made for grinding tapered or curved internal surfaces consists of a formed control plate *B* which is of the same shape as the surface to be ground. In Fig. 1 the partial front view shows the machine set up for grinding a die *D*, and the formed control plate employed for this purpose is illustrated at *E*, with the feed plunger in contact with the plate.

Fig. 2 illustrates a number of different forms of dies which are now being ground on the Bryant chucking grinder. In doing this work, power traverse is employed for the wheel-slide, and the stroke of the slide is adjusted to give the wheel the required longitudinal traverse to move across the entire length of the hole. In grinding straight tapered holes, the grinding wheel is trued to the required taper, and the finishing is done by merely feeding the wheel up to the work. This method has been found to give a very fine finish.

In cases where the surface to be finished is a cylindrical hole followed by a tapered hole, it is often possible to employ a formed wheel with the desired combination of surfaces, and in such cases the action is the same as grinding a simple tapered surface. When the surface to be ground is curved, the wheel is trued to a radius, thus giving a theoretical line contact between the wheel and the work. The range is for dies from ½ inch diameter up to the respective capacities of the machines.

E. K. H.

* * *

An investigation of the fusible safety plugs used in steam boilers has been made by the Bureau of Standards, Washington, D. C., to determine the cause of plugs failing to melt and give warning. Investigation shows that the tin of which the plugs are made becomes oxidized to tin oxide which has a melting point of about 2900 degrees F. This oxidation is due to the presence of zinc in amounts as low as 0.3 per cent. One dangerous condition found is oxidation of the zinc along the grain boundaries, which results in forming a network of oxide throughout the tin. Lead and zinc were found to be the principal impurities in tin plugs, and the conclusion reached was that if these impurities are eliminated by strict specifications and inspection, allowing only the highest grade tin to be used, such as Banca, the dangers will be eliminated.

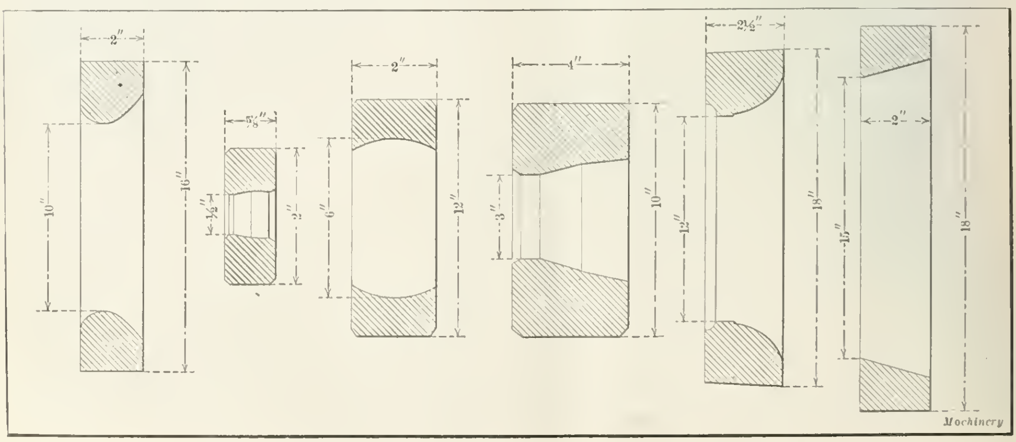


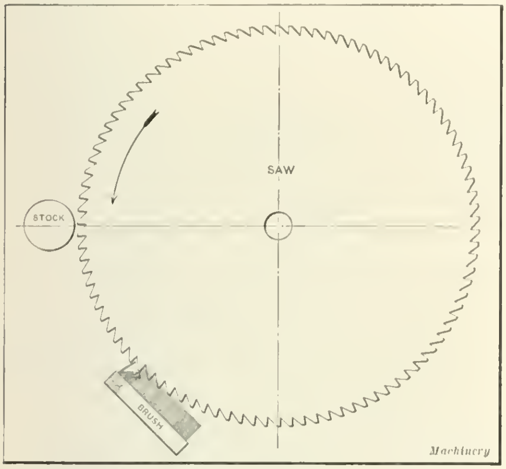
Fig. 2. Cross-sectional Views of Dies which may be finished on Bryant Chucking Grinder

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

BRUSHING CHIPS OUT OF COLD SAWS

In the operation of circular saws for cutting off bar stock in such machines as the Higley, Newton, Espen-Lucas, Cochrane & Bly, Vulcan Engineering Sales Co., and similar types, some difficulty is experienced, particularly when a heavy feed is used, because the chips adhere to the front of the teeth and so prevent them from entering the cut and doing their work effectively. Often a tooth is jerked out of the saw by reason of the fact that the tooth does not do its cutting properly and either the machine, saw or tooth has to break.



Showing Application of Wire Brush for removing Chips from Cold Saws

In trying to overcome this difficulty we have found a very satisfactory remedy.

The remedy consists in attaching to the machine an ordinary foundryman's wire brush in such a position and in such a manner as to brush the chips off the gullets of the teeth just after they leave the cut, thereby taking the chips out while they are hot and before they have time to become sweated on the front of the teeth. In applying the wire brush, it is necessary to rig up a guard to prevent the oil used in lubricating the saw in the cut from splashing on the floor and on the operator. When a very fast feed is used, there is enough heat in the chip itself to affect the cutting edge of the saw.

Another point in the operation of cold saws which may be valuable to MACHINERY's readers is this: Be careful in grinding and sharpening the teeth of these saws that the wheel cuts freely and that it does not blue or even straw-color the points of the teeth. Quite frequently it is the case that a saw on the first grinding will cut quite satisfactorily. But after being ground once the teeth seem softer than before. Heavy grinding and bluing of the teeth in grinding are sure to reduce the temper of the saw at the points where it should be highest, and prevent the saw from doing satisfactory work.

H. C. ATKINS
Indianapolis, Ind. President, E. C. Atkins Co.

DRY BORAX FOR BRAZING

One of the chief difficulties that stands between the amateur brazer and a perfectly brazed joint, is blow-holes. There are many causes for these blow-holes, the two most important being either that the work has been heated to too high a temperature, which causes the brass to boil; or, somewhere, during the process of brazing, water has been introduced.

In the first case, the only precaution that need be taken is to see that the work is never heated above the boiling point of brass. In the second case, water is generally introduced through the medium of the borax, which is used as a flux. As borax absorbs moisture from the atmosphere to a considerable extent, it is always well to keep it air-tight, in glass stoppered bottles, when not in use. As a means of absorbing the moisture that collects while the borax is being used, I find there is nothing better than to suspend a small bag, containing unslacked lime, in one side of the bottle. As unslacked lime is a better absorbent of moisture than borax, the water that is present in the atmosphere will naturally be absorbed by it before it comes in contact with the borax.

As a further means of securing good brazing, brass filings, commonly known as spelter, should, under no condition, be used. As a substitute, brass rods, about 3/32 inch in diameter and two feet long, are very convenient, and will give far superior results. In brazing with brass rods, before applying any flux the work should first be brought slowly to a bright red heat. This operation drives off all surface moisture and grease that may have collected. While the brass and flux are being applied, the flux should be continually stirred by means of the brass rod. This will eliminate any blow-holes that may, for some unknown reason, have formed in the brass.

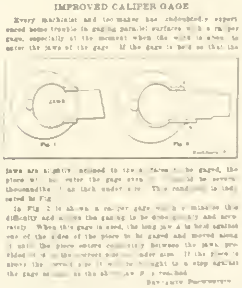
Although I have used this method for over four years in brazing diamond dies, I have yet to experience a single case where serious blow-holes have occurred.

East Orange, N. J. GEORGE N. GARRISON

WHAT IS A PATENT WORTH?

Over 1,160,000 patents have been issued by the United States Patent Office, and, while the general feeling seems to be that most of them are of little or no value, there is no doubt that the patent system has tremendously stimulated invention and the development of industries. The following correspondence is reproduced, not to throw discredit on the patent system, but to call attention to the practical impossibility of the examiners finding all references that might be cited against a patent application.

In the December, 1911, number of MACHINERY, Benjamin Brownstein of Ellwood City, Pa., described an improved caliper gage, the feature of which was one extended jaw, the extension being provided for the purpose of guiding the piece to be measured squarely between the jaws.


IMPROVED CALIPER GAGE

From MACHINERY December 1911

From Patent Office Gazette September 7 1915

A patent was granted to Fred. B. Corry for identically the same idea September 7, 1915, as stated in the following:

Ellwood City, Pa., September 18, 1915.

Commissioner of Patents, Washington, D. C.

Dear Sir:—I have noticed in the Patent Gazette of September 7, 1915, a patent issued to Fred B. Corry, Edgewood, Pa., No. 1,152,792. I must protest against the issuing of the above named patent as it is public property since December, 1911.

In June 13, 1906, I conceived the idea of making a caliper gage with one jaw longer than the other, so as to overcome the inaccuracy of gaging parallel surfaces. I therefore made a sketch of same, which you will find enclosed and marked "Original." Not being able to make much success with the patents I had already taken out, I decided to send it to MACHINERY and have it published as a shop kink, as I had done with other ideas of mine previously. I sent the article "Improved Caliper Gage" to MACHINERY on July 21, 1911, and it was published in December, 1911, of which article you will find enclosed a photo print. Now compare this article, the original sketch and the claims of Fred B. Corry's patent No. 1,152,792.

There is but one conclusion to be derived from this comparison, and that is that this patent represents just what is shown and claimed in my original sketch and article published in MACHINERY, which is already public property, and may be used in many machine shops throughout this country.

Hoping that you will consider this matter in its true light and will let me know your decision as soon as possible, I am,

Yours truly,
Benjamin Brownstein.

Department of the Interior,
United States Patent Office,
Washington, D. C., Sept. 24, 1915.

Mr. Benjamin Brownstein, Ellwood City, Pa.

Sir:—Your letter of the 18th inst. in relation to patent No. 1,152,792 granted September 7, 1915, to Fred B. Corry, has been received. Replying thereto you are informed that a report has been made by the examiner in charge of the case in which it is stated that the publication in MACHINERY in December, 1911, was not available at the time the search was made. In addition, the examiner calls attention to patent No. 199,807.

After a patent is granted it passes beyond the jurisdiction of this office.

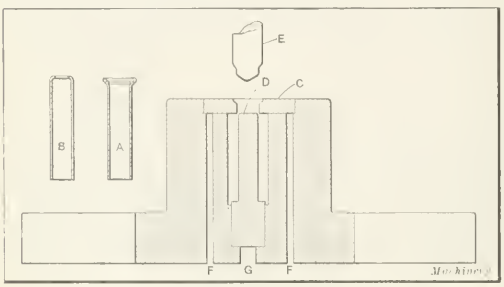
Respectfully,
W. F. Woolard, Chief Clerk.

A SET OF "FLARING" TOOLS

It was required to produce tubes of the form shown at *A* which have the metal folded in double at one end of the tube and the edge of the tube flared out. The problem of designing the tools for performing the necessary operations gave considerable trouble, but finally we hit upon the idea of drawing up shells of the form shown at *B* and piercing a ¼-inch hole in the bottom of each shell. We then designed a set of tools for use on the punch press, which provided for folding in the edge of the shell and "flaring" out the edge to bring the end of the tube to the required shape. The press tools, which are shown in the accompanying illustration, fold in and flare the end of the tube at a single operation.

The tools for performing these operations on the end of the tube consist of a die-bed, into which is driven the die *C* that forms the outside part of the flared end of the tube. The peg *D* is also driven into the die-bed and is made a sliding fit in the inside of the work. The holes *F* are provided for the purpose of driving out the die *C*, while the hole *G* provides for driving out the peg. In operation, the shell *B* is slipped over the peg *D* and rests on the shoulder at the base of the peg. When the punch *E* descends, the rounded end enters the pierced hole at the bottom of the shell and folds in the stock; after this has been accomplished, the continued downward movement of the punch brings the bevel section into contact with the shell and presses it down into the die *C* which results in flaring out the shell to the required shape. On the up stroke the shell clings to the punch, from which it is readily removed by one hand while the other hand is employed in placing a fresh shell in position in the die. These tools can be used in either a foot press or in a small bench power press.

JOHN A. FORBES



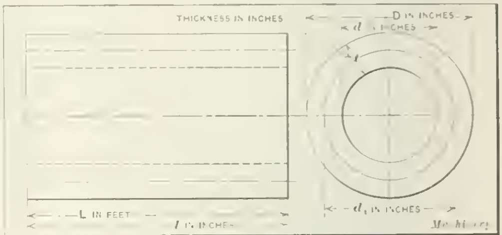
Punch and Die for Use in folding and flaring End of Tube A

WEIGHT OF CAST-IRON HOLLOW CYLINDERS

To determine the approximate weight of a cast-iron hollow cylinder in the foundry, for the purpose of judging the amount of metal needed for casting, the following formula gives satisfactory results:

$$W = 10 d_1 t L$$

in which W = weight of hollow cylinder in pounds;
d_1 = mean diameter in inches;
t = thickness of metal in inches;
L = length of hollow cylinder in feet.



Showing Dimensions of Hollow Cylinders, used in Formulas

In fact, this formula is fairly accurate, as the error is small, the weight obtained being only about 2 per cent greater than that which would be obtained by the use of either of the following formulas:

$$W = 0.2604 \times 12 \times \pi d_1 t L$$

Simplifying,

$$W = 9.82 d_1 t L$$

Another formula is:

$$W = 0.7854 c l (D^2 - d^2)$$

in which W = weight of hollow cylinder in pounds;
D = outside diameter of hollow cylinder in inches;
d = diameter of hole in cylinder in inches;
d_1 = mean diameter of cylinder in inches;
L = length of cylinder in feet;
c = 0.2604 pounds, weight of one cubic inch of cast iron;
l = length of cylinder in inches.

The first-mentioned formula has the advantage of being very simple, and as it gives results which are accurate enough for foundry work it should find a place in every practical man's note-book. The last two formulas give almost identical results and are very accurate.

Another formula for use in figuring the weight of copper tubes or pipes is as follows:

$$W = d_1 t l$$

This gives quite accurate results and is much shorter than the ordinary formula in which the cross-sectional area is multiplied by the length and the constant for copper.

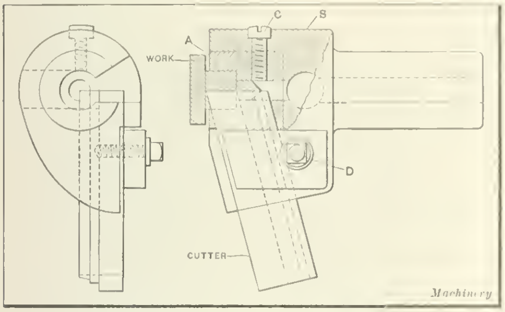
Schenectady, N. Y. W. L. TRYON

A USEFUL BOX-TOOL

The box-tool illustrated and described herewith was made for use in turning brass work, the particular tool shown in the illustration being fitted with a cutter that adapts it for turning work of the form shown. Tools of this type are extensively used in some of the large brass working shops of the Middle West, the features of their design consisting of the ease and rapidity with which they may be set up on a machine, and the provision which is made for working to very close limits. It will of course be evident that such tools can only be used to advantage when there are a large

number of duplicate pieces to be made; otherwise the expense of making such box-tools would not be warranted. It will be evident that the cutter is made of tool steel and is of a form to suit the particular piece of work which is to be turned, due allowance being made for the 15-degree angle at which the cutter is set in the box-tool.

The construction of the tool is, briefly, as follows: A tool steel bushing *A* is bored to fit the work with an allowance of 0.001 inch for clearance; this bushing is hardened to make it durable. The holder *B* is made of cast iron and bored to fit bushing *A* which is held in place by a fillister-head screw *C*. The holder is machined in such a way that there is a solid stop for the cutter to bear against, with the result that the edge is located exactly on the center line. The cutter projects about 1/64 inch beyond the bushing. Where these tools are used it is customary to have a grinding machine equipped with a plate set at an angle of 15 degrees in order to facilitate keeping the angle constant while sharpening the cutters. When it becomes necessary to sharpen the cutter, the operator merely loosens the square-headed cap-screw *D*, slides out the cutter and sends it to the tool-room, where the grinding is done by one of the employes of this department. After it has been sharpened, the cutter is slipped back into the holder until it engages the stop, after which the cap-screw *D* is tightened. When sharpened in this way the cutter will continue to produce work of the required dimensions, no matter how intricate the shape may be.



Box-tool for turning Work of the Form shown

Rochester, New York. CARL M. WEBER

HANDY KINK FOR DIEMAKERS

One of the best methods that the writer knows of for fitting an irregular shaped punch to a die is described by the following: A lighted wax taper is held close to the face of the punch so that it is covered with a film of black soot. After the entire face of the punch has been covered with soot in this way the punch is struck into the die. It will be found that the soot will not spread—a difficulty which is often experienced when preparations containing oil are used—and that the punch shows a clear white line where it comes into contact with the die. As a result the punch may be machined to an accurate fit.

The same method may be employed in fitting a force to a die used for stamping up irregular shaped brass shells, where it is required to have the force bear all over the inside of the work in order to harden and toughen the metal. The first step is to stamp up the shell after the force has been fairly well fitted to the die by the aid of narrow brass strips of metal that are of the same thickness as the shell. The inside of the shell is next covered with soot from a lighted wax taper in the manner previously described, after which the shell is again placed in the die and given a second blow. When the shell has been removed it will be found that the soot has been deposited on the high spots of the force, which should be machined down to enable it to find an even bearing surface on the entire inside of the shell.

Waterbury, Conn. CHARLES DOESCHER

MEASURING 28-FOOT FLYWHEELS WITH A 3-INCH MICROMETER

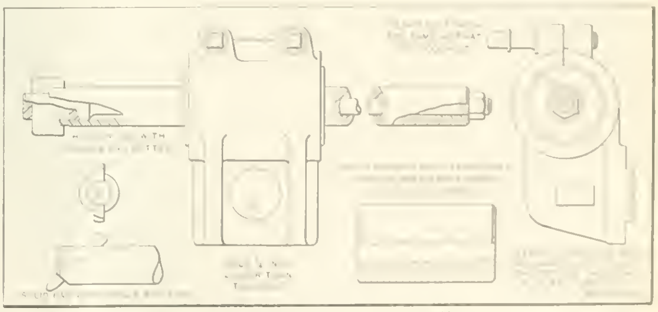
The machinist knows what it is to turn large flywheels and to measure them around the circumference with a tape line. A number of heavy 28-foot flywheels were to be machined on a 28-foot mill. The wheels were split in three sections edgewise, necessitating the machining of each one of a set so that it would be an exact duplicate of the others in the same set. This was easily accomplished by filing off a spot on the inside of the housing opposite the job on the table. Then it was just a case of setting the 3-inch inside calipers to the distance between this spot and the finished rim. This exact distance was found by setting the 3-inch micrometer to the calipers and marking down the size; then the others were made to the same measurement. While the machinist was doing this the boss noticed that the sections were all O. K., and wondered how he did it, as he never saw the machinist measure them. When told how it was done the foreman got busy and had a gage made to fit this space, as the man might turn one or two sections and then quit and no one else would know what the size should be.

Wausaukee, Wis. W. E. BUTLER

COMBINATION LATHE BORING-BAR AND HOLDER

The combination lathe boring-bar and holder shown in the accompanying illustration may be used for boring, counterboring, drilling, reaming, or facing work held in a chuck or on a faceplate or fixture, employing the regular carriage feed of the lathe. The holder consists of a casting planed to fit the compound rest and clamped to it with the regular toolpost and screw, with a small bar projecting through the slot in the casting. This makes the boring-bar holder very easy to attach, the time required to change to either the holder or regular tool being less than thirty seconds. The hole for the bar should be bored with the casting in place on the lathe in order to insure having it in line with the centers. This hole should be about 3 inches in diameter when the tool is made for use on lathes of from 12 to 24 inches swing.

After being bored the casting is split and screws are provided with square ends of the same size as the toolpost screw in order to avoid the necessity for extra wrenches. For use with taper shank drills and reamers, a solid bushing is provided with a taper hole the same as that in the tailstock. For use with the boring-bar or other tool, split bushings are provided for any size of bar that is required, and these may vary from the smallest up to 3 inches in diameter. For general use, a ¾-inch, 1-inch and 1¼-inch solid bar with single-end tools, and a 1-inch and 1¼-inch hollow bar with double-end tools, will meet most requirements. The solid bars are made from a piece of bar stock turned to size with a tool


Design of Lathe Boring-bar and Holder

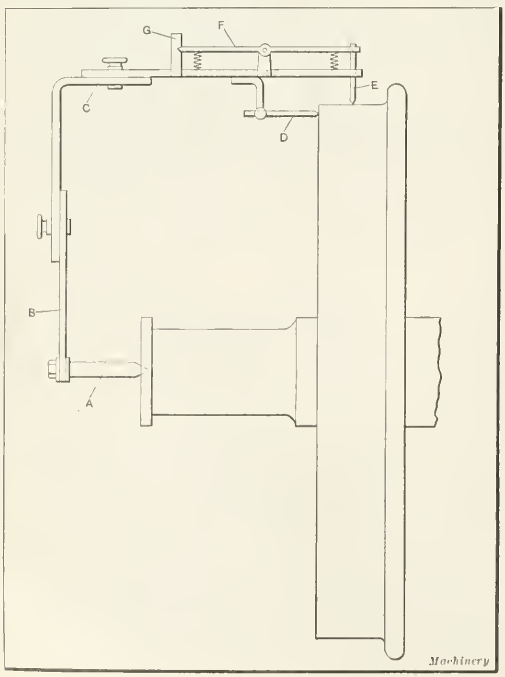
inserted in one end. The bar is made of any suitable length but is allowed to project just far enough beyond the holder to meet the requirements of the work, thus making the most rigid possible construction and still having adjustment to meet the requirements of deeper work.

The hollow bar is made from steel tubing, the tool being held in a slot in the end of the tube by means of a draw-rod. A slot 1/8 inch deep is cut in one edge of the tool to allow of its being locked to prevent endwise movement, the arrangement being clearly shown in the illustration. The tube is also finished for a short distance on each end on the inside, to provide a fit for the draw-rod which is enlarged to fit the tool, and to fit a bushing and washer under the nut. The draw-rod is provided with centers in both ends to permit of its being turned the entire length after the first tool is in place. In this way a very simple and inexpensive method is provided for holding a considerable number of different sized cutters for each size of bar. As all shops have more or less chucking work for which a tool of this kind is adapted, the combination boring-bar will be found to pay for itself in a very short time.

Fairfield, Me. M. P. Chaplin

CAR WHEEL INDICATOR

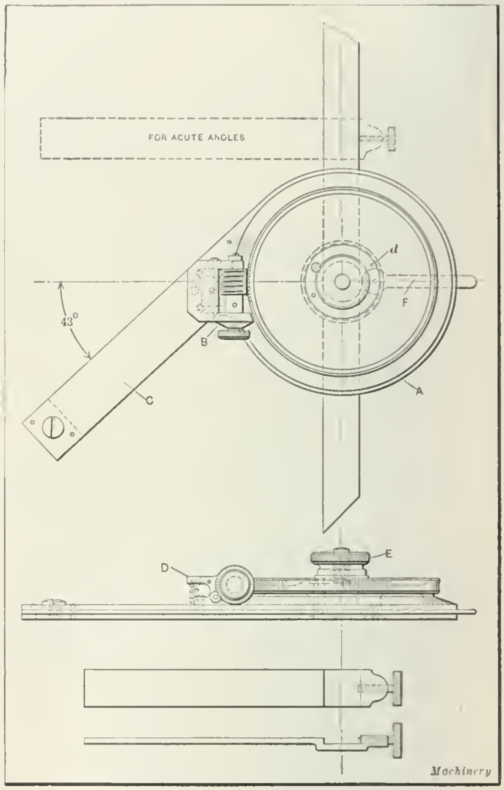
The accompanying illustration shows an indicator for use in determining whether car or tender truck wheels are out of true. A method of determining the accuracy of wheels is highly important, because if they get out of round, heating of the journals and other undesirable conditions are likely to result. Referring to the illustration, it will be seen that the center *A* is placed in the center of the axle, and that this center is supported by an arm *B* which is slotted at the upper end to provide the necessary adjustment for using the indicator on wheels from 33 to 36 inches in diameter. It will also be noticed that means for making horizontal adjustment are provided at *C*, where the connection is slotted for this purpose. The pin *D* engages the side of the wheel and holds the indicator point *E* at the center of the tread of the wheel, the pin *D* having horizontal adjustment for wheels with treads of different widths. The indicating pointer *F* is slotted at the end so that it straddles the scale *G* which is graduated on both sides. In this way, provision is made for reading the indicator from either side. This device has given entire satisfaction in the shops of one of the Eastern railroads, where it has been in use for some time. L. K.



Indicator for Use in testing Accuracy of Car Wheels

PRECISION BEVEL PROTRACTOR

The bevel protractor illustrated herewith will be found useful where exceptionally fine angular measurements are required, as this instrument reads to minutes without the aid



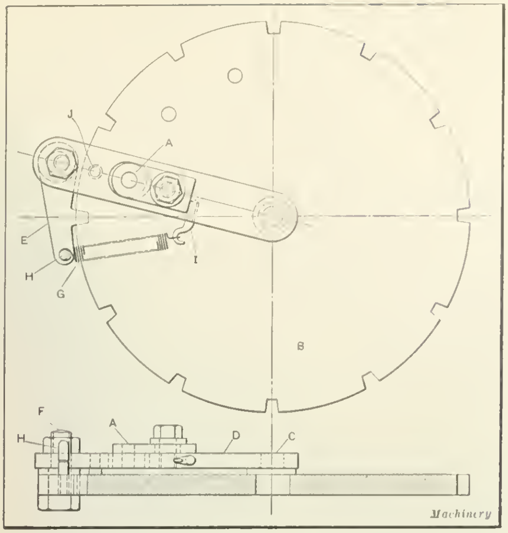
Precision Bevel Protractor

of a magnifying glass. After referring to the illustration, little description will be necessary to make the use of this protractor quite clear. The disk *A* has 360 teeth cut in it and the dial *B* is graduated into sixty spaces. This dial is carried on a short shaft supported in a bracket on the protractor blade *C*. At the opposite end of the shaft from the dial *B* there is a worm which meshes with the teeth cut in the disk *A*. Thus, by turning the dial *B* through one space, the protractor blade *C* moves through an angle of one minute relative to the stock of the protractor. By pressing the end of the small lever *D*, the worm on the end of the dial shaft is disengaged from the teeth in the disk *A*, so that the protractor blade *C* can be swung around to approximately the required position. The worm is then allowed to re-engage the teeth in the disk and the protractor is further adjusted by turning the dial *B*. After the setting has been made, the protractor is locked by tightening the knurled nut *E*. The protractor blade is locked by the binding cam *F*. The instrument is then ready for use.

New Britain, Conn. W. C. Betz

DRILLING POWER PRESS DIAL PLATES

The accompanying illustration shows a jig used for drilling dial plates of the form employed on automatic feed



Jig for Use in drilling Holes in Power Press Dial Plates

mechanisms for power presses. These were shipped to us by the makers finished all over, with the center hole bored and the notches milled to suit the locating plungers on the power presses, but the holes could not be drilled because the location of these had to be made with reference to the particular presses on which the dials were to be set up. For use in drilling the holes we designed a special jig, but before using it we had to make center punches to fit the punch-blocks on the different power presses and also to fit bushing *A* in the jig. Each dial plate *B* was then put on its bed and the press was set in the usual way, care being taken to have the locking device fit properly in one of the notches. The center punch was then mounted in the punch-block and one prick-punch mark was made on the dial in the proper relation to one of the notches. The dial plate was next placed on the table of a drill press and the center punch was set in the chuck in the drill spindle so that the prick-punch mark on the dial could be lined up with the spindle. The plate was then strapped to the table and stud *C* driven into the center hole. The top of the stud *C* is machined to fit the pivot hole in the arm *D* of the jig.

The next step consisted of lining up the bushing *A* of the fixture with the center punch in the drill spindle. It will be noted that the bushing is made adjustable relative to the center *C* about which the arm swings, so that it may be set in the required position before clamping the binding bolt. The bushing is located in the proper relation to the notches in the dial plate by means of the locking pawl *E*, and the eccentric screw *F* adjusts the position of the pawl relative to the arm *D* of the jig. The pawl is held in the proper notch in the dial by the spring *G* which is mounted on the pins *H* and *I*; and stud *J* is used to hold the arm of the fixture true with the face of the dial plate. It will be evident that after this setting has been made, the bushing *A* is located directly over the center punch mark which was made on the dial plate while the prick-punch was mounted in the punch-block of the power press. The hole can now be drilled in the dial plate, after which successive holes are drilled by simply swinging the dial around the pivot *C* and locking it for drilling each hole by dropping the pawl *E* into successive notches in the dial plate.

Waterbury, Conn. CHARLES E. GRILLEY

INKING OVER ERASURES ON TRACINGS

Recently I had occasion to change the numbers on several tracings, the inking of which had been done on the dull or unglazed side of the cloth. In order to remove all the old ink marks, it was necessary to rub until the fabric of the cloth was exposed. In such cases the ink will not take without running. Having some prepared white shellac on hand, I applied a very thin coating to the cloth. This dried quickly and left an excellent surface on which to do my lettering, there being no tendency for the ink to run.

Cicero, Ill. R. D. BONNAMY

FROM A MECHANIC'S NOTE-BOOK

Always use the right-hand ram for the long reach and the heavy cut on a boring mill. The reason for this is obvious—the strain is too great when pulling away from the rail, which is the condition that obtains when using the left-hand ram.

I have often seen notes on using two blades in a hacksaw to cut slots, etc., but have never seen anything about both of these blades being the same age, which is very important. You want either two new ones or two that have been worn about the same and preferably of the same pitch.

To lay out a keyway on a shaft, especially one with collars, etc., when all finished in the lathe, tighten up the centers and run the tool up to the shaft till it touches. Then run the carriage lengthwise, pulling out the cross-feed to get around the collars, and you will have a keyway laid out with very little work.

It often happens that there is a job to be planed against a shoulder—very often a keyway—and the planer won't stop where you have it set, either riding over too far and breaking off the tool, etc., or not going far enough. The remedy is to tighten up the reverse belt, and you can stop anywhere you want to.

Anyone who has ever had to do much filing on large dies or heavy work of any kind knows what a slow job it usually is. On a large surface, take a $\frac{5}{8}$-inch square or a $\frac{3}{4}$-inch square bastard file instead of one $1\frac{1}{4}$ or $1\frac{1}{2}$ inch wide, and you will find that you can take off twice as much metal and won't have to push half as hard.

In large shops it is customary to use pin gages to make sizes. On boring mill or planer work when you have a boss or other elevation to face off, in order to get the pin gage squared up under the tool, just take the oil-can and squirt a few drops of oil on the tool; wherever the first drop lands is the exact location for the lower end of the pin gage.

In a small shop it is often necessary to use the vise on the planer to plane up a set of brasses or other small work. Instead of trying to get the vise squared up with a surface gage from the planer bed to the vise jaws, just clamp a straightedge—the longer the better—in the vise. Then you can measure from the edge of the bed to the straightedge with a scale and a two-foot rule and get the vise square at once.

On tool work it is often necessary to make snap gages. The quickest way to do this is to caliper the cutter with a micrometer, and after taking the first cut through the gage use the graduations on the cross-feed, moving the job over the desired amount. After the hardening, they will be warped either too large or too small. Take a light hammer and give the jaws a few blows one way or the other, and many minutes can be saved in grinding and lapping.

On repair work it often happens that you want to make a rod out of cold-rolled stock, just turning down enough on the end to make a fit for the piston and a couple of nuts behind it. Some go to the trouble of getting the steadyrest ready, but that is not necessary. Just prick-punch a good sized center in both ends about where they ought to be. Then use the square center, shoving the back end of a tool that has been ground off smooth against it gently, with a little oil to lubricate, feeding in on the square center until you have a center as large as you want, and the job will run just true.

Wausaukee, Wis. W. E. B[illegible]

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SOLDER FOR ALUMINUM

An aluminum solder patented April 7, 1914 is made up of the following metals in the proportions indicated: aluminum, 17.5 parts; zinc, 52 parts; tin, 30 parts; and nickel 0.5 part. It permits soldering and welding to be done at low temperatures and can be used without acids or welding powders.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

ALLOWANCE FOR SHRINKAGE IN MALLEABLE CASTINGS

A. S. G.—How much allowance should be made for shrinkage in the making of malleable castings? I understand that malleable castings will shrink more than 1/4 inch per foot when cast, and will then expand nearly 1/8 inch when annealed. Is this correct? What means are taken to insure that a casting of the correct size will be obtained after annealing? What will be the difference in gray iron castings and malleable iron castings, cast in molds made from the same patterns?

A.—As the iron used for making malleable castings usually has a shrinkage of practically 1/4 inch per foot, with a return of 1/8 inch in the annealing, the shrink-rule of the ordinary pattern shop is used for making the patterns for malleable castings; as a rule there will be no appreciable difference in gray iron castings and malleable iron castings cast in molds made from the same patterns. It should be remembered, however, that the contraction of 1/4 inch per foot in malleable castings is not constant, but will vary from 3/16 to 5/16 inch, and, in extreme cases, may even be beyond these limits. This depends on the kind of iron used—the lower the percentage of silicon, the greater will be the contraction. Also, the more sprues used and the more steel used in the mixture, the greater will be the contraction; hence, malleable iron castings made from a pattern used for cast iron should be checked up to make sure that the shrinkage and the return in the annealing are according to the figures given, as otherwise an adjustment must be made in the shrink-rule used. On the whole, the shrinkage of malleable castings is not uniform enough to permit absolute dependence upon the figures given. With rather thin castings, the expansion in annealing may be so great as to counteract the contraction entirely, and the casting will then be as large as the pattern. This is particularly true when the silicon content is high.

PLUG AND RING GAGE ALLOWANCES

F. M. & F. Co.—In the past year we have had several arguments on what size a 4-inch gage should be made in order that it will just fit a 4-inch hole. We looked for an authority on this subject and could find none, there appearing to be no published data or table on allowances for plug and ring gage fits. I would like to see a table giving definite data as, for example, a 1-inch plug 0.0002 inch under size to fit a 1-inch ring; a 2-inch plug, say 0.0003 inch under size to fit a 2-inch ring; and so on.

A.—There appears to be no agreement of gage makers on the matter of allowances for plug and ring fits. One well-known concern claims that it makes the plug and ring of the standard size, *i. e.*, a 1-inch plug measures 1 inch and a ring to fit also measures 1 inch. These can be assembled only by an expert and so close is the fit that the plug must be kept moving constantly or it will be seized by the ring. Other makers of gages make the plug to standard size and fit the ring to the plug, making an allowance of about 0.0001 inch on the 1-inch size. The Johansson gages are made to a uniform limit of 0.00001 inch per inch of length. This is proportional in all sizes, the one-tenth inch gage being accurate to the 0.000001 inch or one one-millionth inch. Having this in mind, the following experiment indicates how small the clearance may be in an accurately fitted plug and ring gage: Four Johansson gages were taken, two half-inch and two of other sizes; the other gages were locked to the half-inch, one on each side overlapping so as to form a snap gage. The three were held together alone by the air suction or molecular attraction that these gages possess for one another. The other half-inch gage or block was forced through the snap gage opening without breaking the air suction between the three assembled gages. Here we have the condition of the snap gage opening being exactly the same size as the gage fitting it, and still the one can be moved freely within the other.

ALLOWABLE TOLERANCES WHEN TESTING ENGINE LATHES

J. J. R.—I am inspecting machine tools for an exporting concern and have to pass on the accuracy of a lot of engine lathes. There seems to be no agreement on the allowable variations in engine lathes, and I would like to have your opinion on the subject.

A.—The limits of various makers of machine tools vary somewhat, it is true, but greater variations than allowed by the makers' inspectors will be found apparently unless great care is taken. When testing an engine lathe, it should be leveled perfectly, and the slides and other working parts should be examined to see that they are free and in good working condition. The carriage should move freely the entire length of the bed, and the cross-slide should also work smoothly and freely. The principal tests for accuracy should be made with a steel bar 12 inches long, provided with a taper shank accurately fitting the taper hole in the spindle. This bar may have, say, three turning points or collars equidistant, from which measurements are taken. With this bar in position, a light chip with a sharp tool is taken over the three collars, and then the collars are measured. All three should measure the same, the allowable variations being 0.0005 inch, plus or minus. The vertical alignment in the 12-inch distance should not vary more than 0.0005 inch up or down. The variation in alignment of the taper hole in the spindle shown by the bar being turned half way around in the hole should not be greater than 0.001 inch at the end. The taper hole in the spindle should run true and there should be no appreciable end motion or shake of the spindle. The faceplate should align with the cross-slide and when faced should be flat, or concaved 0.0005 inch in a diameter of 12 inches. The tailstock spindle when run out full length may have a maximum deviation from truth of 0.0005 inch vertically, preferably upward. The spindle should align with the head spindle in three positions on the bed, the allowable variation being 0.0005 inch upward.

PRACTICE IN SURFACE SCRAPING MACHINE PARTS

R. D. M. Co.—We have had some discussion concerning the correct method of using scraping compound when surface scraping machine parts. Some mechanics contend that the compound should be placed on the surface plate and others that it should be placed on the work. We have heretofore always used the first method but are having very good success with the second. We would be pleased to have your opinion on the subject as to which is the better method. Some contend that placing the marking compound on the work increases the wear on the surface plate. Placing the marking compound on the work has the advantage that it is easier on the men's eyes, as the bright surfaces are covered up and do not reflect the light.

A.—When scraping surfaces of machine parts to a surface plate, the common practice is to apply the venetian red (mixed with lard oil or mineral oil) or prussian blue to the surface plate, and to scrape off the high spots on the work surface as indicated by the red or blue markings. The reverse practice of applying the marking compound to the work is used to some extent by toolmakers, but it has no marked advantage aside from that of reducing the glare of the bright surfaces on the workmen's eyes. On the other hand, the practice has the disadvantage that the scrapings stick to the work and cannot be so easily cleaned off. As far as the wear on the surface plate is concerned, there should be little in favor of either practice. When the marking compound is applied to the surface plate, the plate is somewhat protected by the compound it is true, but as it is not necessary to clean off the plate at each trial when the alternative method is employed, the difference in wear would be very slight. The experiences of readers who have used both methods are solicited for publication.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

AJAX TWO-BLOW HEADER FOR HOT WORK

Until recently heading machines equipped with continuous feed, and intended for working hot metal, have been confined to the single-blow type. Two- and three-blow headers are commonly used for working cold stock, but several difficulties have stood in the way of employing the multiple-blow type of machine on hot material. These difficulties have recently been overcome by the Ajax Mfg. Co. of Cleveland, Ohio, which has introduced a header for working on hot metal in the production of work that cannot be satisfactorily handled by a single-blow machine. A feature of the design is that this header may be converted into the single-blow type, which is an important advantage in adapting it to the requirements of those shops that have not enough work for a two-blow header to keep the machine constantly employed.

A two-blow automatic header for hot work has been developed by the Ajax Mfg. Co., Cleveland, Ohio, in response to the demand for a machine that will automatically upset heads in which the quantity of metal or the shape is such that the work cannot be done in one operation. Screw spikes used by many railroads have such a large head that two upsetting operations are necessary to produce a good job without buckling the material and causing cold shuts in the head. Also hexagon and square bolt heads may be upset on round stock, forming a very good forged bolt head, with a two-blow header, where a single upset can never make a good square or hexagon head from round stock without getting a large flash.

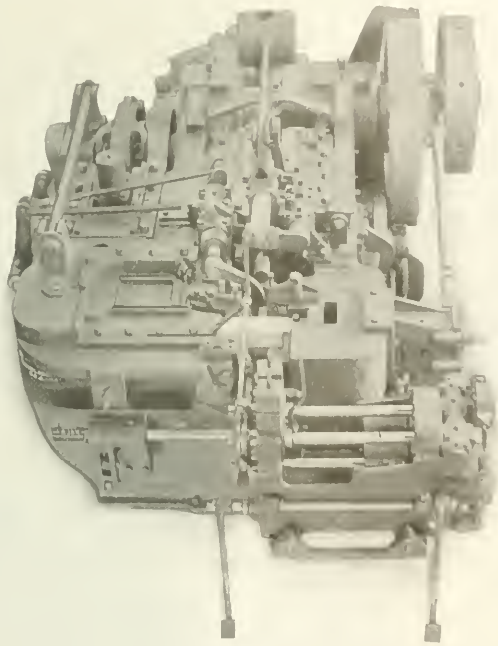


Fig. 1. Top View of Ajax Two-blow Automatic Heading Machine for Hot Work

Until recently, heading machines with continuous feed, for working on hot metal, have been confined to the single-blow type. Two- and three-blow headers for working cold stock are in successful operation, but the problem of adapting the multiple-blow machine for working hot material presents serious difficulties. In the first place, the pieces to be headed hot are generally much larger and require a much sturdier machine to do the work than those which are headed cold. The two-blow machine is necessarily more complicated than the single-blow machine, and where strength and rigidity are of paramount importance, it is necessary for all complications in the design to be kept down to an absolute minimum. Second, the severe conditions under which the dies are worked in the single-blow heading machine are augmented in the two-blow machine. In the single-blow machine the dies grip the stock while it is being headed; then they open and are cooled by running water before they close and grip the stock for another piece. In the two-blow machine the dies open so that the water can get to them only once in two full revolutions of the crank, thus reducing the chance of cooling the dies 50 per cent and increasing the duration of the heating period. The dies must be kept cool to keep them from losing their temper; also the cold water running onto the dies, which have been heated by close contact with the hot stock, is liable to check them. The recently developed special alloy steels which retain their temper to almost a dull red heat have proved invaluable in making dies to be used in both single- and double-blow hot headers.

The bed plate of the two-blow header is a single steel casting cored out and machined to take the necessary slides, bushings for shafts, and brackets. All moving parts are bushed or lined so that no wear comes directly in the bed casting. The crankshaft bearings are solid, making a much more rigid construction than could be obtained with split bearings. the drive is provided by an electric motor geared to the crankshaft. To prevent damage being done to the motor by stalling the machine, a friction clutch is interposed on the pinion shaft, which slips when the machine stops suddenly. The machine shown in the accompanying illustrations is rated as a 1-inch machine, i. e., it will upset stock up to 1 inch in diameter.

The principle of the two-blow header is fundamentally the same as that of the single-blow machine. It depends on the closing of the moving die to shear the stock for one forging from the bar, and this blank is then gripped between the dies. The heading tools are carried in the main slide which is operated continuously by the crankshaft. These tools receive the material which protrudes from the dies and form it to the desired shape, the forming operation taking place during the last part of the forward

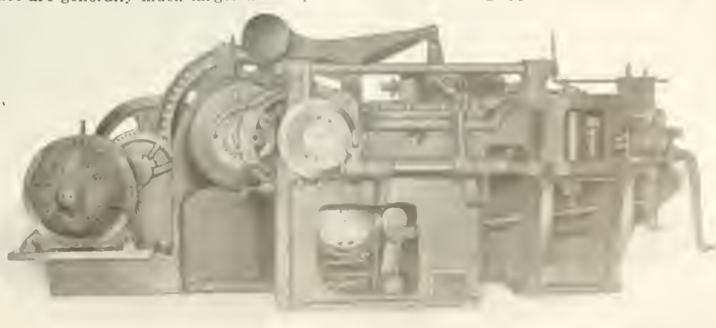


Fig. 2. Left-hand Side of Machine, showing Mechanism for operating Feed Rolls and Stop

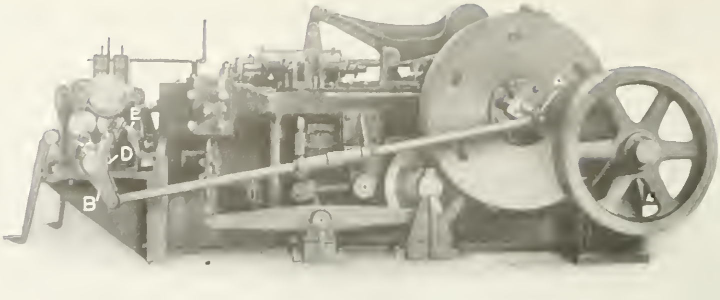


Fig. 3. Showing Mechanism for operating Intermittent Feed Mechanism, Movable Die and Vertical Tool-slide

stroke of the slide. The necessity of holding the stock in the dies, while the tools come forward twice, introduces several difficulties which have to be overcome.

The cam which operates the moving die runs at one-half the speed of the crankshaft, being driven by gears which have a ratio of 2 to 1. This forged-steel cam moves the roller arm which embodies the safety device, and operates the dies through a knuckle system. These features are illustrated in Figs. 1 and 3. The safety device consists of a wedge which is forced between two rollers against the force of two heavy compression springs, if the resistance offered to the closing of the dies becomes too great. It will be noticed that the roller arm is of very heavy construction and is guided rigidly in the bed of the machine.

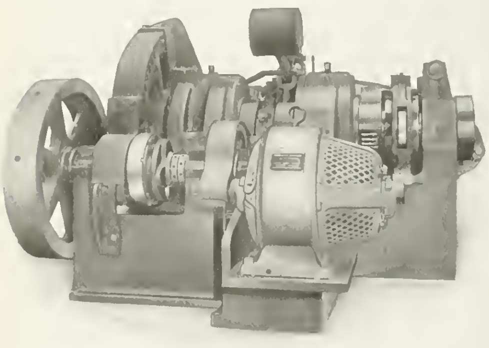


Fig. 4. Back View of Machine showing Arrangement of Drive

The mechanism for moving the tool-holder up and down, so that one tool operates on the material during one forward stroke and the other tool during the following forward stroke, is actuated by a cam on the lower cam-shaft. This shaft is driven by a gear from the die-slide cam-shaft and runs at the same speed. The cam is so designed that the movement of the tool-holder, either up or down, is accomplished during the back half of the stroke, so that when the tool approaches the dies or recedes from them it travels in a horizontal line during one-half of the stroke. This allows the tool-holder to be guided horizontally during the first half of the stroke by a guide bolted rigidly to the bed of the machine, thus insuring perfect alignment when the material is being upset. The motion is transmitted from the cam to the tool-holder through the roller arm, link, and lever. The reciprocating motion of the header-slide is taken care of by the top of the tool-holder sliding back and forward on a large bar in the lifting lever.

The stock gage is operated from a cam mounted on the end of the die-slide cam-shaft, the arrangement being shown in Figs. 1 and 2. The stock gage drops into position as the stock is fed into the machine, then moves out of the way of the first upsetting tool as it comes forward, and remains there until it is needed to gage the stock when it is next fed into the machine. After the forging operation has been completed and the dies have opened enough to release the work, the piece is ejected from the dies by a "kicker" similar to that used on single-blow machines; this kicker is operated from a cam on the end of the lower cam-shaft, as shown in Fig. 2. As the lower cam-shaft runs half as fast as the crankshaft, the design of the kicker cam is very similar to the cam used on the single-blow machine, *i. e.*, it has one high spot that throws the kicker against the finished piece and ejects it from the dies.

The mechanism used to feed the stock into the machine is identical with that used on the single-blow machine, except that an additional device is added to make the machine feed at alternate revolutions of the crankshaft, the mechanism being shown in Fig. 3. The feed rolls are turned during slightly less than 180 degrees rotation of the crank by eccentric *A* on the crankshaft. Arms *B* oscillate pawls *C*, thus rotating ratchet *D*. Pawl *E* rotates a small cam at *F* which is so designed that at alternate stopping positions the tails of pawl *C* are pressed downward, thus holding the pawls clear of ratchet *D*. This results in the motion of the eccentric *A* being transmitted to the feed rolls only once in every two revolutions of the crankshaft.

An additional device is provided for pinching the end of the bar, previous to its being fed into the dies, and this device is especially useful in the upsetting of square or hexagon bolt heads. In such cases the round bar would be pinched to a square or hexagon section; and with this section the corners of the bolt head can be well filled without getting a flash between the tool and dies. This pinching device is operated from a cam mounted on the lower cam-shaft on the right-hand side of the machine, as shown in Fig. 3. The roller lever operates a toggle joint which, in turn, slides a loose block in the backing plate, pinching the end of the stock and then moving away without remaining in contact with the hot bar any appreciable length of time.

Another feature of this machine is that it is so constructed that it may be changed to a single-blow machine and operated in that way by detaching certain parts and substituting

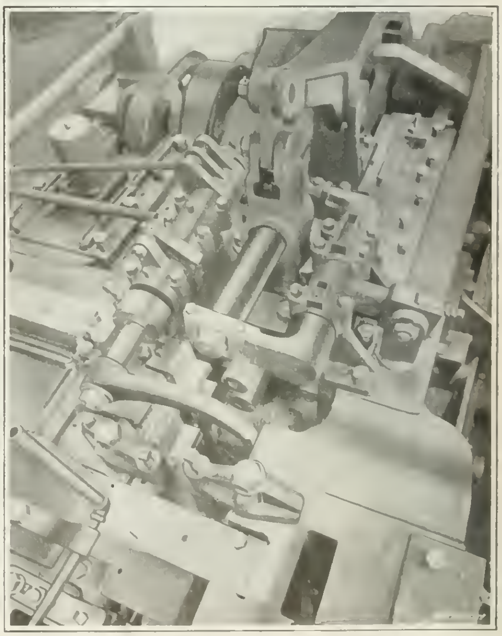
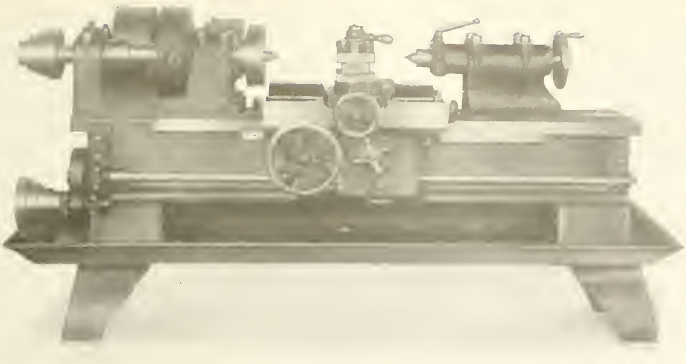


Fig. 5. View of Dies, Tools, Tool-holder Mechanism, Stock Gage, etc.

other pieces. In making the change a 1 to 1 gear drive is substituted for the 2 to 1 drive for operating the die-slide. Also, the die-slide cam and its shaft are replaced by a small crank-shaft. The roller arm is replaced by a slide which is driven by the crank, and the change of gears to operate the die-slide leaves the lower cam-shaft disconnected. The tool-holder mechanism is disconnected at the top of the machine and a stationary tool-holder is bolted to the header-slide. The pinching device may be disconnected if desired, but it is useless as its cam does not move. The feed is made to act at every revolution of the crank by simply removing the pawl *E*, Fig. 3, and setting the cam *F* in such a position that it allows the pawl *C* to rotate the ratchet *D*. A kicker cam is provided to be put on the main crankshaft outside the left-hand bearing, for use when the machine is operated as a single-blow machine. This flexibility of usage is especially useful where there is not enough work to keep a two-blow machine busy all the time. The time required to make the change is only a few hours, and the machine operates perfectly as a single-blow machine.

SHOOK & FLETCHER PROJECTILE TURNING LATHE

The Shook & Fletcher Supply Co., Inc., 827-830 Brown-Marx Bldg., Birmingham, Ala., is now manufacturing a projectile turning lathe which has a nominal swing of 20 inches over the bed. The noteworthy features of the machine are the exceptional driving power and strength that are provided, an idea of which will be gathered from the fact that the lathe will operate continuously on 0.45 per cent carbon forgings up to 10 inches in diameter, when taking a cut ½ inch in depth with a feed of 1/16 inch per revolution, at a peripheral cutting speed of 65 feet per minute. Working at this exceptionally high rate, it is stated that the machine shows absolutely no vibration or tendency of the bearings to heat; and the claim is made that the above figures do not represent the maximum capacity.


Shook & Fletcher 20-inch Manufacturing Lathe, which is especially adapted for Shell Work

The machine is driven by a single pulley which is belted to a two-speed countershaft, and slip gears provide the necessary changes of speed. The spindle is made of 0.60 per cent carbon steel, ground to size and bored from a solid forging. The headstock bearings are lined with bronze bushings and alternate steel and bronze washers take the end thrust of the spindle. The carriage is provided with an oil trough around the front vee, which prevents lubricant from running down over the apron. The carriage is gibbed to the bed at the front and rear on the outside, and is also gibbed to the inside of the bed underneath the bridge, *i. e.*, the carriage is gibbed at four points so that it will not lift under any conditions.

The apron is of the double plate type which provides a bearing at both ends of all shafts, and the apron is tongued and grooved to the carriage. The feed friction is of large diameter and will pull the heaviest feeds without slipping. The knob for engaging the friction is provided with a pilot wheel 6 inches in diameter, which draws in the friction firmly without requiring undue effort from the operator. The machine is equipped with a four-step feed cone which carries a belt 1½ inch in width. The gear ratios in the feed mechanism are very high and ample power is provided for the heaviest feeds. When necessary a gear-box is provided which furnishes four changes of feed

The principal dimensions of the machine are as follows: swing over ways, 20 inches; swing over carriage, 10 inches; capacity between centers for 7 foot 6 inch bed, 31½ inches; diameter of hole through spindle, 1⅜ inch; maximum travel of tailstock spindle, 8 inches; gear ratios, 8.5 to 1 maximum, and 2.85 to 1 minimum; available feeds per revolution, 0.020, 0.040, 0.060, and 0.080 inch; range of spindle speeds, 28 to 112 R. P. M. for 3- to 6-inch shells and 20 to 80 R. P. M. for 4½- to 9-inch shells.

NEWTON VERTICAL MILLING MACHINE

The accompanying illustration shows an improved type of heavy vertical milling machine, which has recently been added to the line of the Newton Machine Tool Works, Inc., Philadelphia, Pa. The feature of the machine is a flexible control which provides for the successful use of end-mills as small as ¾ inch in diameter on die work, and the cutters which can be used on the machine range from this size up to those required for performing the heaviest milling operations in locomotive shops. The illustration shows how well the design of the machine lends itself to the application of alternating-current motor drive as changes are obtained through the speed-box gearing without requiring the removal of gears. Another feature is the counterweighted spindle saddle which is provided with vertical feed and fast power movement; reversing fast power traverse is also provided for the circular, in and out and [illegible] table motions, which also have reversing power feed and means of making hand adjustment. All of these motions are governed from a centralized control.


Heavy Vertical Milling Machine made by the Newton Machine Tool Works

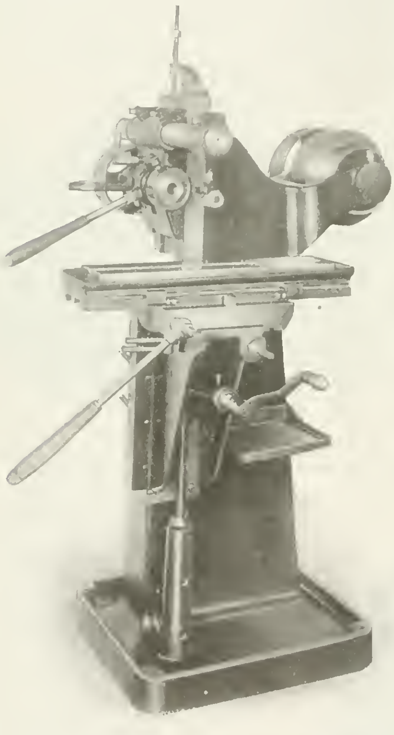
The important dimensions of the machine are as follows: Diameter of circular table over [illegible], 42 inches; maximum [illegible] feed, 30 inches; maximum in and out feed, 20 inches; range of spindle speeds, 8½ to 2[illegible]2 revolutions per minute; maximum diameter which can be milled when table is in its forward central position,

38 inches. The table is of the corner clamp construction, and is surrounded by a pan which is drained from the center. In conclusion, it may be mentioned that machines of this type have found successful application in milling the solid ends of shrapnel forgings, for which purpose the continuous circular feed motion provided on the machine is found most suitable.

KENT-OWENS MILLING MACHINE

The high-speed hand milling machine shown in the accompanying illustration is a recent product of the Kent-Owens Machine Co., Toledo, Ohio, and the P. H. Biggs Machinery Co., 809 Hippodrome Bldg., Cleveland, Ohio, has the sales agency. A feature of this machine is that it is equipped with Bock taper roller bearings for the spindle and back shaft. The machine may be run at speeds ranging from 1200 to 1500 revolutions per minute, which permits of the use of end-mills or "fish-tail" cutters as small as 3/16 inch in diameter. The high speed at which the machine may be operated makes it particularly suitable for milling splines.

The machine can be equipped with an oil pump and pan;



High-speed Hand Milling Machine sold by the P. H. Biggs Machinery Co.

and sufficient power is provided for driving two 3-inch straddle mills at a normal cutting speed. The clamping levers for the head are conveniently located at the front of the saddle; and all feed-screws have milled threads. The regular equipment furnished with the machine includes a countershaft and wrenches. A V-block for holding shafts which are to be splined, and a vise for general milling operations can be supplied as special equipment.

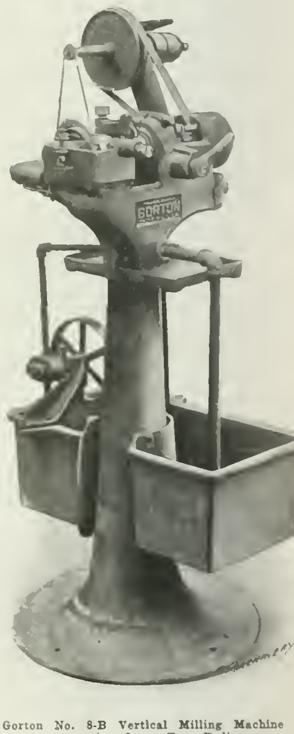
The principal dimensions of the machine are as follows: Diameter of hole through spindle, 17/32 inch; taper of spindle, No. 9 B & S; maximum vertical travel of head by lever, 6 inches; over-all size of table, 8 by 26 inches; size of working surface of table, 5 by 17 inches; maximum distance from spindle to table, 14 inches; and maximum table feed by lever, 4 inches. By using a crank handle, the table has a maximum travel of 17 inches, and positive stops are located on the side of the table. The weight of the machine is 1800 pounds.

GORTON FUSE ROUTING MACHINE

The No. 8-B vertical milling machine shown in the accompanying illustration was designed by the George Gorton Machine Co., Racine, Wis., for routing the wrench slot in graze fuse bodies. The fuse body is mounted on a plug in the reciprocating work-holder and securely clamped by a half-turn of a knurled screw. The horizontal plunger locates the work from the percussion pellet hole. The work-holder is actuated by the reciprocating mechanism, motion being provided through an eccentric shaft and connection link. The spindle is made of hardened tool steel and runs in ball bearings; and a horizontal movement of two inches is provided by means of the lever at the right-hand side of the machine, a micrometer stop being provided which insures obtaining a uniform depth of slot on all pieces.

When changing cutters, a cutter gage is swung into position in front of the spindle to determine the exact position of the cutter; the cutter is then clamped in the collet and the gage dropped down out of the way. The countershaft is provided with ball bearings which are packed in grease; it is mounted on the machine and can either be driven from the lineshaft or by means of a motor carried by a bracket bolted to the under side of the shelf. It should run at approximately 2000 R. P. M., but this speed may be varied, according to the nature of the work. The tight and loose pulleys, which are $3\frac{1}{8}$ inches in diameter by $1\frac{5}{8}$ inch face width, are provided with ball bearings.

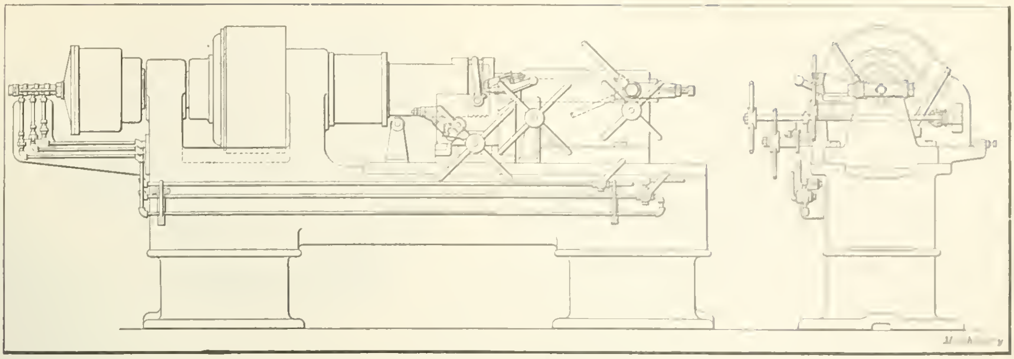
This machine is equipped with a cutter lubricating system including a pump., tank, strainer, relief valve, flexible tube for delivering the lubricant to the cutters and all necessary piping. The pump is driven from the lineshaft and the lubrication flows from the work-holder into the lower portion of the cutter-head, from which it drains back into the tank. The tank is provided with a well, which extends to within a few inches of the top, and the chips are retained in this well so that they cannot be drawn into the suction chamber of the pump. The average rate of production is about 120 steel parts per hour and a correspondingly greater number of brass parts. The P. H. Biggs Machinery Co., 809 Hippodrome Bldg., Cleveland, Ohio, has the sales agency for this machine.



Gorton No. 8-B Vertical Milling Machine for routing Graze Fuse Bodies

JENCKES BAND TURNING MACHINE

For use in turning the copper rifling band used on British high-explosive shells of the 8-, 9.2-, and 12-inch sizes, and corresponding sizes of Russian, French and Italian shells, the Jenckes Machine Co., Ltd., Sherbrooke, Quebec, Canada, has recently developed a single-purpose machine, which is



Jenckes Band Turning Machine equipped for machining Bands on British 9.2-inch High-explosive Shells

illustrated and described herewith. The illustration shows the machine equipped for operation on the 9.2-inch shells, and it will be seen that the bed is liberally proportioned to provide the necessary strength and rigidity to withstand the severe service conditions to which machines are put in the manufacture of ammunition. The bed is strengthened by box girths, and the spindle bearings are cast integral with the bed. The cap on the forward bearing is interlocked with the frame to provide for taking the end thrust, and both bearings are furnished with babbitt liners, which are peened in, bored and finally scraped to fit the spindle.

The tailstock may be located and bolted to the bed to suit any size of shell which is to be machined. The spindle is 5 inches in diameter and furnished with a heavy center. The spindle has a quick movement of about 6 inches which is actuated by a rack and pinion; its exact position is determined by a swinging stop at the rear which drops over the end of the spindle when it has advanced far enough. A limited adjustment is provided by means of a screw and lock-nut in the stop; this enables the center to act as a stop and also as a bearing for the shell, so that the band can be finished off exactly the correct distance from the end of the shell. The driving spindle is made of steel and carries a chuck which is built into the extension on the spindle. The chuck is of the collet type with jaws which are opened or closed by compressed air, the controlling valve being located close to the operator's right hand when he is in his customary position at the front of the machine. The drive is through a single clutch pulley 22 inches in diameter by 10½ inches face width; this pulley has bronze bushings and runs loose on the spindle. The clutch is the full diameter of the pulley and is of the taper cork insert type.

The tool base is bolted to the bed and carries both the roughing and finishing heads. In machining the 9.2-inch shells, the roughing operation is divided between two cuts. Each tool is fully adjustable but when once set, the tools can be removed and accurately replaced. The feed of both tools is provided by a single screw which works in connection with positive stops. The undercutting tool is carried on a separate block mounted on the front slide, and is set at the correct angle. The feed is through a lever end cam. The finishing tool is located at the rear and so mounted that the tool slides past the band and shears it to exactly the required size and shape. The feed is actuated by a rack and pinion operated by a handle which is conveniently located for the operator.

STUEBING ELEVATING TRUCK

The improvement of facilities for handling work in factories has received considerable attention during recent years, and one of the most important developments along this line has been the introduction of elevating trucks for use in connection with inexpensive platforms on which the work is stacked preparatory to moving it from one department to another. The chief advantage possessed by the elevating truck and platforms over the use of individual trucks is that the investment is materially reduced because it is merely necessary to buy a sufficient number of trucks for actually transporting the work through the factory.

The Stuebing Truck Co., Cincinnati, Ohio, is now manufacturing the elevating truck which forms the subject of the present description. It will be seen that this is a four-wheel truck and the frame is constructed entirely of steel, which combines the desirable properties of strength and lightness. The wheels are carried by roller bearings, which reduces to a minimum the amount of effort required to pull the truck. When the handle is raised to a vertical position, the platform

Fig. 1. Handle raised to lower Platform of Truck

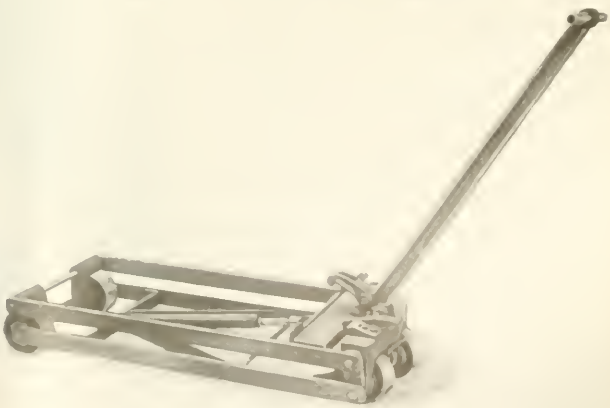


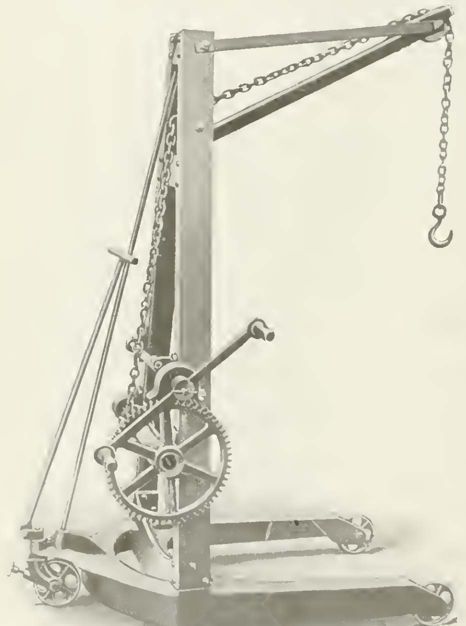
Fig. 2. Handle drawn forward ready to be released from Elevating Mechanism

of the truck is lowered, and when the handle is pulled forward the platform of the truck and the load are lifted by means of a hook which automatically disconnects, thus giving free use of the handle for pulling and steering the truck. The front wheels can be turned entirely around with the platform in the raised or lowered position, which permits of easy handling of the truck in close quarters or in making sharp turns.

A hydraulic check is provided for lowering the load, and by pressing a foot-treadle the load is released and lowered automatically under control of the hydraulic check. An important feature of this truck is that it is designed and constructed in such a way that it is an easy matter to make special trucks of any required width and length. The different sizes of trucks can be provided with wheels 6, 7 or 9 inches in diameter.

UNITED PORTABLE CRANE

The advantage of a portable crane for shop use is that it is capable of reaching all corners in the factory and eliminates danger of workmen straining themselves in an effort to lift heavy loads which cannot be handled by the regular traveling



Portable Crane made by the United Engine & Mfg. Co.

crane. The Manley "Hilite" portable crane which is a recent product of the United Engine & Mfg. Co., Hanover Pa., possesses the general advantages of portable cranes. In addition, the design has been worked out along lines which give this crane certain individual features. The superstructure is made entirely of steel, and it will be seen that the sections used are angles and channels which afford plenty of strength without making the crane unduly heavy.

The base is made of cast iron with ribs to give additional strength. As the base is of heavier construction than the superstructure, it will be evident that the center of gravity of the crane is quite low, and as a result, the possibility of tipping it over has been materially reduced. The casters and front wheel support the base at three points so that a uniform bearing is obtained regardless of possible inequalities in the floor. All twisting strains are thus eliminated. The crane is locked by a hand-nut on the caster, which can be operated by the foot-treadle without stooping. These cranes are made in four different sizes which have lifts of 6 feet 6 inches, 7 feet,

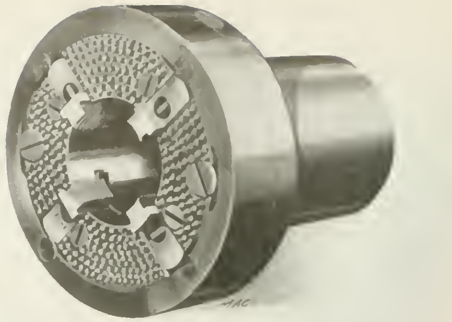


Fig. 1. National-Acme Adjustable Chaser Die

7 feet and 8 feet. The two smaller cranes have a lifting capacity of 1 ton and an overhang of 33 inches, while the two larger cranes have a lifting capacity of 2 tons and an overhang of 38 inches.

ADJUSTABLE CHASER DIE AND COLLET HOLDER FOR SPRING DIES

The National-Acme Mfg. Co., Cleveland, Ohio, has recently added to its line an adjustable chaser die that is adapted for use on all automatic screw machines and hand lathes. The chasers in this die are separate, so that they may be easily taken out and ground, and when the chasers are worn out they may be replaced. Another claim made for this tool is that in threading work over $1\frac{1}{4}$ inch in diameter, it can still be held extremely close to the required adjustment. The die has the same heavy one-piece body that is used in the National-Acme self-opening dies, and the chasers are held in accurate adjustment by a ring which has a bearing on hardened dowel pins seated against the backs of the chasers. Adjustment for tight or loose fitting threads is made possible by a screw in the side of the head, which operates on the principle of a micrometer gage after the screw holding the chasers has been loosened. To prevent side play, eccentric screws are turned against the sides of the chasers at the time the adjustment is made. These adjustable chaser dies are made in eight sizes which have capacities for threading work from 5/32 inch to $5\frac{1}{2}$ inches in diameter.

The chief advantage claimed for the collet holder for spring dies which has recently been placed on the market by the National-Acme Mfg. Co. is that a bearing is provided for the lands of the spring die for their full length. This is the means of overcoming difficulty which is sometimes experienced in holding spring dies to exactly the required cutting size. When the required adjustment has been made by turning the master chuck, the collar at the back of the die is screwed up against the bottom of the chuck, thus making the adjustment secure and permanent. The back of the die is slotted to receive two pins for keeping it from turning in the holder; and the holder is furnished with the necessary float to compensate for variations in the spindle alignment when starting the thread. This collet holder is made in six sizes to accommodate dies for cutting threads on work from $\frac{1}{4}$ up to 1 inch in diameter. Using the National-Acme spring dies, one holder has a capacity for a wide range of work.

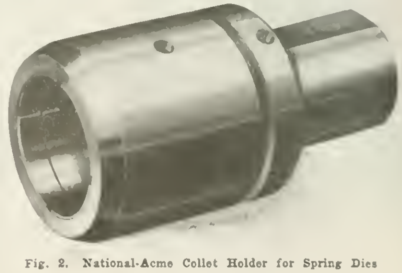


Fig. 2. National-Acme Collet Holder for Spring Dies

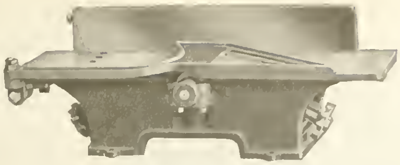


Fig. 1. Crescent Patternmakers' Bench Jointer

CRESCENT BENCH JOINTER

To meet the demand of patternmakers for a small jointer that can be set up on a work-bench, the Crescent Machine Co., 56 Main St., Leetonia, Ohio, has developed the tool shown in the accompanying illustrations. This machine is provided with a 4-inch head, which has ample capacity for most of the work handled in average pattern shops, and the percentage of work which can be done on this little jointer is further increased by the fact that most pattern work is relatively short. Having the jointer right on the work-bench, instead of having to carry the work to a machine, is naturally the means of saving a considerable amount of the patternmaker's time. The head of the machine is 4 inches wide and the overall length is 20 inches. It can be furnished with individual electric motor drive or belted to a countershaft according to the requirements of different shops. The design has been worked out along lines which provide ample strength for the work for which this machine is intended.

SKATE SHARPENER

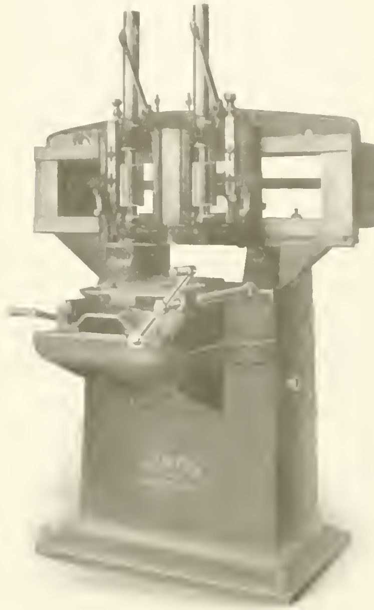
It is a matter of general knowledge that a satisfactory skate sharpener must hold the blade in such a manner that it may be fed evenly along the face of the grinding wheel. This requirement has been fulfilled in the skate sharpener which has recently been developed by the Luther Grinder Mfg. Co., Milwaukee, Wis. This company is making three different skate sharpening outfits. One of these consists of a grinding machine which is driven by foot-treadles and equipped with a skate grinding attachment; the other two consist of skate grinding attachments furnished for the use of those who already have the Luther foot-power grinder or the Luther power-driven bench grinder. The feature of the attachment is its extreme simplicity. It consists of two C-shaped clamps which hold the skate that is to be ground, and a metal baseplate. The method of using the attachment is so simple that it can be readily operated by any mechanic of average intelligence.

NEWTON PROFILING MACHINE

The accompanying illustration shows a profile milling machine which is a recent product of the Newton Machine Tool Works, Inc., Philadelphia, Pa. The design includes certain improved features which facilitate the rapid production of accurate work. The spindles are mounted on separate slides provided with vertical hand adjustment, and are carried by double tapered bronze bushings which have means of adjustment for wear. Each spindle slide is supported on a stout spring which acts as an automatic saddle return; the vertical movement of either spindle is controlled by the hand-lever at the right-hand side of the spindle, and the extreme limit of the vertical movement in either direction is controlled by adjustable limit stops.

The duplication of parts which have faces to be finished at two or more elevations is facilitated by the use of removable master gage strips which are notched to engage a latch to provide the proper location for each surface on the work. A clamp is provided for locking the spindle saddle in any position when such a procedure is found desirable. The pilot on the duplex saddle is guided across the master former by means of a hand-lever, which controls the compound spur gears that transmit motion to the pinion meshing with the rack on the bottom of the saddle; and for lengthwise operations, the table to which the master former and work are attached is moved through compound gears controlled by the other hand-lever on the machine.

The spindles are driven direct from the countershaft by continuous belts which are guided by sliding idler pulleys. Two spindle speeds are provided which are 840 and 1200 R. P. M. It will be seen that the table has two T-slots and is surrounded by a lubricant pan arranged with drains leading to a central reservoir at the rear of the machine. The principal dimensions are as follows: Maximum distance from end of spindles to table, $5\frac{1}{2}$ inches; minimum distance from spindles to table, 3 inches; fixed distance between spindle centers, 12 inches; size of table, 12 by 15 inches; width between uprights, 19 inches; and maximum table movement, $2\frac{1}{2}$ inches.



Newton Profile Milling Machine

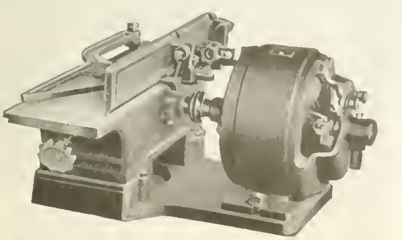


Fig. 2. Machine shown in Fig. 1 equipped with Individual Motor Drive

NEWTON BORING, TURNING AND FACING MACHINE

For use in machining a new automobile rear axle [illegible] the Newton Machine Tool Works, Inc., Philadelphia, Pa., has recently developed a boring, turning and facing machine which is illustrated and described herewith. It will be seen that this tool is provided with individual cross and longitudinal saddle feeds, with positive turret feed stops which give four positions to the longitudinal and two positions to the cross feed. The turrets have circular adjustment and six stations; they are arranged to carry the Acme type of removable tool-holders. The spindle head is equipped with a Horton three-jaw universal chuck at each end, which has sufficient capacity for holding work up to 12 inches in diameter. The

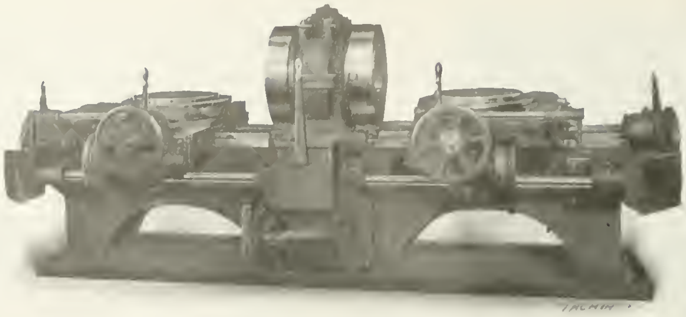


Fig. 1. Newton Turning, Boring and Facing Machine

drive is transmitted to the spindle through a large bronze spiral gear and hardened steel pinions from the three-step cone pulley shown in Fig. 2.

Motion for all saddle movements is taken from the main pulley shaft and transmitted to a gear-box which has a 5 to 1 ratio. The changes are obtained in this box without requiring the removal of gears; and all motions are independently clutched by hand-levers, while the release is effected by dogs on the saddles which engage adjustable stops set in the proper positions. The turrets are 18 inches in diameter on the working surface, and the maximum distance between the turrets is 6 feet 6 inches. This machine is also well adapted to the requirements of simultaneously trimming the closed ends and cutting excess metal from the open ends of two shells up to 12 inches in diameter; and under suitable conditions it may also be employed for performing the contour boring operations on the inside of the shells.

RICHARDSON-PHENIX CUTTING OIL FILTER

The increase in the use of automatic machine tools, the high speeds at which cutting tools are operated, the necessity of obtaining greater accuracy and exact duplication of parts, and the increased cost of labor and raw materials, have made it necessary for manufacturers to adopt more efficient methods of using cutting oils and compounds. As a matter of fact, there is no reason why the lubrication of cutting tools should not be done just as efficiently as any of the other work in the factory, and in progressive manufacturing plants this improvement in the application of cutting oil has already been accomplished.

In its simplest form, a modern cutting oil circulating and filtering system operates as follows: Clean cutting oil or compound contained in an overhead reservoir is carried by gravity through a system of piping to the various machine tools, and applies lubricant not only to the cutting tools but also to the bearings on the machines. The lubricant is generally delivered to each machine through a flexible metal hose, and a control valve is provided at each machine. The used lubricant is carried by gravity into the filter, where it is thoroughly purified; and this filter is so designed that it removes all scale, sand, metal chips, etc., and, when necessary, the oil is also sterilized so that it will be free from bacteria.

It is a well established fact that the use of pure cutting oil more than pays for the expense of purification, and the following outlines some of the advantages which have resulted from the use of pure oil in place of oil contaminated with chips and other foreign matter. In one factory it was found that cutting tools and drills lasted from one-third to two and a half times as long when lubricated with pure oil in place of dirty oil. In another factory difficulty was experienced from the foreign matter carried by the oil causing the sides of drills to wear down, thus producing a tapered drill which had a tendency to wedge in the work. This condition also gave trouble through the drill's generating an excessive amount of heat, interfering with the accuracy of the work and requiring an unnecessary amount of power to drive it. The use of clean oil removed the cause of the trouble and no further difficulty was experienced.

In a shop working on cast iron, the sand and scale carried by the oil were responsible for the rapid wearing down of the cutting edges of the dies and taps, which made it necessary for these tools to be sharpened at frequent intervals. Here, again, the cause of trouble was removed by using clean oil, which effected a saving in power in addition to reducing the cost of tool maintenance. In still another factory a large amount of time was lost owing to the sediment in the cutting oil interfering with the operation of self-opening dies. The use of filtered oil eliminated this tendency of the dies to stick, with the result that the output was materially increased.

Another advantage obtained from the application of a circulating oil system is due to the reduction of fire hazard. The danger of having large bodies of cutting oil around each machines is apparent, but this danger is practically eliminated where an automatic circulating system is employed, because the oil fed to each machine is carried off by the drain pipe as fast as it is delivered to the cutting tools. The only oil kept in the base of the machine is the small quantity adhering to the machine and to the chips, which is not sufficient to support a fire. Where the reduction of fire hazard is an important matter, the oil storage reservoir and filter may be put in a fire-proof compartment that is located at a distance from the main buildings.

Practically every manufacturer realizes the advantages of using a good grade of oil on machine tools. The matter of expense is not so important when an automatic circulating and filtering system is installed, because the cutting oil really becomes an investment and is used over and over again. The advantage obtained from using good clean oil for lubricating the bearings of machine tools is too obvious to require discussion. The Richardson-Phenix Co., Milwaukee, Wis., has recently brought out a line of filters which are especially designed for purifying cutting and lubricating oils, and the accompanying illustration shows one of these filters that has a magnetic separator for use in plants working on iron or steel. The following outlines the principle on which this equipment operates:

Used oil flows through the inlets *A* and passes down through strainer baskets *B* which remove the large chips. The oil then flows under the baffle plate *C* and

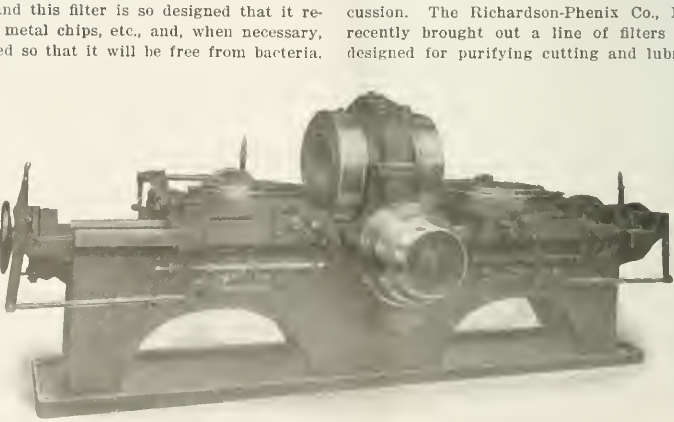
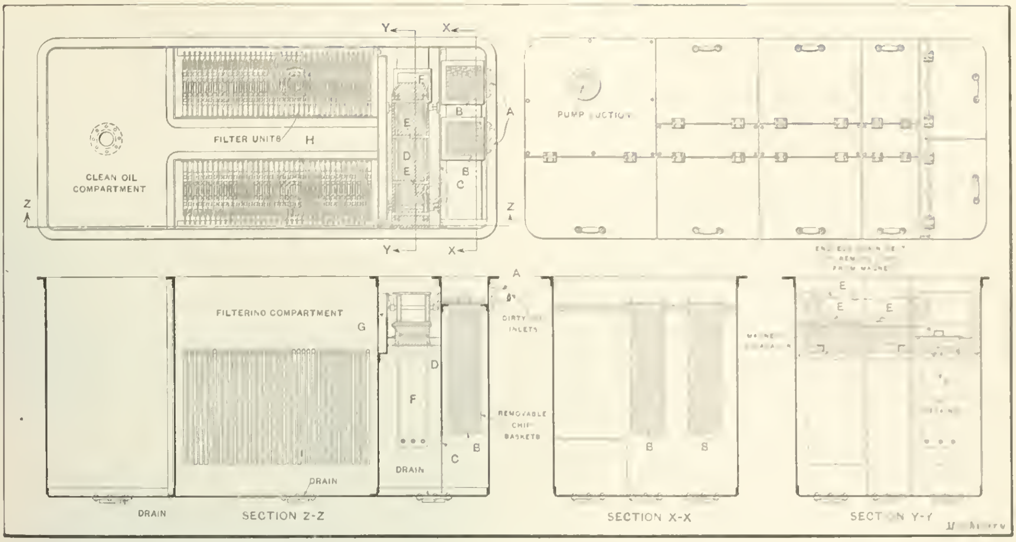


Fig. 2. Opposite Side of Newton Machine shown in Fig. 1



Richardson-Phenix Cutting Oil Filter, showing Method of Operation

up over the top of magnetic separator *D*, where iron and steel chips are removed from the oil. The accumulation of chips on the magnetic separator is removed by scrapers *E*, which are carried by an endless chain belt and travel across the face of the magnet to provide for scraping the chips off into retainer *F*. This retainer is provided with holes at the bottom which are covered by screens to allow the oil to drain out. Referring to the cross-sectional view on line Y-Y, it will be seen that the chip retainer can be slid to the right and lifted out to enable the chips to be removed.

After passing the magnetic separator, the oil flows over dam *G* into the filtering compartment, from which it passes through individual filtering units that remove the most minute particles of foreign matter. The clean oil collects in compartment *H*, from which it is pumped to the overhead reservoir ready to be once more delivered to the cutting tools. If the use of an overhead reservoir is objectionable, the clean oil can be pumped directly into the oil distributing pipes, a relief valve being provided to maintain the required pressure. The cutting oil filters built by the Richardson-Phenix Co. are made in a number of different types to meet various service conditions, and for use with all kinds of oils.

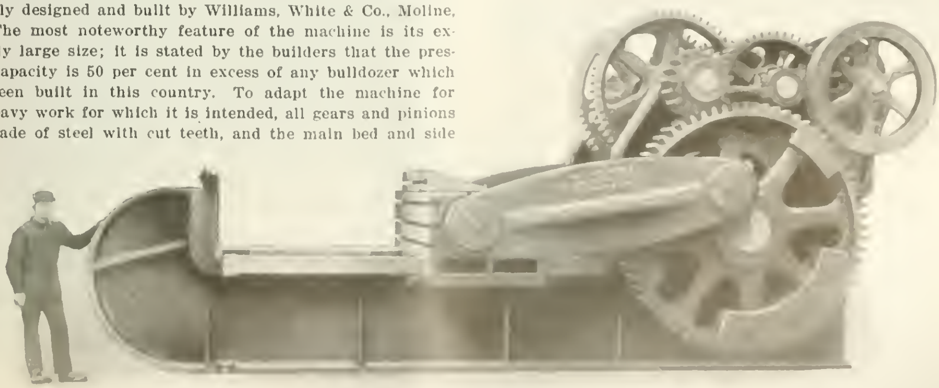
WILLIAMS-WHITE BULLDOZER

The No. 30 bulldozer illustrated and described herewith was recently designed and built by Williams, White & Co., Moline, Ill. The most noteworthy feature of the machine is its extremely large size; it is stated by the builders that the pressure capacity is 50 per cent in excess of any bulldozer which has been built in this country. To adapt the machine for the heavy work for which it is intended, all gears and pinions are made of steel with cut teeth, and the main bed and side arms are of cast steel. A large steel shaft is fitted through the sliding casting, the ends of which serve as trunnions.

Power is provided by a 75-horsepower electric motor which is direct-connected to the machine. It will be seen that the motor is carried on a bracket bolted to the housings. This bulldozer is provided with forward and reverse gearing, both movements being controlled by friction clutches. T-slots are provided in the cross-head and the end lugs are furnished with tapered gibs for adjusting the dies. An idea of the size of the machine will be gathered from the overall dimensions which are 26 feet long by 12 feet wide. The pressure capacity is 500 tons. This type of machine is being successfully employed for forging shrapnel and high-explosive shells, and produces a uniformly smooth and accurate shell forging.

"MOSHER" ADJUSTABLE DRILL BRACE

The "Mosher" adjustable drill brace which forms the subject of this description is made by the Adjustable Drill Brace Co., 100 High St., Boston, Mass., and is designed for the same class of work as a drill-post or "old man." The features of the Mosher drill brace are the pivoting post, the lightness of the tool, and the fact that it can be manipulated without requiring the use of wrenches. The brace is made of steel tubing and is so constructed that it may be easily taken apart and put in the tool chest.



Bulldozer built by Williams, White & Co., which has a Pressure Capacity of 500 tons

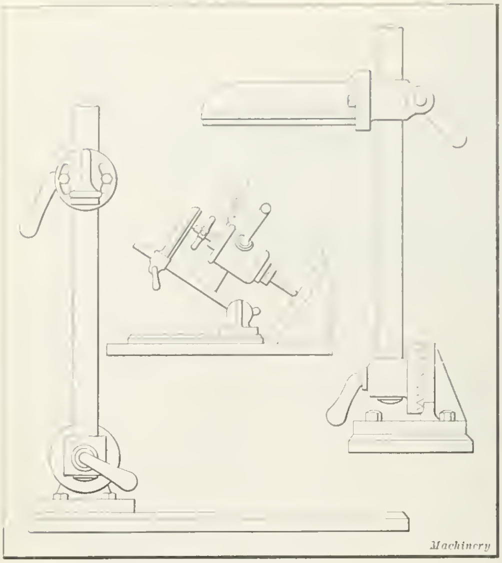


Fig. 1. "Mosher" Adjustable Drill Brace

Fig 1 shows the design of the tool and one of its numerous applications is illustrated in Fig. 2. The brace is made in three different sizes, which are known as Nos. 1, 2, and 3. The No. 1 brace weighs 16 pounds and is intended for use in connection with a small ratchet, air drill or electric drill. The post of this tool is 1⅛ inch in diameter and the arm is 8

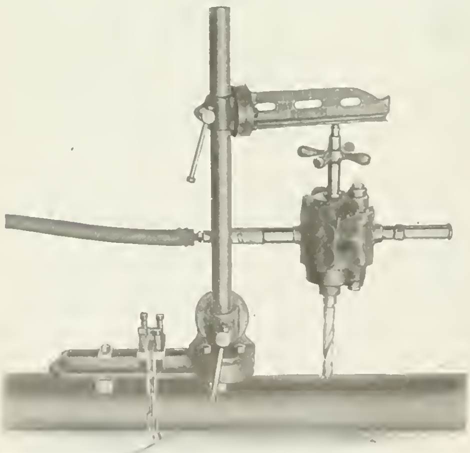


Fig. 2. No. 2 Adjustable Drill Brace used with Pipe Drilling Attachment

inches in length. The No. 2 brace is especially adapted for general machine shop and construction work. It weighs approximately 36 pounds, the diameter of the post is 1½ inch and the length of the arm is 11 inches. The No. 3 brace is adaptable for heavier classes of drilling. It weighs 52 pounds, the post is 2⅛ inches in diameter and the length of the arm, 15 inches. The pivoting feature enables the post to be set at the angle most suitable for the work, and means are provided for clamping the tool rigidly in this position.

I. O. C. OXYGEN AND HYDROGEN GENERATOR

The demand for oxygen and hydrogen for various industrial uses has grown very rapidly in the last five years. Certain lines of manufacture have been built up around the oxygen process of welding, such as welded tanks, steel barrels, automobile parts, tubes, etc., while for repairing broken machinery, for reclaiming castings, and for metal cutting of every nature, oxygen and hydrogen or oxygen and acetylene are used in steel mills, railroad shops, foundries and down to the smallest machine shop. Hydrogen likewise is in active demand. It is used more and more for cutting purposes, and for light welding; it is also used for lead burning, platinum smelting, in the manufacture of filaments for electric lamps, and to a very great extent in the new industry of hardening oils by the hydrogenation process. This rapid development in the uses of the two gases was facilitated by the introduction into this country of oxygen and hydrogen generating apparatus several years ago. Large users of one or both of these gases were thus enabled to obtain their supply direct from their

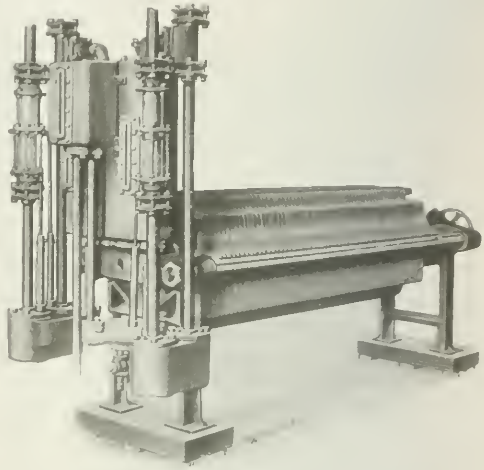


Fig. 1. I. O. C. Bipolar Oxygen and Hydrogen Generator

own generating plant at low cost, in a manner suitable to their individual requirements.

In the field of oxygen and hydrogen generating equipment, the International Oxygen Co., 115 Broadway, New York City, has set a standard for apparatus of workmanlike design and

Fig. 2. An Electrode and Diaphragm from I. O. C. Bipolar Generator

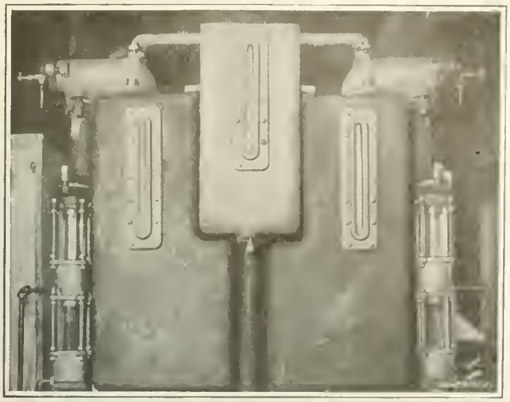


Fig. 3. Close View of Water Tank and Gas Domes

security of operation. The type of machine manufactured by this company known as the "I. O. C." unit type, is recognized as an efficient and high-class apparatus, and is in successful operation in numerous plants throughout the country. Today, the International Oxygen Co. is bringing out a new style oxygen and hydrogen generator under the name of the I. O. C. bipolar generator. This type of generator resembles outwardly a filter press such as is used in many chemical industries. Moritz, of Wasquehal, France, patented this type of apparatus in the United States and elsewhere, and I. H. Levin of the International Oxygen Co., who studied under Moritz and Flamand, perfected this machine.

Briefly described, the I. O. C. bipolar generator consists of a series of metallic plates (electrodes) clamped together in a heavy frame, electrically insulated from one another, and separated by diaphragms of porous fabric. Each pair of these electrodes forms a closed cell, divided by the diaphragm. These cells are filled with the electrolyte (caustic potash or soda) which acts as a conductor. An electric current admitted at one end plate passes on through the plates and the solution to the other end plate. In its passage, the current decomposes the water in the solution into the two gases—oxygen and hydrogen—which are released on opposite sides of each plate and emerge upward into the gas off-takes. The mingling of the oxygen and hydrogen in each cell or compartment is prevented by the diaphragm which, while permitting the passage of the fluid resists the passage of the gases, according to a well-known physical law. As the gases are released and withdrawn, the solution is automatically replenished from a supply tank. The operation is continuous so long as the current and electrolyte are supplied.

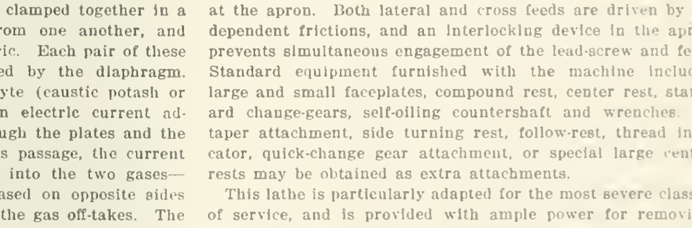
The two gas off-takes discharge into the two independent gas domes illustrated in Fig. 3, the gas emerging below the fluid surface through an inverted "U." It is apparent, then, that the pressure on both gases, clear back to the individual cells, is the same, being that determined by the hydrostatic head in the domes through the two independent risers from the water-feed manifold. This balanced pressure in both gas off-takes forbids any mixture of the gases and contributes to the balancing of pressures on the diaphragms. It will be noted that gas and water pressures are predetermined and constant. The gases, escaping from the gas off-takes, rise through the fluid in the gas domes and pass out through discharge pipes at the top of the domes, thence downward to purgers on each side. These purgers are closed boxes of cast iron filled with water to a certain level. The gases escape below the surface of this water, pass upward through it, and emerge thence through the supply lines to the gas holders. The function of these purgers is threefold: first, to catch any entrained fluid in the gas, second, to cool the gas, third, to a t as a watercheck valve protecting the pressure system of the generator from any undue pressure of the gas holders. The gases produced are extremely pure The oxygen has a purity of 99.6 per cent, and the hydrogen of 99.8 per cent.

BRIDGEFORD HEAVY-DUTY LATHE

In developing its new 26-inch cone-driven lathe, the Bridgeford Machine Tool Works, 225-227 Mill St., Rochester, N. Y., has made several noteworthy improvements. Among these may be mentioned the provision of further reinforcement for the bed by employing a center rib; and this rib carries a rack with which a pawl at the rear of the tailstock may be engaged when the lathe is employed on heavy work. The lathe can be furnished with either a three- or four-step cone pulley; a 5-inch belt is used on the three-step cone, and a 4-inch belt on the four-step cone. The apron is of the double-wall type, providing double supports for all shafts, gears and pinions. The machine is double back-geared, nine speeds being available with the three-step cone, and twelve with the four-step cone. By substituting a suitable sleeve and gearing for the cone pulley, variable-speed motor drive may be employed.

The headstock is provided with heavy bronze bearings, and the spindle bearings are self-oiling. The spindle is of high-carbon steel, ground to size, and has a hole 2 1/8 inches in diameter. The tailstock is designed to clear the compound rest when the lathe is employed for turning angular work, and is so arranged that it may be set over for taper turning operations. Two heavy binders are provided for clamping the tailstock in position. The carriage, compound rest and apron are heavily constructed and the direction of feed is changed at the apron. Both lateral and cross feeds are driven by independent frictions, and an interlocking device in the apron prevents simultaneous engagement of the lead-screw and feed. Standard equipment furnished with the machine includes large and small faceplates, compound rest, center rest, standard change-gears, self-oiling countershaft and wrenches. A taper attachment, side turning rest, follow-rest, thread indicator, quick-change gear attachment, or special large center rests may be obtained as extra attachments.

This lathe is particularly adapted for the most severe classes of service, and is provided with ample power for removing metal rapidly and accurately. To meet these requirements all parts are liberally proportioned. The following are the principal dimensions of the machine: Swing over ways, 27 inches; swing over carriage, 19 inches; distance between centers for 12-foot bed, 6 feet; range of spindle speeds, 6 to 260 R. P. M.; range of threads that may be cut, 1 to 14 per inch or 2 to 28 per inch; size of front spindle bearing, 4 1/2 by 7 1/2 inches; size of rear spindle bearing, 3 1/4 by 5 3/8 inches; diameter of hole through spindle, 2 1/8 inches; diameter of tail spindle, 3 15/16 inches; dimensions of lead-screw, 1 15/16 inch in diameter by 2 pitch, and weight of lathe with 12-foot bed, approximately 8000 pounds.



Bridgeford 26-inch Heavy-duty Cone-driven Lathe

NEW MACHINERY AND TOOLS NOTES

Nut Die: Mummert-Dixon Co., Hanover, Pa. A nut die for use in re-threading studs on which the thread has become bruised. The use of this die enables the stud to be re-threaded without removing it from the machine.

Cast Vanadium Steel Die-blocks: Sivyer Steel Casting Co., Milwaukee, Wis. Cast vanadium steel die-blocks which are said to be suitable for use in place of hammered carbon steel blocks in making dies for a great variety of purposes.

Soft Metal Hammer: Bauth Mfg. Co., 901 Gerke Bldg., Cincinnati, Ohio. A soft metal hammer adapted for general machine shop use, and also for use in sheet metal shops, garages, and other places where such a hammer is necessary.

Alligator Shear: Doelger & Kirsten, Milwaukee, Wis. A machine adapted for service in warehouses and mills for cutting bars, angles, flats and rounds. The shear is equipped with an automatic stop and is made with 12, 18, 21 or 24 inch blades.

Oil Grooving Attachment: Cleveland Machine Tool Works, Cleveland, Ohio. An oil grooving attachment for use on the horizontal boring machines of this company's manufacture. The attachment provides for cutting internal or external oil grooves.

Bench Vise: Luther Grinder Mfg. Co., Milwaukee, Wis. This vise is intended for light assembling work and is not a general-purpose vise. An attachment is provided for use in the vise which adapts it for handling pipes, tubing and other cylinder work.

Electric Welder: National Electric Welder Co., Warren, Ohio. An automatic electric welding machine for welding rings. The machine takes No. 11 wire from the coil and automatically welds, forms and cuts off the rings at the rate of 60,000 per day.

Pressed Steel Truck Wheel: W. J. Clark Co., Salem, Ohio. The advantages of this truck wheel are that it is extremely light and still provides the necessary strength for supporting the maximum rated loads of the different types of trucks for which it is intended.

Electric Hoist: Dake Engine Co., Grand Haven, Mich. A hoist equipped with the usual form of crane hook, and two wire ropes wound on individual drums. The hoist is made in two styles, one of which has a hook suspension while the other is equipped with a trolley to run on a rail.

Portable Electric Drill: Standard Electric Tool Co., Cincinnati, Ohio. A drill made in 3/16, ¼, and 5/16 inch sizes, which weigh 6, 7, and 8 pounds, respectively. The two smaller tools are fitted with three-jaw geared chucks, and the largest size with a two-jaw screw chuck.

Test Indicator: William H. Simpson, 30 Church St., New York City. A test indicator which can be readily attached to a surface gage or caliper. Each graduation represents 0.001 inch. The instrument is fitted with a hardened steel contact point and the working parts are protected by a case.

Portable Air Compressor: Zin-Ho Mfg. Co., 1324 Michigan Ave., Chicago, Ill. This unit consists of an air compressor driven by a gasoline engine. The entire outfit is mounted on a four-wheeled truck so that it may be pulled about the shop to supply compressed air at any point where it is required.

Pattern Shop Miller: Oliver Machinery Co., Grand Rapids, Mich. A vertical milling machine for use in the making of wooden patterns. The machine is adapted for a great variety of operations, and by using a dividing head it will be found particularly useful for making gear patterns and similar work.

Portable Crane: Zinke Co., Inc., 1322 Michigan Ave., Chicago, Ill. The distinctive feature of this crane is that it has no chains, the load being raised by raising the arm in its vertical support. This raising of the arm is effected by means of a crank which turns the elevating screw through a train of gears.

Universal Right-angle Drive: Diamond Clamp & Flask Co., Richmond, Ind. A joint which consists of a series of universal joints that are connected. These joints are contained in an oil-tight elbow and run in oil. The device may be used in place of gears or quarter-turn belts, and effects a considerable saving of space.

Shop Truck: Orenstein-Arthur Koppel Co., Koppel, Pa. An electric shop truck made in various sizes, and known as the "Electromobile." Four helical steel springs support the frame, which have sufficient carrying capacity so that they will not be fully compressed under the full load for which the truck is adapted.

Electric Grinder: Standard Pattern Works, Erie, Pa. A small electric grinder designed for use in pattern and woodworking shops, and also in machine shops and tool-rooms. The table of the machine may be set in an inclined position at any angle between horizontal and 45 degrees, to provide for grinding beveled work.

Shaft Coupling: Coronum Equipment Co., 110 Fulton St., New York City. This shaft coupling consists of three essential parts which are a split sleeve and two coupling members. The sleeve is tapered to fit the couplings and when the latter are screwed upon the tapered sleeve, compression is obtained for securing the shaft.

Belt Tightener: Cleveland Fabric Belting Co., 1473 W. 110 St., Cleveland, Ohio. A device for use in taking the slack out of belts ranging from 1 to 36 inches in width. It consists of clamps applied to either end of the belt which are drawn back to secure the required tension, after which the ends of the belt are cemented together.

Acetylene Generator: Metals Welding Co., Cleveland, Ohio. An acetylene generator in which every seam and fitting is welded. The motors used to operate the feeding mechanism are controlled by a sensitive diaphragm regulator which affords an even pressure on the gas and assures delivering an accurate supply of carbide to the generator.

Oil Cleaning Machine: De La Vergne Machine Co., New York City. A tank for use in washing oil which has been used in bearings. The oil to be cleaned is introduced into the tank which is about half filled with water, resulting in the impurities separating out in the form of a sludge which collects in a layer between the oil and water.

Hydro-pneumatic Press: Metalwood Mfg. Co., Detroit, Mich. A type of press designed for use in conducting physical tests on 105, 120, and 149.1 millimeter high-explosive shells. In conducting these tests an internal pressure is applied to the inside of the shell, and it is for the development of this pressure that the presses are employed.

Arbor Press: Special Tool Co., West Hancock, Mass. An arbor press equipped with a V-plate having a series of holes on both sides. The design is such that any of the holes or any section of the slot can be placed directly under the ram without detaching the plate from the press. The ram is actuated by a hand-operated rack and pinion.

Electric Butt Welder: Detroit Electric Welder Co., Detroit, Mich. The important feature of this machine is that it is equipped with an improved form of equalizing clamp for holding stock which varies slightly in size. The machine is constructed in such a way that a single movement of a foot-treadle clamps both pieces which are to be welded.

Portable Grinding Machine: Stow Mfg. Co., Binghamton, N. Y. A grinder which is driven by a flexible shaft that receives power from an electric motor mounted on a truck. From this it will be evident that the entire outfit may be easily transported to provide for taking the wheel to the work instead of having to bring the work to the wheel.

Vertical Milling Machine: George Gorton Machine Co., Racine, Wis. A vertical milling machine particularly adapted for grooving the timing rings for shrapnel shell fuses. This is the Gorton vertical milling machine equipped with a special work-holder and set by automatic stops to insure the rapid production of duplicate work. One operator can attend to two machines.

Shear: Danville Foundry & Machine Co., Danville, Pa. The important feature of this machine is that the knives are so driven that a dwell is provided at the top of the up-stroke to allow ample time for putting the material in place ready for the next shearing operation. The capacity of the machine is up to 3-inch rounds, and the rate of production twenty cuts per minute.

Shell Grinding Machine: Guy G. Townsend, Winchendon, Mass. A machine equipped with hand feed, which is particularly adapted for grinding shrapnel and high-explosive shells. The wheel is 20 inches in diameter by 4 inches face width, and stops are provided on the carriage and an adjustable dial on the screw to show when the work has been ground to the required diameter.

Extension Tap Holders: Allen Mfg. Co., Hartford, Conn. Extension bars which can be used in connection with taps of standard lengths to do away with the necessity of making up special taps for work where exceptional length is necessary. The extension bar has a socket at one end which receives the squared end of the tap, and is squared at the opposite end to fit the tap wrench.

Portable Electric Drill: Neil & Smith Electric Tool Co., Cincinnati, Ohio. The outstanding features of this tool are strength of construction and simplicity of design. The motor is of the universal type, i. e., it will run on either alternating or direct current without showing a perceptible change of speed. The tool has a capacity for driving drills up to ½ inch in diameter, and weighs 14 pounds.

Shell Grooving, Waving and Undercutting Machine: Jenckes Machine Co., Ltd., Sherbrooke, Quebec, Canada. This machine is adapted for cutting the band seats on 4.5- and 5-inch shells. The work is held in an air-operated collet chuck, and the drive is transmitted through cut gearing. The machine is equipped with a single friction clutch pulley which may be belted direct to the lineshaft.

Universal Sawing Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A universal cold saw cutting-off ma-

chine particularly adapted for use in shops engaged in bridge and other structural steel work. The machine is equipped with a compound table which may be swiveled for performing various angular cutting and milling operations, and it is an easy matter to relocate the table in the zero position when square cuts are to be made.

Heat-treating Furnaces: Bellevue Furnace Co., Detroit, Mich. Four types of heat-treating furnaces, one of which is a gas heated furnace for high-speed steel, which is provided with a pre-heating oven. The second and third outfits are cyanide furnaces heated by gas or oil and provided with pre-heating ovens. The fourth is a combination outfit consisting of a gas or oil heated oven furnace, a cyanide bath and a lead bath.

Die Filing Machine: W. D. Rearwin, 341 Mill Ave., Grand Rapids, Mich. This die filing machine is provided with a universal adjustment, and the machine takes files from 12 inches rough down to "needle fine." The file is released from the work on the up-stroke, and the length of the stroke may be adjusted from zero to 7 inches. The table is 17 by 18 inches, and it may be tilted through any angle up to 7 degrees in either direction.

Collapsible Tap: Murchey Machine & Tool Co., Detroit, Mich. This tap has been especially developed for the performance of tapping operations on shrapnel and high-explosive shells. There are two sets of chasers 4.888 and 5.083 inches in diameter, each of which has 11 threads per inch. Both sets of chasers are equipped with a collapsing mechanism which is the same as that employed on standard collapsible taps made by this company.

Thread Miller: Automatic Machine Co., Bridgeport, Conn. A 3-inch internal thread milling machine in which the spindle is advanced to the work by means of a lead-screw which has the same pitch as that which it is desired to produce on the work. The lead-screw is a shell which is fastened to the exterior of the spindle at the rear of the main bearing and its lead is transmitted directly through the lead-nut without gearing. The weight of the machine is approximately 945 pounds.

Cartridge Case Heading Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A press designed for use in heading brass cartridge cases after they have been indented. The heading operation is accomplished by inserting a fullering block between the head of the press and the top of the cartridge case which is held in a suitable die. As the pressure is applied, the fullering block causes the brass to flow outward in all directions and forms the head on the case.

Roll Grinding Machine: Norton Grinding Co., Worcester, Mass. An exceptionally large grinding machine constructed for the Carnegie Steel Co. for use in roll grinding. This machine weighs 50 tons and has a capacity for grinding rolls up to 21 feet in length by 50 inches in diameter. The rolls can be swung on centers or supported on their necks, and the machine is capable of removing from 2 to 4½ cubic inches of metal per minute when using wheels 24 inches in diameter by 8 inches face width.

Shell Turning and Boring Machines: Amalgamated Machinery Corp., Chicago, Ill. These are single-purpose machines especially adapted for use in the manufacture of heavy shells. The turning machine has a range for shells from 4.5 to 12 inches in diameter. The range of feeds is from 0.026 to 0.200 inch, and the carriage is provided with quick return and automatic stops. The boring machine is of somewhat similar construction. Both hand and power feed are provided and the hand feed may be used either to accelerate or retard the power feed. The range of power feeds is from 0.006 to 0.200 inch.

Combination Miller and Shaper: Grayson Tool & Mfg. Co., Indianapolis, Ind. A combination machine which differs considerably from other machines for the performance of those classes of work for which the present tool is adapted. The machine is not only adapted for cutting in either direction when used as a vertical shaper or slotter, but it is also provided with vertical and horizontal milling spindles which may be used for drilling, boring or cherrying operations, in addition to regular milling. The machine is particularly suitable for use in the tool-room for working on dies, gages and fine tools of numerous kinds.

Engine Lathe: Dalton Machine Co., 1911 Park Ave., New York City. A single back-geared lathe designed to meet the requirements of general machine shop work. This is nominally a 14-inch machine, but it has an actual swing of 16¼ inches over the ways and 8 inches over the carriage. The cross-slide has a travel of 10 inches and the maximum distance between centers is 36 inches. The range of threads which can be cut is from 3 to 40 per inch, including 11½ per inch. The travel of the tailstock spindle is 5 inches, and the ratio of the back-gears is 7 to 1. The maximum weight of the machine with a six-foot bed is 1850 pounds.

QUOTATIONS OF WHOLESALE METAL PRICES

Week Ending December 24

Aluminum, pig, per pound, ton lots	$ 0.60
Antimony, Asiatic, per pound	0.39
Black sheets, No. 28, per 100 pounds, Pittsburg	2.50
Copper, electrolytic, per pound	0.21
Copper, lake, per pound, New York	0.21
Galvanized sheets, No. 28, per 100 pounds, Pittsburg	4.75
Iron bars, refined, per 100 pounds, Pittsburg	1.90
Iron, pig, foundry No. 2, per ton, Philadelphia	19.00
Iron, pig, basic, valley, furnace, per ton	18.00
Iron, pig, Bessemer, per ton, Pittsburg	19.95
Iron, pig, gray forge, per ton, Pittsburg	18.10
Lead, per pound, New York	0.05½
Nails, cut, per 100 pounds, Pittsburg	1.90
Nails, steel wire, per 100 pounds, Pittsburg	2.00
Spelter, per pound, New York	0.17½
Steel angles, per 100 pounds, Pittsburg	1.70
Steel bars, per 100 pounds, Pittsburg	1.80
Steel beams, per 100 pounds, Pittsburg	1.70
Steel billets, forging, per ton, Pittsburg	52.00
Steel rails, per pound, at mill	0.01¼
Steel tank plates, per 100 pounds, Pittsburg	2.25
Tin, per pound, New York	0.38½
Tin plate, per 100-pound box, New York	3.74
Wire, barbed, galvanized, per 100 pounds, Pittsburg	2.85

The urgent demand for metals continues, and prices are generally higher. Quotations are variable and unreliable as a general index of prices obtained. Pig iron of all grades will be quoted at $20 a ton by January 1, probably. Steel billets have advanced $2 a ton; sheet and tin plate stock at recent sales brought $31 for billets and $32 for bars. Prices as high as $40 a ton have been quoted for rerolling billets. Forging billets are selling as high as $55 a ton. While steel bars are nominally quoted at $1.80, no sales are being made below $2. Bar iron is maintained at $1.90. Wire mills are sold six months ahead and pig iron is being bought for the latter half of 1916. An indication of the profound effect of the war on metal prices is in the price of platinum. While this is a precious metal, it is used to such an extent in the chemical industry in the manufacture of acids required for explosives as to be indispensable. A few months ago, platinum was selling at about $40 an ounce. It now commands $100 an ounce, but is practically unobtainable at any price because of the embargo laid on its exportation by the Russian, French and German governments.

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CORRECTION—"MAKING SLUSH CASTINGS"

An error appears in the statement of allowable impurities in high-grade spelter and the intermediate grade of spelter on page 378 of this number. The paragraphs should read as follows:

High-grade spelter shall contain not over 0.05 per cent cadmium, 0.07 per cent lead, and 0.03 per cent iron, and the sum of these impurities shall not exceed 0.10 per cent

The intermediate grade of spelter shall contain not over 0.5 per cent cadmium, 0.2 per cent lead, and 0.03 per cent iron, and the sum of these impurities shall not exceed 0.5

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STEAM RAILWAY STATISTICS FOR YEAR ENDING JUNE 30, 1914

The Interstate Commerce Commission's report for the year ending June 30, 1914, covers 247,397.59 miles of line operated, including 11,298.88 miles used under trackage rights; the aggregate mileage was 377,102.45 miles, of which 247,397.59 miles were classified as single track, 27,604.12 miles as second track, 2696.03 as third track and 2071.45 as fourth, fifth and sixth tracks; 97,333.26 miles were yard tracks and sidings. The increase over 1913 in the aggregate length of all tracks was 7522.65 miles. There were 64,760 locomotives in service, an increase of 1382 over the number for the preceding year. Of the total number of locomotives, 14,612 were classified as passenger, 38,752 as freight, 10,081 as switching and 1315 were unclassified. The total number of cars of all classes in the service was 2,503,822, as follows: Passenger service, 53,466 cars; freight service, 2,325,647; company's service, 124,709. The total number of persons on the pay-rolls was 1,695,483, a decrease of 119,756 from the number employed in the preceding year. The total amount of wages and salaries paid was $1,373,422,472. The total revenue was $3,047,019,908 and the total operating expenses were $2,200,313,159.

NEWARK WORM-WHEEL SEGMENT HOBBING MACHINE

Two worm-wheel segments are used in the carriages of United States howitzers for the purpose of elevating the gun. In the smaller sizes these are one-piece steel castings containing a hobbed worm-wheel sector which meshes with a Hindley worm. The development of means for hobbing these segments automatically presented some unusual features, but the problem has been worked out very successfully by the Newark Gear Cutting Machine Co., 69 Prospect St., Newark, N. J. The machine employed is a special form of this firm's No. 5 automatic spur gear cutting machine, shown in Fig. 1, the capacity of which has been increased to swing work up to 96 inches in diameter as compared with a swing of 60 inches on the standard machine. The modifications of the design also provide additional travel for the work-head, and the special machine is capable of cutting worm-wheels or worm-wheel segments in addition to spur gears. The cutting of spur gears and worm-wheels is really incidental to the use of the machine for automatically hobbing interrupted worm-wheel segments or those which cannot be cut economically by completely revolving the work.

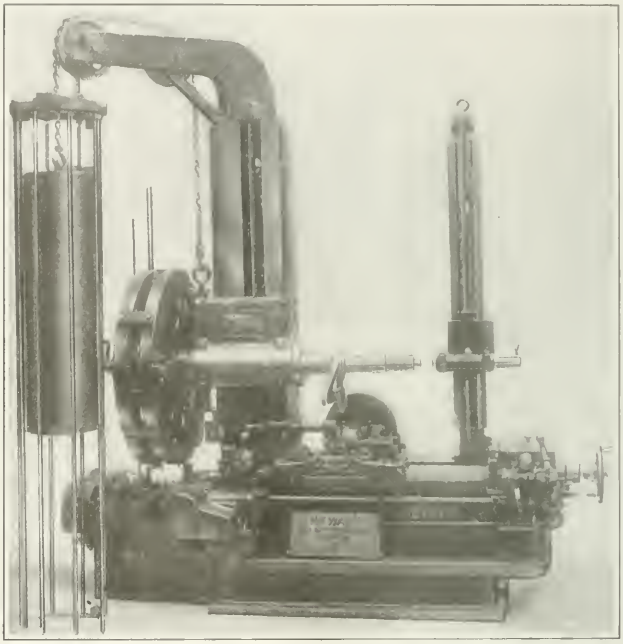


Fig. 1. Newark No. 5 Gear-cutting Machine adapted for hobbing Worm-wheel Segments

An example of such a worm-wheel segment is shown at *A* in Fig. 2, and this is the class of work for which the machine was especially designed. This form of segment is cut entirely automatically by gearing the work-spindle in unison with the cutter-spindle, revolving the hob through its cutting movement until the small gap at the end of the worm-wheel teeth is reached, then lifting the work away from the hob, and reversing and returning it to the free end of the segment, at which point it is lowered and once more engaged by the hob. Each time the work is lowered it descends a little further than on the previous downward movement, and this feeding motion is continued until the correct center distance is reached, at which point an automatic stop disengages the feed. An earlier model of one of these machines has been in use for several years; during a part of this time it has been employed on night work, and it is stated that the machine has always performed its functions correctly.

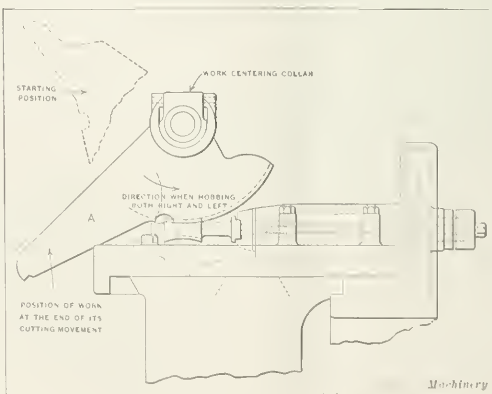


Fig. 2. Diagram showing Method of Operation on a Worm-wheel Segment

It was mentioned that the machine is capable of cutting spur gears and worm-wheels in addition to worm-wheel segments. When engaged in cutting spur gears, the work-spindle head is raised or lowered by power to bring it to the proper position on the column, where it is rigidly secured. For this work, a rotary gear cutter is used in place of a hob, and this cutter is fed through the work and then returned rapidly, after which the work is positively indexed to bring it into position for cutting the next tooth space. This operation is the same as that of the standard No. 5 gear cutting machine of which this is a special type. When the machine is employed for cutting full circle worm-wheels, the work-head is set free to move on the column, the cutter-head is locked in such a position that the hob is located at the center of the worm-wheel face, and the feed and return clutches are locked in their neutral positions. The gearing is engaged to connect the cutter and work arbor drives in the proper ratio for the worm-wheel to be cut, and the feed mechanism for the work-head is brought into action.

When the machine is engaged in cutting worm-wheel segments, in addition to the movements described for use in the cutting of worm-wheels, a positive work-head raising clutch is connected and the mechanism is engaged for breaking and making connection with the worm-wheel ratio gearing, as well as for reversing this gearing. All power is taken from the constant-speed shaft *A*, Fig. 3, and the drive is transmitted to the cutter through bevel gears which make connection with shaft *B*. Shaft *C* is geared so that its speed is a multiple of the cutter-spindle speed, and this shaft transmits power to the ratio drive reversing clutches *D*, *E*, and *F*. Clutch members *D* and *E* revolve in opposite directions. The ratio drive is carried on through change-gears *G*, *H*, and *I* to the master worm and wheel from which it is transmitted to the work-spindle.

From shaft *B* power is transmitted through gears *J*, *K*, and *L* to shaft *M*, and then through gears *N* and *O* and shaft *P* to gears *Q* and *R*. Gear *R*, in turn, drives clutch member *S*, and when clutch *T* is thus revolved it drives gears *U* and *V* and shaft *W*, from which the power is transmitted to gears *X* and *Y*. The ratio is such that gear *V* makes one revolution to each half revolution of gear *Y*, and this gear *Y* carries a crankpin *Z* which acts in conjunction with link *a* to transmit motion to a second crankpin *b* and gears *c* and *d*. Through shaft *e* power is transmitted to the double stud *f* which

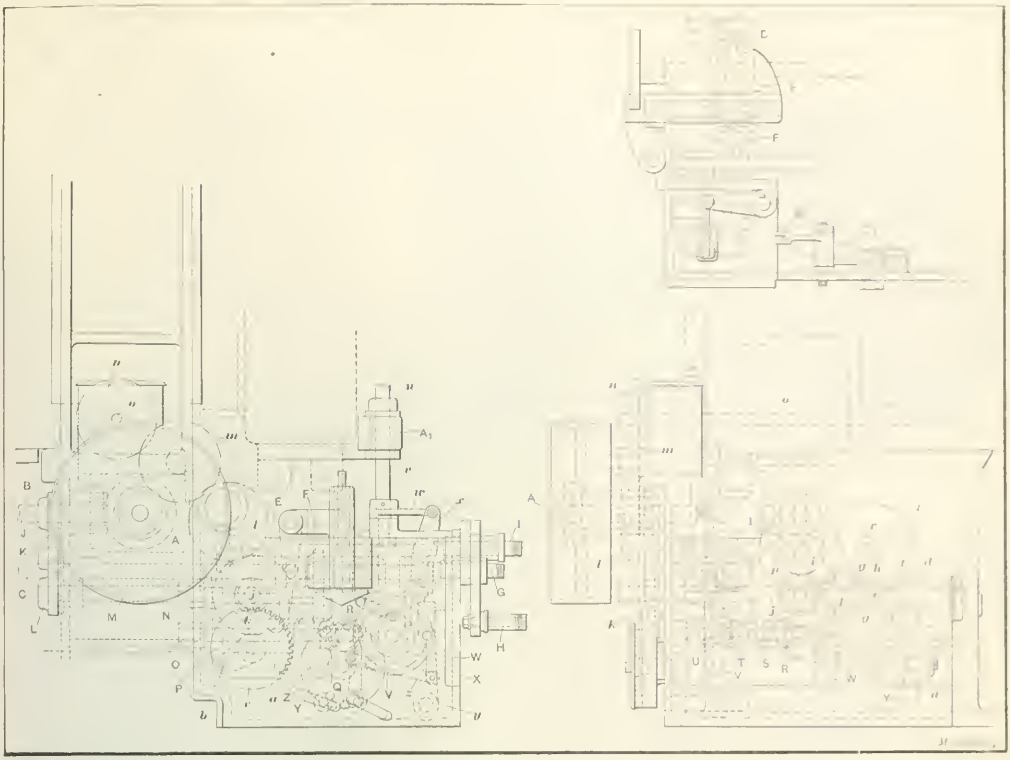


Fig. 3. Details of Mechanism on Machine shown in Fig. 1

carries bevel gears g that engage bevel gear h. In this way the motion is transmitted to bevel gear i, then through shaft j and gears k, l, m, and n to shaft o, whence it is transmitted through bevel gears to the head raising screw, which is not shown.

A small amount of power is by-passed from ratio gear-shaft I through gears p and q to shaft r, which carries a crank-disk operating a pawl that revolves a ratchet wheel on worm-shaft s. From this point the motion is carried on to worm-wheel t, which is secured to bevel gear h, and also acts on the head raising screw. A large ring, which is not shown in the illustration, is mounted on the work-spindle and carries two adjustable dogs that engage lever u, causing shaft v to oscillate. Through link w, levers x and y and link z, engagement is made with clutch members T and S, thus operating the raising and lowering mechanism for the work-head. The feeding train containing the worm-wheel t is stopped by an arm on lever bearing A_1, which engages an adjustable dog on rod B_1, raising the ratchet pawl through engagement with lever C_1.

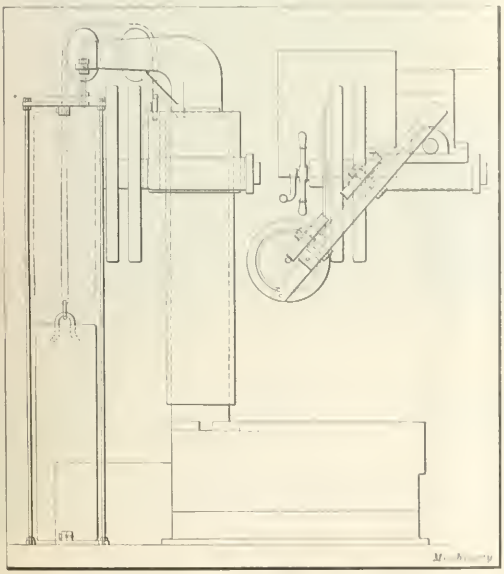


Fig. 4. Arrangement of Counterweight for Work-spindle Head

The raising and lowering gear train simultaneously operates the sliding clutch member F, which results in reversing the ratio train. To insure correct engagement of the ratio train so that the hob will always catch the right tooth, clutch members D, E, and F are made with two teeth of different widths, the arrangement being shown in detail in Fig. 5, so that they can only be engaged when the large tooth is opposite the large space. The purpose of employing two teeth was to provide for easier disengagement of the clutches under strain. As the driving clutch members are geared so that their speed is a multiple of the hob spindle speed, they always

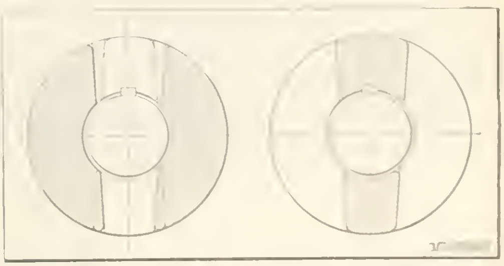
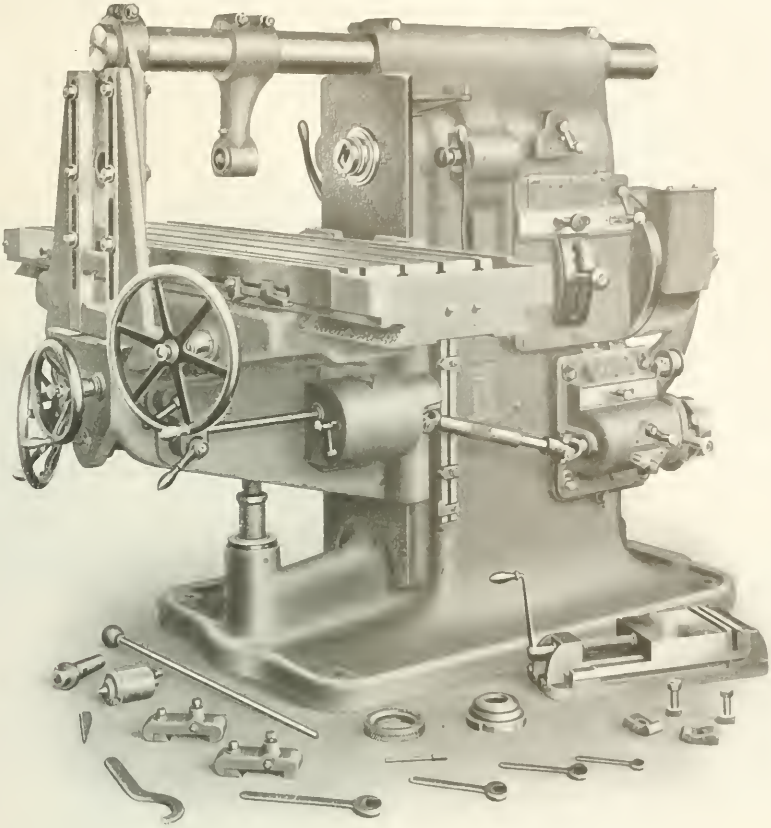


Fig. 5. Form of Clutch employed to insure having Hob always catch the Right Tooth



Brown & Sharpe Heavy Service Plain Milling Machines

in addition to having true, carefully finished bearings, have the sturdiness in design to give them adequate support and prevent them from sagging out of alignment under stresses. The No. 5-B Heavy Plain Machine shown above is characteristic of our line of heavy service milling machines in this respect.

Take careful note of the massive proportions of this frame and the liberal size of the knee saddle and table. Observe the width of the column and the length of the bearing it gives the knee. There is no sagging or warping under heavy loads with construction like that. And the machine is consistent throughout. Every part is proportionately strong and well supported—all designed with these ends in view—heavy service—accurate work—fast production—long life.

We shall be glad to tell you more about this machine. Descriptive literature free on request.

Providence, R. I., U. S. A.

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, [illegible]

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Man[illegible] Sheffield, [illegible] & Co., Frankfort a M. [illegible]; V. Loweuer, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway, [illegible]ardt & [illegible] Fenwick Freres & Co., [illegible] France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain. The F. W. Horne Co., Tok[illegible] [illegible] Melbourne, Australia; F. L. Strong, Manila, P. I.

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engage at the same point on the hob. Two master worm-wheels are provided, the inner one for use in accurate spur gear cutting and the outer one for intermittent worm-wheel work. The reason for providing two worm-wheels in this way was because it was thought advisable to provide against errors due to excessive wear in those sections of the worm-wheel which receive the greatest amount of service in cutting worm-wheel segments. The successful operation of the machine is in a great measure due to the counterbalancing of the work-head, as shown in Fig. 4. To counteract the unbalanced pull of the weight on the column, a screw and jam nuts of generous proportions are provided so that the cage surrounding the weight takes the direct strain of the weight and thus increases the stability of the machine as a whole.

* * *

SECRECY VS. ORIGINALITY

One of the reasons for not receiving visitors in manufacturing plants, seldom admitted, is the fear that the visitors may recognize methods and designs stolen bodily from competitors. The usual plea for maintaining a shop closed to visitors is that valuable methods have been developed at great expense and trouble, and that no competitor should be given knowledge of them, either directly or indirectly! An instance illustrating the inconsistency of some such concerns came to our attention not long ago. A concern had accorded the privilege of publishing a description of certain methods developed in its plant, and the article duly appeared; whereupon a competitor raised a dreadful howl because of alleged discrimination. As a matter of fact the "howler" had refused to permit a description of a development in use in his plant—and in several other manufacturing plants—to be published. He dared not claim credit for it. For such cases there is little hope in this world, because the individuals concerned having little or no originality cannot display to the public the generosity necessary to obtain for themselves the recognition they so greatly crave.

* * *

AN EXAMPLE OF SPECIALIZATION

The superintendent of an automobile factory in Indiana was interviewing an applicant for a job.

"Have you ever had any experience on automobile work before?"

"Sure! I worked for the Ford Motor Co. for three years."

"That sounds good. You ought to know something about automobiles then. What department did you work in?"

"The assembling department."

"Well that's all right, but tell me something about the work you did."

"Oh, I gave nut No. 16 two turns on its stud."

* * *

PERSONALS

Thomas F. Fournier, chief engineer of the Becker Milling Machine Co., Hyde Park, Boston, Mass., has resigned the position to become general manager of the Standard Machinery Co., Mystic, Conn.

Albert Vuilleumier, assistant chief engineer of the Becker Milling Machine Co., Hyde Park, Boston, Mass., has resigned the position to become works manager of the Standard Machinery Co., Mystic, Conn.

John Lynch, formerly of the Baird Machine Co., Bridgeport, Conn., has been made superintendent of the Blake & Johnson Co.'s plant in Waterville, near Waterbury, Conn., succeeding Louis A. Crittsinger, resigned.

Edgar W. Cleveland, for some time employed by the National Automatic Tool Co., Richmond, Ind., as mechanical engineer, has returned to his former position in the designing department of the Fox Machine Co., Grand Rapids, Mich.

John W. Bryce, for the past four years superintendent of the steel ball department of the New Departure Mfg. Co., Bristol, Conn., has resigned his position to become general superintendent of the Abbott Ball Co., Elmwood, Conn.

B. W. Burtsell, assistant factory manager of the Packard Motor Car Co., Detroit, Mich., and formerly of the Brown & Sharpe Mfg. Co., Providence, R. I., has taken a position as sales manager with the Whitney Mfg. Co., Hartford, Conn. Mr. Burtsell will be assisted by W. W. Totman and H. L. Sevin.

Charles A. Odegaard, for the last seven years connected with the Marshall & Huschart Machinery Co., Chicago, Ill., as salesman and correspondent, has joined the Federal Machinery Sales Co., 12 N. Jefferson St., Chicago, as secretary. James Jay Sheridan has resigned his position as secretary but retains his directorship in the company.

Campbell Scott, who for the last eleven years has been manager of the Otis Elevator Co.'s works at Yonkers, N. Y., has resigned his position, taking effect the end of December. Before joining the staff of the Otis Elevator Co., Mr. Scott had, for eight years previous, been associated with the C. & C. Electric & Mfg. Co. of New York, as secretary and general manager.

* * *

OBITUARIES

Thomas J. Hennessey, formerly division master mechanic on the Michigan Central Railroad, died December 4, aged seventy years. Mr. Hennessey was retired from service on account of age limit, February 1, 1915.

Joseph Fahys, reputed to be one of the first watchcase manufacturers in America, died December 11, at his home in Sag Harbor, Long Island, aged eighty-three years. He was president of Joseph Fahys & Co., New York City.

H. J. Bierhart, superintendent of C. C. Bradley & Son, Syracuse, N. Y., makers of power hammers, died at his home in Syracuse, November 25, after a brief illness with pneumonia, aged seventy-one years. Mr. Bierhart left a widow, three daughters and a son, Henry J. Bierhart, Jr., who is with the die-casting division of the H. H. Franklin Mfg. Co., Syracuse.

George Nash, former president of the George Nash Co., died at his home in New York, November 29. Mr. Nash was born in England and was educated abroad, but came to America when a very young man. After acquiring some business experience in New York City he entered the employ of Carl Boker, importer of steel, and founder of Hermann Boker & Co., with whom he gained a very wide knowledge of the steel business. In 1890 Mr. Nash started in business for himself in Chicago, and subsequently formed a partnership with Edgar T. Ward of Boston, also a steel importer, under the name of Ward & Nash. The firm kept stocks of steel in both Boston and Chicago. In 1900 this partnership was dissolved, and Mr. Nash established the steel importing house of George Nash & Co., with warehouses in New York and Chicago. In 1906 the corporation of the George Nash Co. was formed, Mr. Nash continuing as its active head as president and treasurer until 1911, when he disposed of most of his interest. After retiring he devoted his time between his winter home at Montclair, N. J. and his summer home at Mallett's Bay, Lake Champlain. Mr. Nash was widely known by the steel trade and the manufacturers of this country.

JAMES MAPES DODGE

James Mapes Dodge, chairman of the board of the Link-Belt Co., died at his home in Philadelphia, December 4, aged sixty-three years. He was born at Waverly, N. J. His grandfather was Prof. James J. Mapes, a noted chemist and scientist,

James Mapes Dodge

and his mother, Mary Mapes Dodge, was a well-known author, for many years editor of the *St. Nicholas Magazine*. Mr. Dodge spent three years at Cornell University and a year at Rutgers, taking a course in chemistry at the latter institution. After working a short time at the Morgan Iron Works in New York City, he entered the shops of John Roach, the shipbuilder, at Chester, Pa., where his marked mechanical ability and ingenuity brought him rapid advancement. During the three years spent at the Chester establishment, he was successively journeyman, foreman and superintendent of erection.

Shortly after the Centennial Exposition at Philadelphia in 1876, Mr. Dodge left the shipyard, and after gaining several years of experience in the East, went to Chicago. It was there that he formed the acquaintance of William D. Ewart, the inventor of the Ewart link-belting, and soon after he joined with Mr. Ewart and his associates in the development of the chain business. At that time—about thirty-five years ago—the application of chains to power transmission was limited, and their use in elevating and conveying machinery was practically unknown. The development of the Ewart chain made a new industry, and Mr. Dodge's early work was confined principally to the development and manufacture of Ewart chains, in which work his genius had full play. New chains, new methods of manufacture and new conveying and elevating appliances were brought out in rapid succession.

After this period of development, Mr. Dodge went East and entered into partnership with Edward H. Burr under the firm name of Burr & Dodge, who represented in Philadelphia the Ewart Mfg. Co. of Indianapolis, the original manufacturer of Ewart detachable link-belting. Out of this partnership grew the Link-Belt Engineering Co. in 1888, and after the formation of this company, Mr. Dodge carried out his idea of development along strictly engineering lines. A highly specialized engineering staff was organized; a scientific study was made of the characteristics of the materials to be handled, and special appliances were invented to meet varying conditions. Machine capacities grew from 30 tons per hour to 1000 tons per hour, and from the simple problems solved by detached machines the company expanded its field to the planning and arranging of works to secure the most economical and efficient handling of both raw and finished product under guarantee of accomplishment. In all this development, Mr. Dodge was the creative and guiding spirit.

It was in 1889, after having become thoroughly acquainted with the needs of the anthracite coal industry, that Mr. Dodge developed the boldest and perhaps the most original of his inventions. This was his system of storing anthracite coal in large conical piles, and reloading it by machinery, accomplishing this result with little labor and practically no breakage. For this meritorious invention, Mr. Dodge was presented with the Elliott Cresson gold medal in 1907 by the Franklin Institute of Philadelphia. This system of handling coal in and out of storage reduced the cost from thirty and often forty cents per ton to less than five cents. Mr. Dodge had the distinction of having taken up over 100 patents. Among his most important inventions and improvements are those relating to the construction and manufacture of the "silent chain."

Though for many years an employer of labor, Mr. Dodge never met with strikes or other labor difficulties. He was a conspicuous leader in the general introduction of the best elements in scientific management, having the double purpose of producing greater efficiency in the mechanical and human equipment and greater pay with shorter hours and improved conditions for the men. He was for many years closely associated with the late Frederick W. Taylor in the accomplishment of remarkable results for the benefit of both employers and employes in a wide circle of industries. He was a member of several engineering and scientific bodies; he was past president of the American Society of Mechanical Engineers, and vice-president of the Franklin Institute.

COMING EVENTS

January 1-8.—National automobile show, Grand Central Palace, New York City. S. A. Miles, general manager, 7 E. 42nd St., New York City.

January 5-8.—Annual mid-winter meeting of the Society of Automobile Engineers. Grand Central Palace, New York City, headquarters. Coker F. Clarkson, general manager, 1770 Broadway, New York City.

January 27-29.—National foreign trade convention, at New Orleans, La., for the discussion of commercial relations of the United States with foreign countries. Hotel Grunewald, headquarters. James A. Farrell, chairman, 64 Stone St., New York City.

September 11-16.—Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Massachusetts Institute of Technology, Boston, Mass. Bulletin of the Institute containing catalogue of officers and students, with a statement of the requirements for admission and description of the courses of instruction.

University of Illinois, Urbana, Ill., has maintained since 1907 ten research fellowships in the Engineering Experiment Station. These fellowships, for each of which there is an annual stipend of $500, are open to graduates of approved American and foreign universities and technical schools. By action of the board of trustees last March, four additional research fellowships were created, making fourteen in all. There will be five vacancies to be filled at the close of the current academic year. Research work may be undertaken in architecture, architectural engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics.

NEW BOOKS AND PAMPHLETS

Rockefeller Foundation Annual Report 1913-1914. 226 pages, 5¾ by 8⅝ inches. 17 illustrations. Published by the Rockefeller Foundation, 61 Broadway, New York City.

The Production of Coal in 1914. By C. E. Lesher. 164 pages, 6 by 9 inches. Published by the United States Geological Survey, Department of the Interior, from the "Mineral Resources of the United States, 1914, Part II."

Annual Report of the Secretary of the Navy for the Fiscal Year Ended June 30, 1915, including operations and recommendations to December 1, 1915. 104 pages, 6 by 9 inches. Published by the Department, Washington, D. C.

Characteristics of Radiation Pyrometers. By George K. Burgess and Paul D. Foote. 88 pages, 6 by 10 inches. 32 illustrations. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 250.

Psychrometric Tables for Cooling Tower Work. 56 pages, 4 by 7 inches. Published by the Wheeler Condenser & Engineering Co., Carteret, N. J., for free distribution to engineers.

This booklet of tables gives the dry and wet bulb thermometer readings, dew point, humidity, and the pounds of water vapor per thousand cubic feet and per hundred pounds of air. It contains a discussion of psychrometry and describes the use of the sling psychrometer, which is illustrated.

Steam Tables for Condenser Work. 32 pages, 4 by 7 inches. Illustrated. Published by the Wheeler Condenser & Engineering Co., Carteret, N. J., for free distribution to engineers.

This booklet of steam tables in the third edition includes pressures below atmosphere, expressed in inches of mercury referred to a thirty-inch barometer. It also includes a discussion of the use of the mercury column, points out the errors in such measurements and gives the constants to be used for their correction.

Principles and Practice of Cost Accounting. By Frederick H. Baugh. 194 pages, 6 by 9 inches. Published by F. H. Baugh, Box 682, Baltimore, Md. Price, $3.

This work on cost accounting is intended for accountants, manufacturers, mechanical engineers, teachers and students, having for its object a comprehensive and practical presentation of the general principles on which cost accounting for manufactured articles is based. It deals with financial accounting, principles of cost accounting, specific job costs, departmental costs, process costs of the simple type, process costs of the complex type and gives examples of departmental cost accounts and process costs.

Arithmetic of Electricity. By T. O'Conor Sloane. 162 pages, 5 by 7¼ inches. Published by Norman W. Henley & Co., New York City. Price, $1.

This book now appears in the twenty-first edition, having first been published in 1900. It is a practical work of electrical calculations of all kinds reduced to a series of rules, all of the simplest forms, and embodying only ordinary arithmetic. Each rule is illustrated by one or more practical problems with detailed solution of each. It treats of Ohm's law; resistance and conductance; potential difference; circular mils; special systems; work and energy; batteries; electro-magnets, dynamos and motors; electric railways; alternating currents; condensers, etc.

Notes on the Use of Low-Grade Fuel in Europe. By R. H. Fernald. 37 pages, 6 by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 123.

This pamphlet treats of the utilization of high-ash coals in non-by-product producer gas plants; the use of wood refuse and similar material; by-product plants; uses of tar; low-temperature distillation; use of powdered fuel, etc. The investigation was made in the interests of the fuel resources in the United States. While we have an abundant supply of high-grade fuel, the rate at which it is being used leads naturally to the assumption that steps should be taken in the near future to utilize our low-grade fuels also, and thus conserve the national fuel supply.

Autogenous Welding and Cutting. By Theodore Kautny. Translated by the author and James F. Whiteford. 157 pages, 5 by 7½ inches. 133 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $1 net.

This small book deals with autogenous welding flames; acetylene manufacture and apparatus; oxygen manufacture and apparatus; gas mains and fittings; autogenous welding burners; autogenous cutting burners; autogenous welding of iron; repairs of gray cast iron; welding of sheet iron; manufacture and repairs of boilers; manufacture of cylindrical and rectangular vessels and miscellaneous articles; manufacture and installation of large pipes and conduits; manufacture and installation of gas and water pipe; construction of pipe-shaped apparatus; welding of copper; welding of aluminum; welding of nickel and other metals.

Laboratory Tests of a Consolidation Locomotive. By E. C. Schmidt, J. M. Snodgrass and R. B. Keller. 129 pages, 6 by 9 inches. 58 illustrations. Published by the University of Illinois, Urbana, Ill., as Bulletin 82 of the Engineering Experiment Station. Price, 65 cents.

The tests whose results are recorded in this bulletin constitute the first work done in the recently established locomotive laboratory of the University of Illinois, and relate to a typical consolidation locomotive. The locomotive was first tested in the condition in which it was received from service. It was then repaired and again tested. The maximum amount of dry coal fired per hour was 11,127 pounds per square foot of grate per hour. The maximum equivalent evaporation per hour was 57,954 pounds, or 17.65 pounds per square foot of heating surface per hour.

Inventions and Patents. By Philip E. Edelman. 288 pages, 6¼ by 8 inches. Published by the D. Van Nostrand Co., New York City. Price, $1.50 net.

The author, realizing the general ignorance of patent procedure, and the possibilities in patented inventions, has written this book for inventors, investors, manufacturers and others for whom elementary information on the patent system would be acceptable. It treats of the development of the patent system, the patent office, patent attorneys, the fields of invention, preliminary steps required to secure patents, patentability and practicability, how to apply for and prosecute a patent, how to protect an invention, the points of patent procedure, how to secure and utilize patent rights, how to dispose of patent rights, what to do in case of infringements, foreign patents and other matters of general interest.

Eighteen Articles. By J. P. Brophy. 87 pages, 5 by 6¾ inches. Bound in paper. Published by the Cleveland Automatic Machine Co., Cleveland, Ohio.

This little book, by the general manager of the Cleveland Automatic Machine Co., is compiled chiefly from articles contributed by Mr. Brophy to the technical press. The contents are short essays as follows: Interchangeability; Punctuality; Office Management; Value of the Setter-up; The Difference between Designer and Inventor; Management and Responsibility; Efficiency—Its Meaning; Classified Supervision; The Fault Finder; Selecting Foremen and Assigning Their Duties; Inventory—Costs, Depreciation, All Closely Allied; Reflection—Its Definition Elaborated. Defining a Purchasing Agent's Duties; Stock Parts in Advance—Does It Pay?; Making Headway; At What Age are we most Efficient?; Writing an Advertisement; Little Things—and a Place for Everything.

Engineering Thermodynamics. By James A. Moyer and James P. Calderwood. 203 pages, 6 by 9 inches. 70 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $2 net.

This work is offered as a textbook on thermodynamics that is brief and concise, and so clearly expressed on the fundamentals of the subject that students of average ability can read and study it without difficulty. It has been the aim of the authors to make the work particularly suitable for use in the larger technical schools where the study of thermodynamics is preceded by courses on steam boilers and steam or heat engines, and where courses on steam turbines, internal combustion engines, pneumatic machinery, refrigeration and pumping machinery are included. Following the introduction to the theory of heat engines, the properties of perfect gases are taken up, and then expansion and compression of gases. In logical order follow the cycles of heat engines, properties of steam, practical applications of thermodynamics, entropy, practical steam expansions and cycles, and flow of fluids.

The Testing of Machine Tools. By George W. Burley. 231 pages, 4½ by 7¼ inches. 110 illustrations. Published by Scott, Greenwood & Son, London, and sold in the United States by D. Van Nostrand Co. Price, $1.50.

The author, a well-known writer on machine tool design and machine shop practice, has dealt in this work with the various aspects of machine tool testing in a way that makes it suitable for the use of apprentices, students and engineers. It deals with tests on machine tool elements for accuracy; machine tool speed and feed tests; machine tool mechanical efficiency tests; cutting force tests; output and power consumption tests; comparative tool testing; and commercial machine tool testing. A chapter describes engine lathe tests, bed leveling tests, spirit levels, spirit level graduations, hydrostatic level, gravity or pendulum level, pendulameter, headstock tests, micrometers, test indicators, driving headstock spindle tests, loose headstock mandrel tests, slide-rest tests, finished lathe tests, wear tests, lead-screw tests, slide screw tests, lathe test report, turret lathe tests, milling machine tests, drilling machine tests, planing machine tests, general observations. The work is one that should be of general value to all concerned with the manufacture and use of machine tools.

Corrosion of Iron. By L. C. Wilson. 178 pages, 5 by 7¼ inches. Published by the Engineering Magazine Co., New York City. Price, $2.

This is an age of iron and steel, but the works of iron and steel are far from being permanent. Perhaps one of the greatest problems confronting the engineer today is that of preserving metal structures from the deteriorating influences of wind and water. The author's purpose has been to assemble and condense the most interesting and important studies and facts connected with the corrosion of iron and its protection therefrom. After dealing with the rust problem, he takes up the theories of corrosion. Three principal theories are discussed, these being the hydrogen peroxide theory, the carbonic acid theory and the electrolytic theory. Protective measures then receive attention. These include oxidizing, galvanizing, electroplating and painting. Paint materials are dealt with in Chapter IV and protective paints in Chapter V. Following the discussion of protective paints, the influences of different elements on the corrosion of iron are taken up, and then corrosion of wrought-iron and steel pipe. So serious is the deterioration of steel pipe that iron pipe is being used largely in preference because of its superior rust-resisting characteristics.

Smoke Abatement and Electrification of Railway Terminals. 1177 pages, 9 by 12 inches. 719 illustrations. Supplied by Rand McNally & Co., Chicago, Ill. Price, $6.

This comprehensive report of the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals—Dr. W. F. M. Goss, chief engineer—is a notable contribution to the literature of engineering. The physical characteristics of the city of Chicago are described and the work of smoke abatement in foreign and American cities. The work is divided into four parts and an appendix, as follows: The Necessity for the Electrification of Chicago's Railroad Terminals; Technical Feasibility and Cost of Electrifying the Railroad Terminals of Chicago; A Study of Results which are to be Anticipated from the Electrification in Chicago; Financial Practicability of Electrification; Summary of Conclusions with Reference to the Electrification of Railroad Terminals; Summary of Conclusions with Reference to Atmospheric Pollution. An idea of the amount of statistical matter can be gathered from the fact that 478 tables accompany the text. The work has been prepared with great care; it is logically arranged and thoroughly indexed so that any subject can be quickly referred to.

Steel and its Treatment. By the Metallurgical Staff, E. F. Houghton & Co. 104 pages, 5¼ by 7½ inches. 24 illustrations. Published by E. F. Houghton & Co., Philadelphia, Pa.

The company publishing this book has for over forty years been engaged in the manufacture of materials used in the heat-treatment of steel and during that time it has conducted a laboratory of research. During the last fifteen years the development of the heat-treatment of steel has led to the collection of data which is now published in convenient form. The work deals with the composition of steel; the thermal critical points of steel; annealing; methods of testing the hardness of metals; Turner's sclerometer; Shore's scleroscope; Brinell's tests; Keep's test; pyrometers; carbon steels; low carbon steels; thermal critical points of a medium high carbon steel, eutectoid steel and hyper-eutectoid steel; influence of carbon, manganese, phosphorus, sulphur, silicon, nickel, chromium and vanadium; thermal- or heat-treatment of steel; hardening of steel; tempering or drawing; carburizing; composition of steels for carburizing, carburizing temperatures; depth of penetration; casehardening, carburizing compounds, heat-treatment after carburizing; composition of the metal; quenching; special alloys; nickel steels; nickel-chromium steels, etc.

Safety in the Foundry. By Magnus W. Alexander. 187 pages, 5¼ by 7¼ inches. 140 illustrations. Published by the National Founders' Association, Chicago, Ill. Price, $1.25 to members of the association, and $1.50 to others.

This book by Mr. Alexander of the General Electric Co., chairman of the committee of safety and sanitation of the National Founders' Association, embodies the results of many years of experience in foundry work, and should be found of the utmost value by foundry managers in preventing distressing accidents. The general contents are listed under the following heads: Personal Caution is the Greatest Safeguard; Danger and Caution Signs; Foundry Yards; Foundry Floors; Natural Light; Artificial Light; Ventilation; Cranes, Hoisting Accessories; Rules for Cranemen; Industrial Railways; Wheelbarrows and Trucks; Foundry Ladles; Foundry Crucibles; Foundry Machinery; Grinding Machines; Tumbling Mills; Sandblasting and Other Dusty Operations; Hand Tools; Miscellaneous Safety Devices; Protective Foundry Clothing; Safety Goggles; First Aid Treatment of Injured Persons; Physical Examination of Employes. The halftone and line engravings illustrate danger points, guards, proper and improper methods of handling work, safe and unsafe equipment, etc. This is another example of specialized safety literature that should be of much value to the trade concerned.

Mechanical Drawing for Colleges and Universities. By James D. Phillips and Herbert D. Orth. 283 pages, 6 by 9 inches. 292 illustrations. Published by Scott, Foresman & Co., Chicago, Ill. Price, $1.75.

This work on drawing was prepared for use in universities and colleges, and will be followed by another suitable for high schools, the two books forming a complete course in mechanical drawing for high school and university work. The aim in the present work has been to arrange a course that shall develop the imagination and the faculty of coordination between the hand and the eye. The elements or general divisions in drawing are introduced in the order in which they would naturally come in a commercial drafting-room as follows: perspective sketching, orthographic sketching, pencil mechanical drawing, tracing and blue-printing. The importance of a working knowledge of perspective drawing is being recognized more and more as its advantages for instruction in shop work are realized, and special attention has been given to perspective and orthographic sketching. Every problem in this course requires thought on the part of the student, the aim being to develop originality. The chapter on lettering contains many plates for copy and the instructions for lettering are precise and to the point. Much importance is attached to neat and attractive work, and rightly so, as nothing injures the appearance of a drawing more than slovenly legends and dimensions.

Thomas' Register of American Manufacturers and First Hands in All Lines. 3100 pages, 9½ by 12 inches. Bound in cloth. Published by the Thomas Publishing Co., 129-135 Lafayette St., New York City. Price, $15.

This great trade directory contains an index or finding list; a list of manufacturers classified according to business; an alphabetical list of leading trade-names; and lists of architects, banks, boards of trade, chambers of commerce and similar commercial organizations, trade papers, machinists and foundries. An idea of the comprehensiveness of the work is gained from the fact that the index to the classified section covers over 140 pages, five columns to the page. The classified manufacturers list which constitutes the body of the work is the chief feature, but many users will find the alphabetical list and the list of trade-names of almost equal value. Frequently the name of the maker of a product known under a trade-name is wanted in a hurry, and this trade register generally will furnish the desired information. It is hardly necessary to point to the value of these lists to those desiring to compile mailing lists for circularizing various trades or lines of manufacture. A valuable feature of the classified manufacturers list is the approximate rating of each concern. These ratings are not intended, however, to indicate credit, but are given solely to indicate the size of the concern. The 2670 advertisements of nearly 1300 concerns of course add to the value of the work, as they often give the exact information required and save the time and trouble of writing for catalogues.

Safety Engineering Applied to Scaffolds. 354 pages, 6 by 9 inches. 127 illustrations. Published by the Travelers Insurance Co., Hartford, Conn. Price, $3.

The literature on safety engineering is becoming extensive and this latest valuable addition to the list of books specializes on a subject of great importance to builders, contractors, erectors and others having charge of work requiring the erection of scaffolding for workmen. The first section of the book discusses the reality of the scaffold hazard and the second part treats of scaffolds in a general way, outlining the subject as a whole and reviewing the various forms that are most widely used. Then follows a section on the bricklayers' pole scaffold, describing American practice and going into details under the following heads: the poles or uprights, the ledgers, the putlogs, the platform, bracing, and other safety measures. The fourth section describes the independent pole scaffold as built in American practice and the fifth section is on lashed scaffolds. Other forms of pole scaffolds are described in section six, and special safety features form the subject of section seven. General features and operations, including ladders, runways, stairways, nails, dismantling pole scaffolds are treated in section eight, and building with horses in section nine. Suspended scaffolds for construction work, under the heads of platform type of scaffold machine, overhead type of scaffold machine, features common to both types of suspended scaffolds, are dealt with in section ten; and scaffolds of other kinds, structures similar to scaffolds, and general counsel, in sections eleven, twelve and thirteen, respectively. The work is profusely illustrated with halftones and drawings. It is one of the most valuable works on safety we have seen.

The Theory of Machines. By R. F. McKay. 440 pages, 5½ by 8½ inches. 407 illustrations. Published in America by Longmans, Green & Co., New York City. Price, $4.20 net.

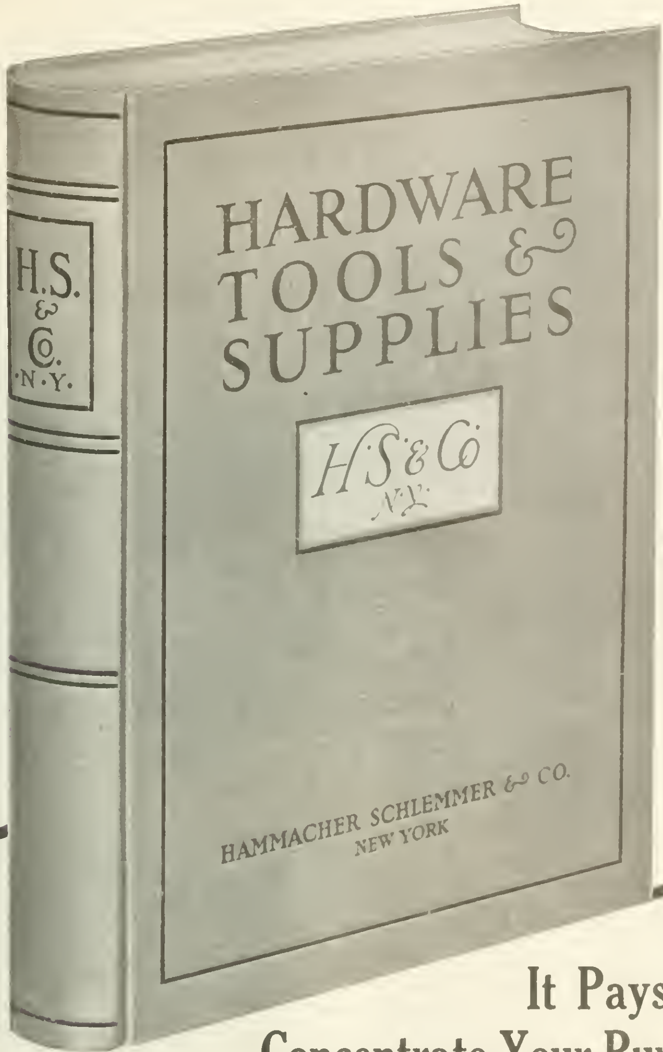
This work on mechanism and mechanical movements deals systematically with the subject, having been prepared to meet the requirements of engineering students. It treats of mechanics, kinematics of machines, and dynamics of machines under the following heads: Plane Motion of a Particle; Force and Torque; Work and Energy; Plane Motion of a Particle under Variable Acceleration—Displacement Velocity and Acceleration Diagrams; Introduction to Statics; Analysis of Motion; Synthesis of a Machine; Lower Pairing—Examples of Mechanisms obtained by Inversion; Relative Linear Velocity and Acceleration; Determination of the Angular Motion of Links; Reciprocating Motion of the Slider Crank Chain; Straight Line Motions; Higher Pairing—Toothed Gearing; General Propositions on the Forms of Wheel Teeth; Involute, Cycloidal, and Pin Teeth; Helical Gearing; Non-circular Gears; Trains of Wheels and Epicyclic Gearing; Belts and Belting; Rope and Chain Drives; Cams; Spheric Motion—Hooke's Joint; Screw Motion—Screw Gears; Friction; Static Equilibrium of Machines; Turning-Moment Diagrams, Governors; Balancing, Brakes and Dynamometers. Each chapter concludes with a list of problems that require the application of principles given in the foregoing matter for their solution. The answers to these problems are given in the back of the book. While the work is more suitable for the use of university students than machine designers, it nevertheless is one that many of the latter could use to advantage. The chapter on epicyclic gearing for example contains twenty-two pages, illustrating a number of epicyclic trains and giving methods of solving for the relative motions on each member of the trains.

Machine Design. By Albert W. Smith and Guido H. Marx. 500 pages, 6 by 9 inches. 279 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $3 net.

This work, which was published in 1905, now appears in the fourth edition. The authors have taken the opportunity to thoroughly revise the text and to include results of recent investigations of machine elements, but it is not offered as a substitute for practical experience; the authors frankly recognize the fact that the true designer must have judgment ripened by experience in constructing and operating machines. One who has experience and judgment will find in this work indispensable data, rules and formulas that he can apply and modify as the conditions seem to suggest. The contents are comprised in twenty-two chapters and an appendix under the following general heads: Motion in Mechanism; Parallel or Straight-line Motions; Cams; Energy in Machines; Proportions of Machine Parts as Dictated by Stress; Riveted Joints; Bolts and Screws; Means for Preventing Relative Rotation; Sliding Surfaces; Axles, Shafts, and Spindles; Journals, Bearings, and Lubrication; Roller- and Ball-bearings; Couplings and Clutches; Belts, Ropes, Brakes, and Chains; Flywheels and Pulleys; Toothed Wheels or Gears; Springs; Machine Supports; Machine Frames. Many illustrations of mechanical movements and machine elements are shown that to some extent have been taken from the columns of technical journals. In the selection of this material the authors were not always fortunate; an example is the Hall coupling for transmitting motion from axes at 90 degrees, at uniform angular velocity. This device is quoted from "Power," January 26, 1915, thus giving the reader the impression that it is a new and novel device. As a matter of fact, it is old, having been described in a work on mechanical movements published nearly twenty years ago as "Hobson's right-angle shaft coupling."

Ford Methods and the Ford Shops. By H. L. Arnold and F. L. Faurote. 440 pages, 7 by 10 inches. Illustrated. Published by the Engineering Magazine Co., New York City. Price, $5.

This book is based on the articles contributed to the "Engineering Magazine," by H. L. Arnold, whose death occurred in January, 1915. Mr. Faurote took up the unfinished work of Mr. Arnold and carried it through to completion. The work is unique, the authors having been afforded extraordinary privileges by the Ford management. The data covering arrangement and equipment of departments, construction and performance of special machines, detailed sub-divisions of machining and assembling operations, times and costs of jobs and finished parts, methods of cost reduction and results in practice, belong to a class of shop information seldom made public and probably never before revealed with such frankness. The fact that Henry Ford would permit intimate data of this nature to be published is an interesting sidelight on his character as a broad-minded employer and manufacturer. The contents of the book by chapter heads follow: The Genius of the Plant; The Ford Stock System and Employment Methods; How the Work is Done; Inspection and Assembly; Motor-test Blocks and Chassis-assembling Lines; Machining and Assembling the Front Axle; The Crankshaft, Piston and Piston Rings; The Commutator Production and Assembly Job; Sheet-metal Work; Conveyors, Work-slides and Roll-ways; The Bushings Job; Special Machines and Fixtures; The Foundries; How Ford Bodies are finished—Painting, Upholstering, Japanning and Baking; The New Factory Condi-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NEW YORK

tions; Safeguarding the Workmen. The book is one that can be studied with much profit by all concerned with the problems of manufacturing and especially those dealing with the production of motor cars and motor trucks. Production data of details are given throughout.

Shrapnel Shell Manufacture. By Douglas T. Hamilton. 296 pages, 6 by 9 inches. 172 illustrations. Published by the Industrial Press, New York City. Price, $2.50.

This book is a comprehensive treatise on the forging, machining and heat-treatment of shells, and the manufacture of cartridge cases and fuses for shrapnel used in field and mountain artillery, giving complete directions for tool equipment and methods of setting up machines, together with government specifications for this class of munition. The book has been brought out to meet the demands for a treatise dealing comprehensively with the various operations on shells, fuse parts and brass cases. In this book are included not only the unusually complete articles on shrapnel manufacture contained in the April, 1915, number of MACHINERY, but also all other material that has been published at various times in MACHINERY relating to shrapnel manufacture. In addition, there is a great deal of material obtained by the editors of MACHINERY especially for this book, and there is also a section containing abstracts of the official specifications, together with line engravings, of the details of Russian, British and American shrapnel shell bodies, fuses and cartridge cases. Hence, it is believed that this book will prove the most valuable addition to the literature of the manufacture of munitions that has been made since the beginning of the war. The chapter heads are as follows: Shrapnel Shells; Forging Shrapnel Shells; Machining and Heat-treatment of Shrapnel Shells; Machines and Tools for Shrapnel Manufacture; Making Fuse Parts; Making Shrapnel Cartridge Cases; Specifications for the Manufacture of Russian Shrapnel Shells; Specifications for the Manufacture and Inspection of Fuses for Russian Shrapnel Shells; Specifications for the Manufacture and Inspection of Russian Cartridge Cases; Specifications for British Quick-firing Shrapnel Shell; Specifications for British Combination Time and Percussion Fuses; Specifications for British Quick-firing Cartridge Case and Primer; Specifications for American Shrapnel Shells.

NEW CATALOGUES AND CIRCULARS

United Engineering & Mfg. Co., Hanover, Pa. Bulletin 20 of the Manley "Hilite" portable crane, so designed that it is not top heavy.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y., has issued a special calendar of interest to belt users. Copies will be sent to belt users upon application as long as the supply lasts.

Ozone Pure Airifier Co., 536-538 S. Clark St., Chicago, Ill. Booklet describing ozone machines for keeping air fresh and pure in theatres, offices, stores and places where the air becomes vitiated.

Newton Machine Tool Works, Inc., Philadelphia, Pa. Catalogue 50 of Newton rotary planing machines, slotters, cold-saw cutting-off machines, vertical multiple-spindle rail drilling machines, etc.

Noble & Westbrook Mfg. Co., Hartford, Conn. Circular of marking machine designed for marking large shells, being so constructed that the shells may be rolled into the machine, marked and rolled out without requiring the operator to lift them.

Chain Belt Co., Milwaukee, Wis. Price list of standard detachable chain belt, superseding the list given in the company's general catalogue 56. The sharp advance in the cost of raw materials and labor has necessitated the fixing of higher prices.

Athol Machine Co., Athol, Mass. Circulars advertising Athol and Starrett vises, and single and double adjustable taper attachments for vises. These vises are guaranteed to be free from defects of material and workmanship, and any vise found defective will be replaced without charge.

American Blower Co., Detroit, Mich. Pamphlet entitled "The Commercial Value of Washed Air," illustrated with views of hotels, stores and other structures in which the "Sirocco" purifying and ventilating systems have been installed. Data on the capacity of air purifiers and heaters are included.

Stuebing Truck Co., 308-314 Walnut St., Cincinnati, Ohio. Pamphlet entitled "System in Trucking," describing Stuebing lifting trucks and showing their application in a variety of plants. The different models are illustrated and data covering capacity, dimensions, weight, etc. are given.

Diamond Power Specialty Co., Detroit, Mich. Circular describing "insuluminum" used in the construction of the "Diamond" soot blower. The process by which insuluminum is produced was originally called "calorizing." By it, aluminum is deposited on steel (or other metals), forming an alloy that is highly resistant to the action of heat.

Speed Controller Co., Inc., 257-259 William St., New York City. Circular of the "Speedco" automatic precision governors for regulating the power and speed of machinery. The construction of the apparatus is illustrated and described, and data on the sensitiveness of the double-acting controller, as applied to electric motor control through field rheostat, are included.

Deane Steam Pump Co., 115 Broadway, New York City. Bulletin D 184 on high-pressure hydraulic power pumps, illustrating vertical and horizontal pumps of standard types, and giving partial lists of sizes. Automatic by-pass and check valves for high-pressure hydraulic pumps are also described, these valves being made as independent units, so they may be readily replaced in case of damage.

Gleason Works, Rochester, N. Y. Booklet entitled "Spiral Type Bevel Gears," giving a clear and concise description of this type of gearing, together with such information as is required by designers and users of these gears. The booklet relates to the advantages, strength and wear, efficiency, applications, angle of spiral, direction of spiral, thrust, and the machining of the blanks for spiral type bevel gears.

J. E. Snyder & Son, Worcester, Mass. Catalogue of vertical drilling and tapping machines, illustrating twenty-three patterns, ranging in size from a 21-inch sliding-head high-speed drilling machine to a 46-inch sliding-head friction back-geared machine. J. E. Snyder & Son is the only concern in the United States that has specialized exclusively on vertical drilling and tapping machines for the past thirty years.

Standard Electric Tool Co., Cincinnati, Ohio. Bulletin G-9 on "Standard" high-power portable electric ball bearing grinders. Bulletin D-11 on "Standard" high-power direct-current portable electric drills. Bulletin D A-11 on "Standard" high-power two- and three-phase alternating-current portable electric drills. Bulletin U-11 on "Standard" high-power universal portable electric drills, operating on direct current and single-phase alternating current, sixty cycles or less.

National Tube Co., Frick Bldg., Pittsburg, Pa. Colored circular illustrating the relative merits of the grand prize, the medal of honor, gold medal, silver medal and the bronze medal conferred by the jury of awards at the Panama-Pacific International Exposition. The artist has depicted a mountain scene in which the grand prize is represented by a snow-capped peak overshadowing the lesser peaks representing the inferior medals. The National Tube Co. was awarded the grand prize, and its advertising department has adopted this method of illustrating what the grand prize means. It puts the "National" pipe and allied products in a position of "overshadowing supremacy."

New Departure Mfg. Co., Bristol, Conn. Pamphlet entitled "Ball Bearings in Commercial Applications," illustrating a great variety of applications of "New Departure" bearings, including motor cars, motor trucks, agricultural tractors, industrial tractors, electric and gasoline motors, motor-driven fire apparatus, etc. The ball bearing is referred to as the "conqueror of friction." The great strength of steel balls is described, and apparatus for testing steel balls up to 2½ inches in diameter is illustrated. The large number of illustrations of apparatus to which ball bearings have been successfully applied shows how wide-spread is the movement for eliminating useless friction and waste work. The New Departure Mfg. Co. in publishing this pamphlet feels that it is doing an educational work, and that the pamphlet is in no sense a catalogue. The object is to educate the great mechanical public in the use of ball bearings and to overcome the prejudices of mechanical engineers in general.

TRADE NOTES

Rub-On Mfg. Co., Inc., 87-97 Brayton St., Buffalo, N. Y., is now manufacturing and selling the "Crone" valve dressing and reseating tool.

Aberthaw Construction Co., Boston, Mass., has removed its office to more commodious quarters in the newly erected Niles building, 27 School St.

Defiance Packless Valve Co., 801 Rand-McNally Bldg., Chicago, Ill., has been reorganized. J. W. Flower of the Rose-Stephens Co., has joined the concern.

Midvale Steel Co., Nicetown, Philadelphia, Pa., and Worth Bros. Co., Coatesville, Pa., have taken the sixteenth floor of the Widener building, Chestnut St., Philadelphia, Pa., for their general offices.

American Swiss File & Tool Co., 24 John St., New York City, was awarded a medal of honor, the highest, by the superior jury of awards, at the Panama-Pacific International Exposition, for its exhibits of "American-Swiss" files.

Federal Machinery Sales Co., 12 N. Jefferson St., Chicago, Ill., has opened a store and warehouse where it will carry a line of new and used machine tools. The officers are: James L. Gough, president; J. B. Doan, vice-president; Charles T. Bush, treasurer; and Charles A. Odegaard, secretary.

La Salle Machine & Tool Co., LaSalle, Ill., has added to its line of machine tools by purchasing the manufacturing rights in the "American" twist drill grinders from the Heald Machine Co., Worcester, Mass., whereby it has taken over all patents, drawings, patterns, parts in stock and good will of this line.

American Tool Works Co., Cincinnati, Ohio, is preparing for the construction of a new plant on the block bounded by Pearl, Eggleston, Third and Butler Sts. The building will be of reinforced concrete, 256 feet front by 260 feet deep, four stories and basement, and will afford 238,000 square feet of floor space.

Reliance Engineering Co., Lansing Mich., has succeeded the Seager Engine Works, builders of the "Olds" stationary and portable gas, gasoline and kerosene engines, hoists, pumping outfits, etc. The officers of the Reliance Engineering Co. are: C. P. Downey, president; F. L. Smith, vice-president; E. C. Shields, secretary; and J. W. Wilford, treasurer and manager.

Whitney Mfg. Co., Hartford, Conn., announces that, owing to the changed conditions with regard to labor, materials, machinery, etc., it has withdrawn all prices and quotations on chains, sprockets, and milling machines, Woodruff keys and cutters. During the next few months customers will be requested to submit estimates of their requirements, and quotations will be made for each individual case.

Hyatt Roller Bearing Co., Newark, N. J., announces that J. D. Mooney, sales manager, has put O. W. Crawshaw in charge of the sale of Hyatt lineshaft bearings. Mr. Crawshaw was formerly with one of the largest power transmission houses in Chicago, and is well acquainted with the mill supply business throughout the country. He will give his entire time to the work of the new division, giving closer attention to dealers handling the Hyatt line than has heretofore been possible.

New Process Gear Corporation, Syracuse, N. Y., has nearly completed the improvements in the building formerly used by the Monarch Typewriter Co., which has been acquired by the corporation, and the machinery is being installed. The five-story, reinforced concrete building that is being erected for the general manufacturing and heat-treating use is well under way. This building is 180 by 100 feet. The two buildings when completed will give the corporation greatly increased floor space and manufacturing capacity.

Armstrong Bros. Tool Co., 318 N. Francisco Ave., Chicago, Ill., was awarded the grand prize for tool-holders at the Panama-Pacific Exposition at San Francisco, Cal., this being the first grand prize ever awarded for an exhibit of tool-holders at any international exposition and the only grand prize awarded exclusively and specifically to an exhibit of tool-holders independently of other products. The company was also awarded a medal of honor for its other Armstrong products exhibited, including ratchets, drop-forged wrenches, clamps, lathe dogs, etc.

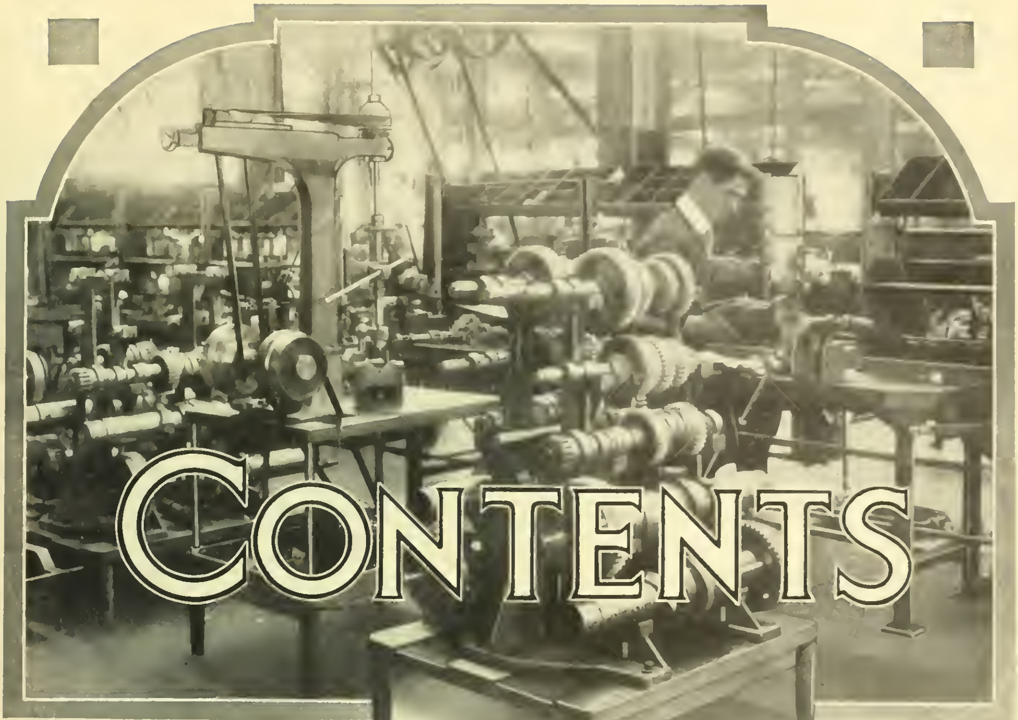
O'Brien Machinery Co., 107 N. 3rd St., Philadelphia, Pa., is a new concern, organized for selling steam and electrical equipment, machine shop equipment, power transmissions, wood-working machinery and supplies of all kinds. The company is composed of Clarence J. O'Brien and Frank L. O'Brien, formerly with Frank Toomey, Inc. The concern has a warehouse and an organization equipped to store and overhaul all machinery before shipment. Catalogues, price lists and jobbers' discounts from the manufacturers whose products will be sold, are solicited.

Buffalo Foundry & Machine Co., Buffalo, N. Y., builder of "Buflovak" vacuum apparatus, including vacuum dryers of all types for drying all sorts of materials; dry vacuum pumps; condensers, vacuum drying and impregnating apparatus; "Buflokast" chemical apparatus, including complete plants and apparatus for the manufacture of aniline, phenol, beta, naphthol, picric acid, caustic soda, acids, chemicals, and kindred organic materials; and "Bell" steam hammers; has opened a New York office at 1432 Whitehall Bldg., 17 Battery Place. The company also does a general jobbing foundry and machine business, and is prepared to quote on castings up to 200 tons in weight each, including the necessary patterns and machine work.

Reed-Prentice Co., Worcester, Mass., has changed ownership in its common stock. The entire common stock, the par value of which is $750,000, has been sold to a group of Boston investors, headed by Robert F. Herrick. The original issue of $1,250,000 common stock was cut down about a year ago to $750,000, which reduced the capital stock of the company from $2,500,000 to $2,000,000. The new officers of the corporation are: Robert F. Herrick, president; Albert E. Newton, vice-president and general manager; Jeremiah J. Mackin, clerk and treasurer; Charles M. Thayer, general counsel. The board of directors consists of Robert F. Herrick, Malcolm Donald, Robert O. Morse, Henry P. Kendall, George C. Lee, Frank A. Drury, Homer Gage and Albert E. Newton. The company has unfilled orders amounting to about $3,000,000.

Electric Steel Co., Chicago, Ill., has been organized by men prominent in the Link-Belt Co. for the manufacture of small castings, and especially small castings in alloy steels. The officers are: Charles Piez, president; P. L. Coonley, secretary and treasurer; John M. Olmsted, vice-president. Mr. Piez is president of the Link-Belt Co., Mr. Coonley is vice-president and Mr. Olmsted for some years has been a member of the sales force of the Link-Belt Co. These three, with W. C. Frye and C. R. Messinger of Milwaukee, constitute the board of directors. Mr. Frye is the financial head of the Sivyer Steel Casting Co., the Federal Malleable Co. and other corporations of Milwaukee; while Mr. Messinger is vice-president of the Sivyer Steel Casting Co. In order to start production at once the company has leased the plant at 31st and Wood Sts., formerly occupied by the Wildman Boiler Works.

Peter A. Frasse & Co., Inc., 417-421 Canal St., New York City, importers and manufacturers' agents of tubing, steel, tools, and supplies, has purchased a tract of land, 65 by 344 feet, close by the tracks of the Central New England Ry. in Hartford, Conn., on which a new mill and warehouse will be erected. Hartford was chosen as the location for the new mill and warehouse, as it is considered the best point from which to serve the trade of Western New England, and is also in direct communication with Pittsburg and within easy reach of the company's warehouses in New York, Buffalo and Philadelphia. The building will be three stories high and of either mill or concrete construction. In the heat-treating department, furnaces for annealing, heat-treating, casehardening and tempering all steels will be provided. Draw-benches for cold-drawing will be installed and lathes for machining steel bars, etc. The equipment will enable the company to deliver at short notice anything that a manufacturer might need in the way of raw material as well as semi-finished material in the various grades of steel of its manufacture.



FEBRUARY 1916

Volume 22 Number 6

Seeing the Market Whole—1

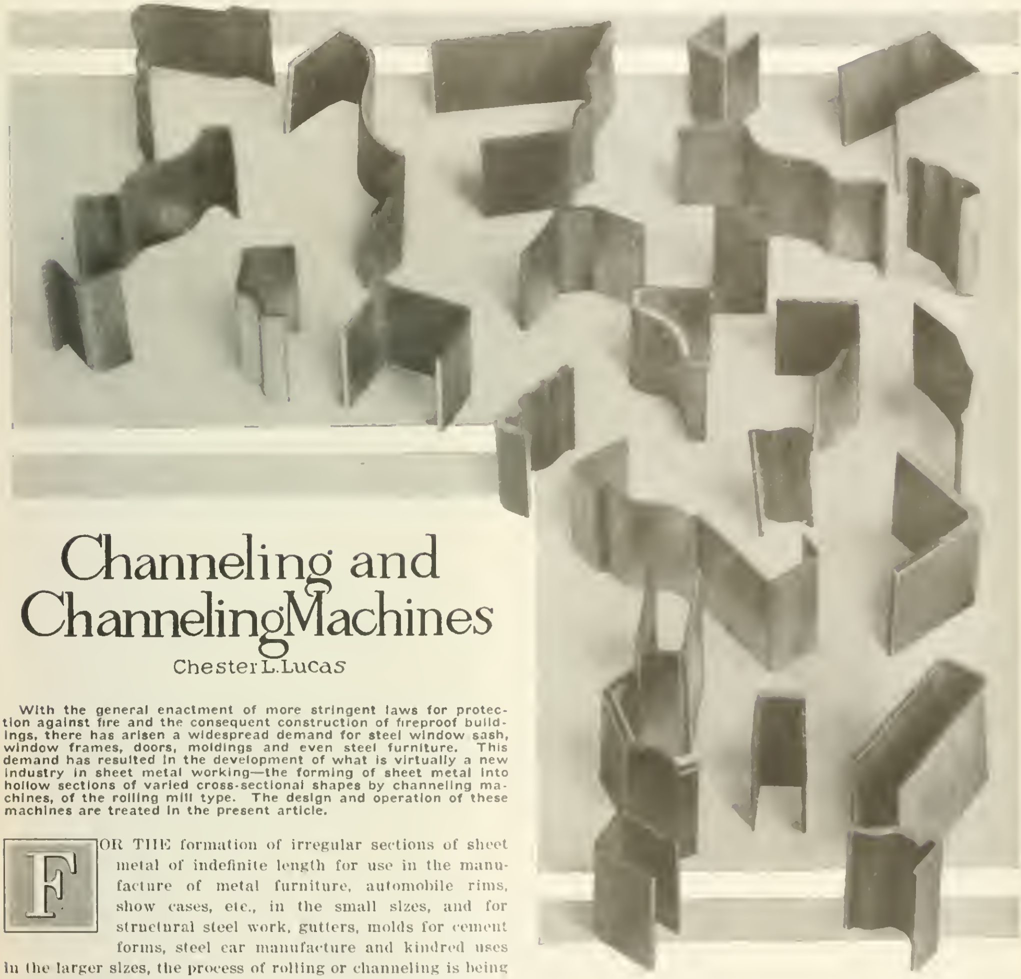
The modern machinery sales manager needs to have the whole world represented in his card index. His conception of his market and opportunity must be worldwide, if he is to rise to a great and unprecedented occasion, for both market and opportunity are worldwide, and buyers are in a receptive mood.

Too many Americans are unfamiliar with the commercial geography of this rolling world outside of North America. But machinery makers in other lands are well posted, and in the midst of war are not unmindful of their future trade opportunities in South America, Australia, New Zealand, China, Japan and elsewhere. How many American sales managers have considered, for example, the Island of Java—old Java in the Southern Seas—in their quest of markets? Mighty few. But they are using American machine tools in Java and in many other remote and unthought-of places well worth cultivating, if the future means anything to American machinery manufacturers.

A great mechanical era will follow the war. The period of recovery and of the re-organization of industry will quickly pass, and will be greatly facilitated by the universal employment of women—a great new labor element which has entered industry. Peaceful production, when it swings free again, will go with an impetus for all the mechanical contrivances that make for lower costs, multiplied power and capacity. War and the manufacture of war munitions, are teaching people everywhere what mechanical engineering means, not only on battle-fields, but in industry—and they are learning that Americans are, so far, the most generally inventive, ingenious and resourceful along mechanical lines. Much of the machinery which they find working wonders is American machinery.

Essentially, the manufacturer should see to it that his advertising in technical journals which go with certainty into *all* markets, is of the definite and specific character which the foreign buyer needs and appreciates. He examines the advertising pages for facts in regard to *design* and *construction*. He wants to know about the *principles*. He is, of course, greatly interested in data which demonstrates *working capacity*. Some of the results achieved in up-to-date American plants amaze him when he learns about them.

The whole purpose of advertising should be to furnish the prospective buyer with definite information—to make him acquainted with the product so that he unconsciously acquires familiarity with it, which means confidence in it. The need of this kind of advertising is great in the domestic as well as in the foreign market. Let both have it.



Channeling and Channeling Machines

Chester L. Lucas

With the general enactment of more stringent laws for protection against fire and the consequent construction of fireproof buildings, there has arisen a widespread demand for steel window sash, window frames, doors, moldings and even steel furniture. This demand has resulted in the development of what is virtually a new industry in sheet metal working—the forming of sheet metal into hollow sections of varied cross-sectional shapes by channeling machines, of the rolling mill type. The design and operation of these machines are treated in the present article.

FOR THE formation of irregular sections of sheet metal of indefinite length for use in the manufacture of metal furniture, automobile rims, show cases, etc., in the small sizes, and for structural steel work, gutters, molds for cement forms, steel car manufacture and kindred uses in the larger sizes, the process of rolling or channeling is being largely developed. Sheet stock of any metal may be formed cold by channeling, and any thickness up to one-quarter inch may be worked without difficulty. The speed at which this class of work is handled varies from fifty to ninety feet per minute, according to the metal and the shape to be produced. It is the purpose of this article to describe some of the principles involved and the type of machinery used in this interesting process. Much of the information was supplied by Kane & Roach of Syracuse, N. Y., who are the builders of the machines illustrated in this article.

Characteristics of Machinery for Channeling

Fig. 1 shows a typical channeling machine, with sections of stock as it appears at each stage of the channeling. Fig. 4 is a side view of the machine that shows the rolls to better advantage, and Fig. 7 shows the driving side of the machine with the gear guards removed. Fig. 2 shows a typical channeling job being done on a four-roll machine. Generally speaking, a machine for channeling has two or more pairs of steel rolls—when the shape is particularly intricate the number sometimes runs as high as twelve or fourteen pairs. These rolls are spaced at equal distances along the machine, and each pair gives the metal strip a bend that is slightly more pronounced than that given by the preceding pair. The rolls are geared together and are driven by connecting gears so that each pair helps to drive the sheet forward as well as to form it. On Kane & Roach machines the rolls are always of the overhanging type, that is, the forming rolls operate on the outside of the machine housing. This permits changing them without difficulty when it is desired to produce different sections. In addition, the work is more readily reached and controlled than would be possible if the rolls were within the housings. Adjustable outer bearings are fitted to the outer ends of each pair of rolls, tying the upper and lower shafts together so they cannot spring apart under the pressure. In very heavy channeling machines, the outer shaft bearings are connected in the horizontal direction as well. Fig. 7 shows a section through a rolling machine and illustrates the construction points here described. The gears for driving the rolls are made of steel in order that they may have the necessary strength. The driving gear is always located as near the center of the machine as possible in order to distribute the strain on the roll gears. In view of the fact that vertical ad-

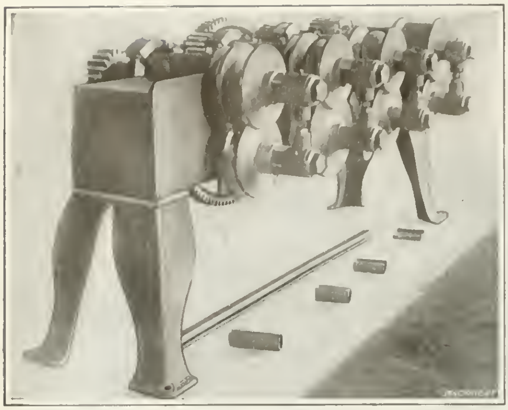


Fig. 1. A Typical Channeling Machine

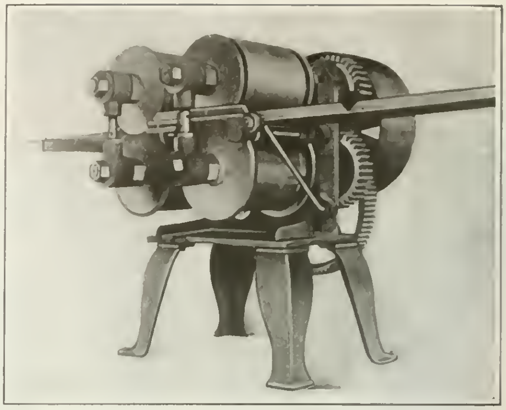


Fig. 2. Four-roll Channeling Machine

justment of the rolls is often necessary, the gear teeth must be cut fairly long to allow considerable latitude in meshing. The vertical adjustment is made possible by mounting the upper roll bearings in eccentric adjustable sleeves. The drive is always to the lower roll first in order to keep the gearing as compact and as low down on the machine as possible. Between each pair of channeling rolls there must be intermediate rolls or guides to carry the stock properly to the next pair of rolls. In order to start the stock correctly, so that it will not start off center or on a slant, a long table or guide is provided before the first pair of rolls. The design of these parts and their functions will be touched upon later.

The Rolls for Channeling

Except for the very smallest and lightest work where there are delicate shapes to be produced, the rolls for channeling machines are made from 0.80 carbon steel castings. When the size and shape permit, they are cored out. The rolls are turned to the finished shape, and after hardening are ground. In the case of delicately shaped or small work, tool steel is used, which is hardened, and afterward ground and shaped even more carefully than is necessary on the larger sized work.

The dimensions and proportions of channeling rolls cannot be laid down by any arbitrary rule, but depend on the depth of the bend and the thickness of the stock. In general, the ideal condition is to have the rolls as small as practical, still maintaining the strength necessary for mounting the rolls properly. Kane & Roach channeling machines are made standard, so that rolls for different sections may be used on the same machines. On these machines the distances between roll centers are arbitrarily fixed; on the machines shown they are from sixteen to twenty inches, which would make the roll diameter about eight or ten inches.

It should be borne in mind that the smaller the roll diameter, the less will be the grip of the rolls on the metal for driving purposes. This is an important point, as it is sometimes hard to secure a sufficient grip on the stock for driving it through the rolls, especially when the channeling section is a difficult one to produce. This is especially true when it is necessary to form metal strips that have been perforated before channeling. In such cases, the amount of metal left for the rolls to obtain a grip on is limited and it is sometimes necessary to throw fine sand on the stock as it is going through in order to make the rolls "take hold." Under no circumstances is a lubricant used, as it would destroy the driving power of the rolls.

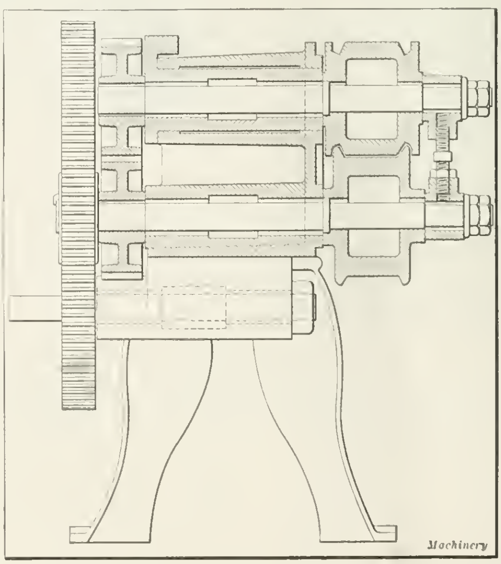


Fig. 3. Sectional View through Channeling Machine to show Roll Construction

Guiding the Stock

The metal to be formed by channeling must be kept under perfect control by guides before it enters the first pair of rolls, and while it passes from one pair of rolls to the next; it must also be guided or straightened after it emerges from the last set of rolls, to counteract the tendency to curl.

It is not necessary to have straightening rolls before the first set of rolls, as the latter are sufficient to remove any kinks or irregularities from the strips, but whenever the shape to be produced can be secured without the help of the first pair of rolls, they should be used perfectly straight as feed rolls. These assist in starting and driving the stock into the first pair of forming rolls. In fact, this feature is absolutely necessary when the metal is so thick that it cannot be readily started into a pair of rolls that will give it the first slight form. When thin stock is to be channeled, it is often possible to fit a pair of forming dies in advance of the first forming rolls, whose function it is to shape the end of the strip so it will enter the rolls easily. These dies are operated by foot-pressure, and the attachment may be seen at the right in Fig. 4. In this manner it is often possible to eliminate the pair of feed rolls at the start.

It is essential to start the stock absolutely central and straight, and for this purpose a long table guide is fitted at the front of the machine. This facilitates starting the strip, and when it has once entered correctly between the first rolls it will retain its alignment unless there is some serious defect in the channeling rolls.

Between each pair of channeling rolls, there must be

means for guiding the stock to the next set of rolls, as mentioned. The usual method of doing this is to provide guides in the form of enclosed boxes in which the stock fits fairly close, which give it the proper direction to enter the next pair of rolls. Fig. 2 illustrates this type of guide. Sometimes however, smaller rolls are used for guiding the partly channeled stock in place of the solid guides, and in addition to guiding the stock these intermediate rolls are always made to help in forming the stock as it passes through. In every case, these intermediate rolls are "dead," merely rotating under contact of the stock. The machine in Fig. 4 illustrates both the guides and intermediate rolls. Intermediate rolls are used between the first and second pairs of channeling rolls at the right-hand end of the machine, and the guides are used between the other pairs.

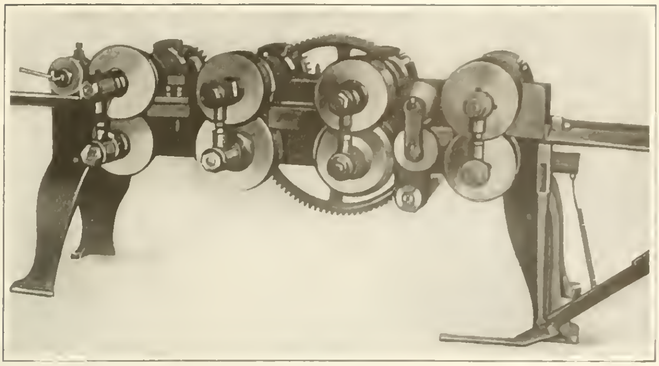


Fig. 4. Eight-roll Channeling Machine as viewed from Roll Side

At times, the shape of the section is such that it cannot be formed with rolls operating in one plane only; that is especially true when the section is deeply undercut. In such cases, side rolls are employed that operate in the opposite plane. These are located in the same manner as the intermediate rolls except that they are turned at right angles and do pressing-in operations on the sides of the stock.

It was also mentioned that, in order to produce accurate work, it is necessary to have a straightening roll at the end of the channeling machine to guide the stock as it leaves the last pair of rolls. On almost every channeling operation there is a tendency for the formed strip to curl either upward or downward, depending on the shape, as it emerges from the machine. To obviate this, a small roll, formed to fit one face of the finished stock, is fitted on the machine, following the last pair of rolls, either above or below the stock as found necessary. Fig. 4 shows a machine with the guide roll above the stock line. When properly applied one roll is sufficient to hold the metal straight, delivering the channeled strip in a perfectly straight condition.

In the case of channeling stock for hoops or rims of any kind, it is sometimes possible to put a bending attachment on the end of the channeling machine, as shown in Fig. 10, so that as the stock runs through the last pair of rolls it enters the bending rolls and is formed into the required circle. In this case, the stock cannot be run through in indefinite lengths, but each strip must be cut to the proper length for rolling into a ring of the required diameter before it is fed to the machine.

Laying Out the Rolls for a Channeling Machine

Before taking up the actual laying out of a set of rolls for channeling a given section, it may be well to study Fig. 5, which shows a few typical channeled sections and will help in illustrating the possibilities and principles involved. The different examples are shown in stages, each representing the work done by each pair of rolls on the machine. For instance, the three pieces on the upper line can be produced on machines like that shown in Fig. 2, having two pairs of channeling rolls. Those at the center of the illustration are typical of work that can be handled on machines having three pairs of rolls. The work on the lower line was done with channeling machines having four pairs of rolls, similar to that shown in Fig. 4. These examples are, of course, elementary but they give an idea of what channeling machines with two, three and four pairs of rolls can do. More difficult sections would require machines carrying a greater number of channeling rolls.

In laying out a set of channeling rolls, there are several general observations to be followed, irrespective of the shape of section to be produced. In addition, there are special lines of procedure to be followed in meeting the many conditions that must be taken into consideration. In order to make these points perfectly clear, they will be taken up in detail in the text and references will be made to Figs. 6, 8, and 9, that show the construction of sets of channeling rolls that have been made by Kane & Roach. Taking, first, the set of rolls for a four-roll machine, which as a matter of fact, were made for the machine illustrated in Fig. 2, and from the dimensions in Fig. 6, it will be possible to get an idea of the proportions and general characteristics of these rolls. In this particular instance, the channeled strip was very wide, and as the centers of the rolls had practically no work to do, cast iron was employed, but at the edges where the actual channeling was done steel was employed. The first bend in the

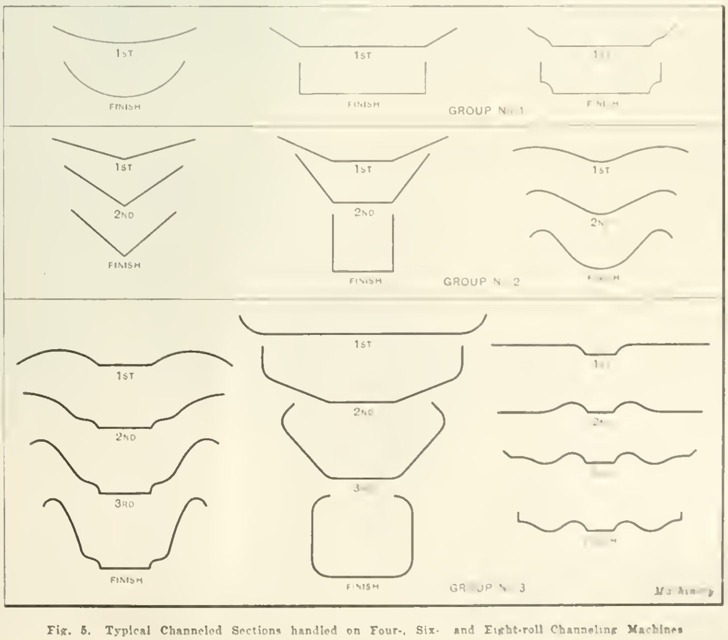


Fig. 5. Typical Channeled Sections handled on Four-, Six- and Eight-roll Channeling Machines

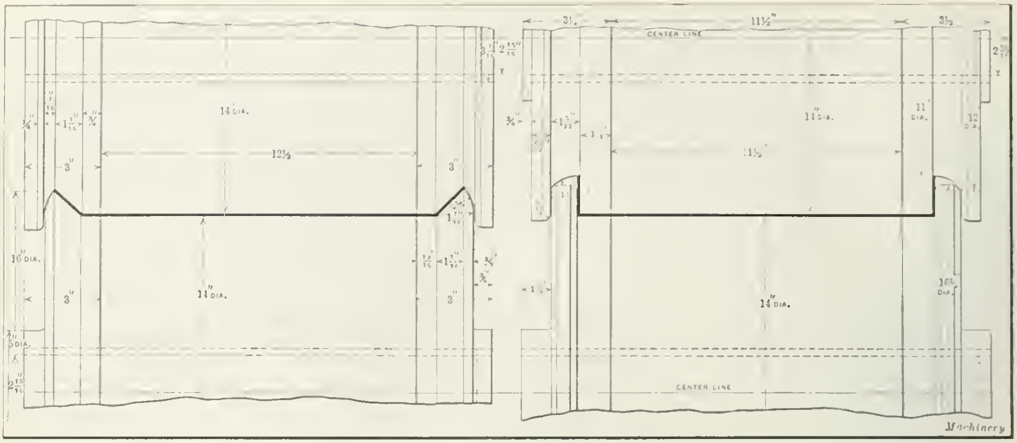


Fig. 6. Rolls from Channeling Machine illustrated in Fig. 2

stock carried the edges up to an angle of about 45 degrees, and the second pair of rolls squared up the bends, leaving them in the finished condition shown by the solid section between the rolls.

A more elaborate job, although similar in general shape, is the one that was performed by the rolls illustrated in Fig. 8. In this case eight rolls were used, the first pair being used as feeders. At the second pair the edges of the stock are thrown up to an angle of 30 degrees from the horizontal. At the third pair, the bending is continued, bringing the edges up to a 60-degree angle from the horizontal, and the fourth pair completes the right-angle bend on the strip.

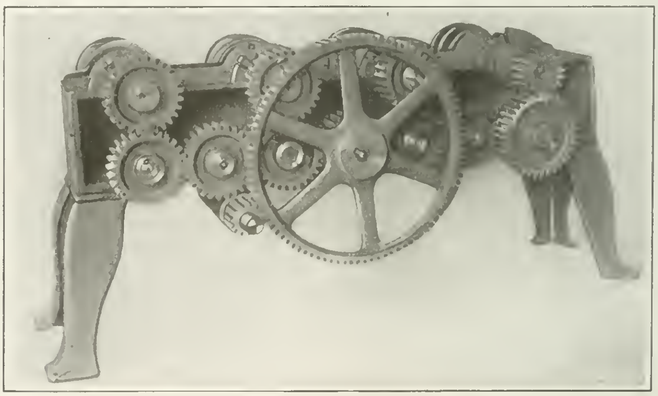


Fig. 7. Eight-roll Channeling Machine as viewed from Driving Side

In this case it will be noticed that cored rolls were employed, as the strain on the rolls was not great.

The sets of rolls shown in section in Fig. 9 are for producing a section of channeling such as would be used for automobile windshield frames or for a similar purpose. This is done on an eight-roll machine as shown in Fig. 1, and the first pair of rolls makes the bends in the sides of the strip; the second pair starts the formation of the tube; the third pair closes the ends as far together as possible, still supporting the work from the inside, while the fourth pair completes the tube, working from the outside of the stock altogether.

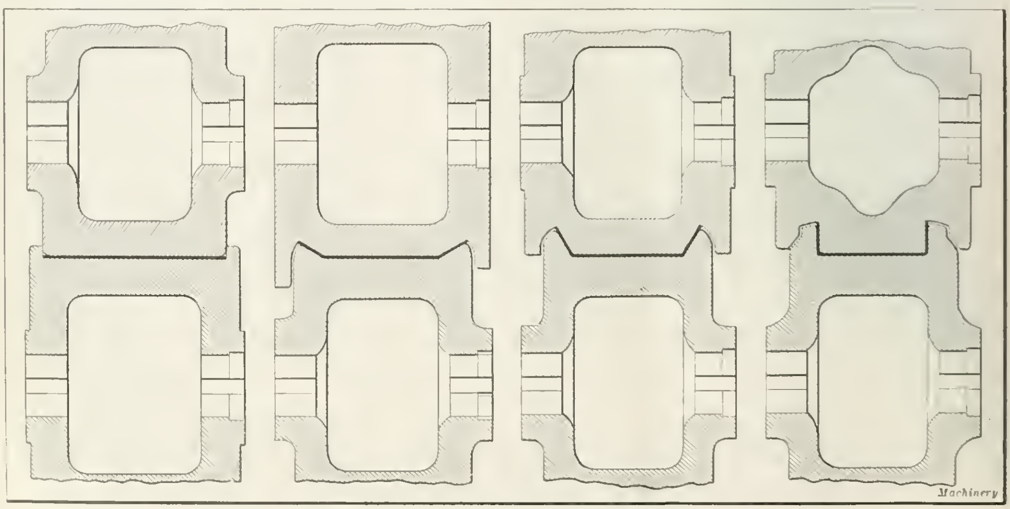


Fig. 8. Roll Sections for producing a Channeled Strip

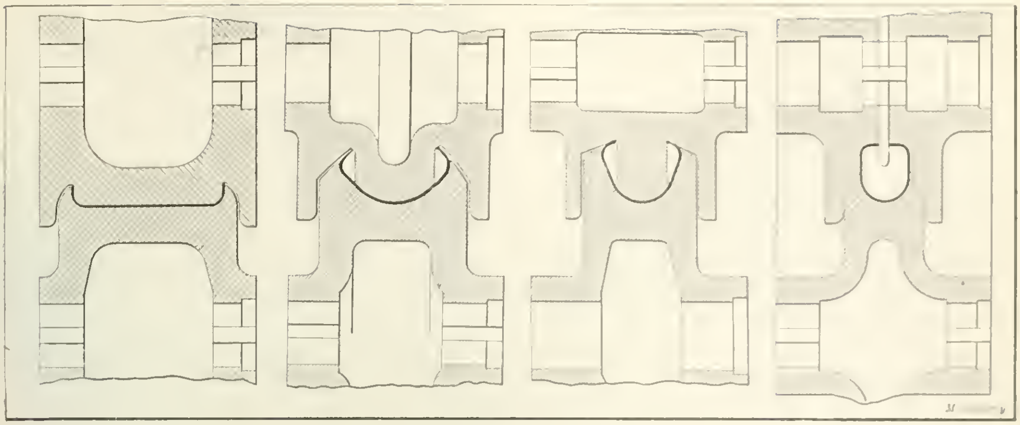


Fig. 9. Roll Sections for channeling a Tube

The channeling forms cut into the rolls should be so proportioned and spaced that the stock will follow as nearly a straight line as possible from the flat sheet to the finished section. This rule applies to the progression of the stock in the vertical plane as well as in the horizontal plane. This means that the transformation of the channeled section from one pair of rolls to the next must follow predetermined lines, and the method of ascertaining how much the change shall be in each case is graphically shown in Fig. 11.

In this view the development of both planes of the section is shown, as effected by a channeling machine with five pairs of rolls. By indicating the width of the stock required for the development of the section as at A, and the completely formed section as at E, and connecting the extremes as shown, the lines that the stock should follow in the course of the channeling operation will be obtained. The condition of the strip at the feed rolls, if the stock is heavy enough to require feed rolls, will be flat as shown at A. The finished condition is shown at E, which also shows the form to which the last pair of rolls must be fitted. By subdividing the intervening distance as at B, C, and D, the widths of the forms of the second and third pairs of rolls are ascertained. By the same method, as shown in the lower part of Fig. 11, the depths for the successive roll forms may be found. It should be understood that this method is used only for finding the outside limits of the stock lines and does not apply to the details of the form for each pair of rolls. This will be readily appreciated by referring to some of the examples in Fig. 5, which show that central details of the channeling are often of necessity formed and finished at the first or second stages of the channeling.

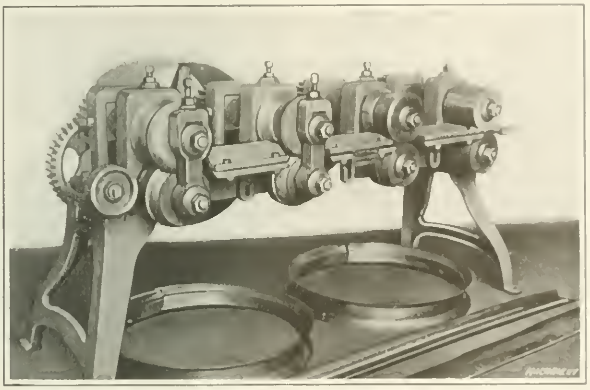


Fig. 10. Channeling Machine equipped with Bending Attachment for rolling Rims

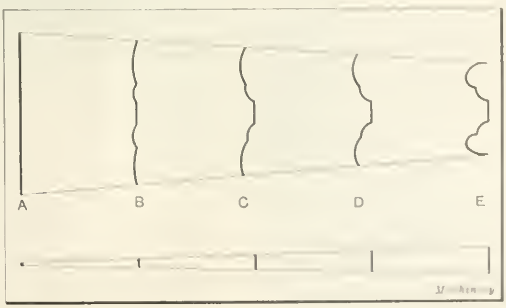


Fig. 11. Diagram illustrating Distribution of Work for Each Pair of Channeling Rolls

Each pair of rolls must have the forms located in the rolls with shoulders or guards at the sides against which the edges of the channeled strip may bear during the rolling process. This construction is clearly illustrated in the rolls represented in Fig. 8. Throughout the contacting surfaces of the rolls the distance between the two rolls must be exactly the same as the thickness of the metal. If this distance is not maintained, there will be a binding or shrugging action on the metal where the rolls are tightest, and the tendency will be not only to channel the stock improperly, but to put a "bow" in the strip as well, thus spoiling it. On each side of the actual contacting surfaces of the rolls, the unused portions are turned off slightly so as to give a clearance between all surfaces not necessary for the channeling. This also allows for making adjustment when the rolls have worn or if it should be necessary to apply more pressure.

One fundamental point in regard to the depth of the forms in the channeling rolls must always be borne in mind. The working center line of the stock should be kept as near to the center line between the two roll axes as possible. The reason for this is obvious, because it will at once be seen that any difference in the working diameters of the two rolls would prevent them from feeding alike, and the rolls would work against each other, sometimes to the extent of breaking the gear teeth. In addition, there would be a constant slipping action all the way through between the stock and the rolls. It is seldom possible to design the rolls so that the velocities of the bearing portions will be equal, but the aim is to approximate that condition. There is no rule that can be set down for the best location of the form in the rolls, but in general terms, the

channeling action should take place as near as possible to the center line between the rolls, as previously stated.

The ideal channeling action is secured when the last pair of rolls turns slightly faster than the others. The last rolls are, of course, the most important, as the metal is finished by the passage through them. By causing them to turn a very little faster than the others, the effect is to constantly exert a slight pull on the strip being channeled. It often happens, however, that these rolls have a tendency toward slower action on account of the deeper contour of the form cut in them. In such cases they must be speeded up by the use of change-gears. This condition is illustrated by the last pair of rolls in the set in Fig. 9, which are from the machine shown in Fig. 1. The rolls turn over the edges of the strip to form a tube. On account of the depth to which the upper roll must be cut to form the section, the contact surface left on this roll is very small in comparison with the contact surface of the lower roll. Consequently, if the speeds of these two rolls were equal, a great deal of slipping would take place. To overcome this difficulty, the upper roll is speeded up with change-gears to secure a uniform surface speed. Channeled stock must, of course, be cut to length by sawing, as shearing would destroy the shape.

For the formation of work that is to be subsequently bent at right angles, the edges of the stock may be notched at the bending points before channeling, so that when it emerges from the channeling machine it will be ready for bending. This was the case with the channeling job shown in Fig. 2, in which the notches may be seen. In the same way, punching, slitting or piercing operations may be conducted previous to channeling.

The great advantage of the channeling operation is that it is continuous—the shapes being produced as long as strip stock is supplied to the machine. Compared with press-working, a great saving of time and material is effected as the machine has no idle moments. On the whole, channeling is an extremely interesting process, and one which, though still in its infancy, clearly has great possibilities.

* * *

A LARGE BROACHING JOB

The W. W. Oliver Mfg. Co. of Buffalo, N. Y., has made several sizes of jewelers' rolling mills for a number of years. In the right-hand lower corner of Fig. 1 may be seen the castings for three sizes of housings for these rolls. The machining of these housings includes the finishing of the slots in which the roll bearings slide and also the finishing of the inside faces that limit the end play of the rolls. It is plain that if the rolls are to work properly these surfaces must be finished accurately and, above all, the cuts must be parallel.

Until the method of machining described in the following was adopted, this work was accomplished by milling, but it was slow, requiring an average of two and a half hours to finish each housing and the employment of an awkward extension milling rig that reached through the housing.

Fig. 1 shows how the job is successfully handled in one-tenth of the milling time, on a Lapointe Machine Tool Co.'s

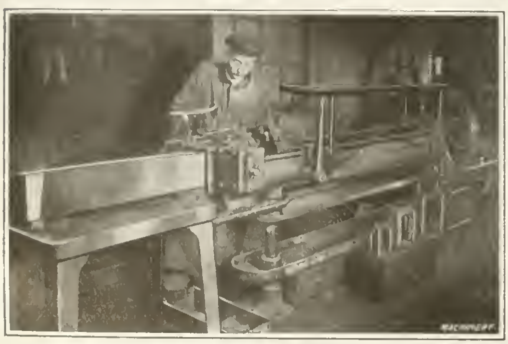


Fig. 1. Broaching Housings of Jewelers' Rolls

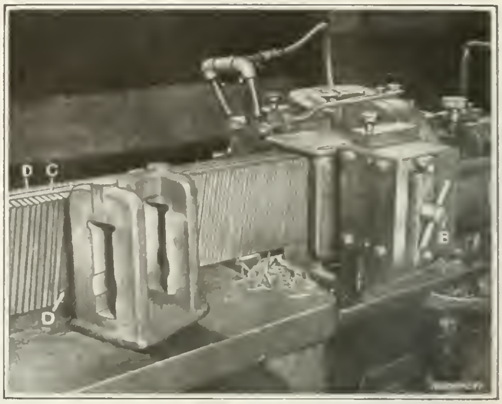


Fig. 2. Close-range View of Broach and Work

broaching machine. Fig. 2 was taken at close range and shows how the work is held for broaching. In the latter illustration the faceplate fixture for holding the housing may be seen, and in Fig. 3 the construction of the broach and the method of supporting the work are shown. The entire job is completed in two broaching cuts; one through the work, as shown in the illustrations, and the other at right angles through the slots in the housing sides. As shown in Fig. 3, the work is held in place by clamping tongues *A* that may be run in to engage the slots at the sides by means of hand-screws *B*. The broaching operation is performed in the usual manner, and after the lot of housings has been broached in

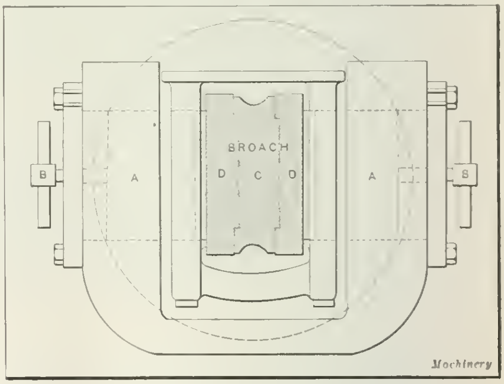


Fig. 3. Broach Section and Details of Work Support

one direction a faceplate is put on the machine to hold the work for taking the cut in the other direction.

The slots in the housings are broached with solid broaches, but the other operation is done with a built-up broach as shown by the section in Fig. 3. This broach, if made solid, would require a very heavy and expensive piece of tool steel and, moreover, as various sizes of housings must be finished, it was decided to make each broach cover as many sizes as possible. To this end, the broaches are made in halves, permitting the insertion of filler-blocks of different thicknesses between the halves when wide cuts are to be made. Thus, in Fig. 3, filler-block *C*, of machine steel, separates the halves of the broach to the required size for broaching the housing shown. By substituting thicker or thinner filler-blocks, larger or smaller sized housings may be handled with the same broach. In the top and bottom faces of the filler-block are grooves that engage guide-blocks in the head of the machine, and thus the action of the broach is effectively controlled. The average machining time for finishing the housings by this method is fifteen minutes, as contrasted with two hours and a half for milling. C. L. L.

TOOL STEEL TRADE-NAMES

COMPILATION OF DISTINCTIVE BRANDS OF TOOL AND HIGH-SPEED STEELS

Prior to the discovery of high-speed steel by Messrs. Taylor and White in the late nineties, there were well-known brands of carbon tool steels, some of which dated back over fifty years. Since that epoch-making discovery many more brands of high-speed steel and carbon tool steel have been placed on the market. Generally these brands are copyrighted trade-names that are distinctive, catchy, or suggestive of high efficiency, but few are self-identifying as the product of the makers. We have often been asked for the names of makers or general sales agents of this, that or the other brand of steel, and have felt the need of a comprehensive directory of these peculiar trade-names. The following list of distinctive and copyrighted names of carbon tool steel and high-speed steel has been compiled from information furnished by the American steel makers and the general sales representatives of brands of carbon steel and high-speed steel sold in America. It has been the intention to include only the names of the American makers, or in the case of foreign steels, the names of the general agencies. In a few cases it has seemed necessary to give both the name of the maker and the general agency. The list is incomplete in the sense that many names have been omitted which could not be regarded as distinctive, such as "Standard," "XX," "Special," "Extra," "Double Extra," etc. But on the other hand some in the doubtful class have been given here because only one concern in each case is using them.

Brand	Maker or Agent
A B C Special	Darwin & Milner, Inc., New York.
Ajax	B. M. Jones & Co., Inc., Boston, Mass.
Albany	Ludlum Steel Co., Watervliet, N. Y.
Albion	Hobson, Houghton & Co., Ltd., N. Y.
Alva	Crucible Steel Co. of A., Pittsburg.
A M C	A. Milne & Co., New York.
Anchor	Colonial Steel Co., Pittsburg, Pa.
Argo	John Illingworth Steel Co., Phila., Pa.
Ark	Wm. Jessop & Sons, Inc., New York.
Arrow	John A. Crowley Co., New York.
Atha	Crucible Steel Co. of A., Pittsburg.
Atlas	Atlas Cr'c'ble Steel Co., Dunkirk, N. Y.
Austenite	Milnor & Goedman, New York.
Austenite Excelsior	Milnor & Goedman, New York.
Aust. Excel. Superior	Milnor & Goedman, New York.
A W Special	Firth-St'rl'ng Steel Co., McK'port, Pa.
Beaver	Colonial Steel Co., Pittsburg, Pa.
Bell	Patriarche & Bell, New York.
Bethlehem	Bethlehem Steel Co., S. Bethlehem, Pa.
B F M	Milnor & Goedman, New York.
Black Diamond	Crucible Steel Co. of A., Pittsburg.
Blue Chip	Firth-St'rl'g Steel Co., McKeesport, Pa.
Blue Chip C	Firth-St'rl'ng Steel Co., McK'port, Pa.
Blue Chip Superior	Firth-St'rl'ng Steel Co., McK'port, Pa.
Blue Label	Heller Brothers Co., Newark, N. J.
Bohler Rapid	Houghton & Richards, Boston, Mass.
Braeburn	Braeburn Steel Co., Braeburn, Pa.
Burgess	Cyclops Steel Works, Titusville, Pa.
C	A. Milne & Co., New York.
Canton	Crucible Steel Co. of A., Pittsburg.
Capital*	Edgar T. Ward's Sons, Boston, Mass.
Cello	McInnes Steel Co., Ltd., Corry, Pa.
Ceswic	Central Steel & Wire Co., Chicago, Ill.
Champion	Crucible Steel Co. of A., Pittsburg.
C L	A. Milne & Co., New York.
Clarite	C'l'mb'a Tool Steel Co., Ch'c'go Hts, Ill.
Class E	Edgar Allen & Co., Ltd., Chicago, Ill.
Class P	Edgar Allen & Co., Ltd., Chicago, Ill.
Cobalt	Becker Steel Co. of America, N. Y.
Coco	Colonial Steel Co., Pittsburg, Pa.
Colonial	Colonial Steel Co., Pittsburg, Pa.
Columbia	C'l'mb'a Tool Steel Co., Ch'c'go Hts, Ill.
Comet	Carpenter Steel Co., Reading, Pa.
Crescent	Crucible Steel Co. of A., Pittsburg.
Cromo	Carbon Steel Co., Pittsburg, Pa.
Crown-Razor	Horace T. Potts & Co., Philadelphia.
C S	A. Milne & Co., New York.
Cyclone	Congdon & Carpenter, Pr'dence, R. I.
Cyclops	Cyclops Steel Works, Titusville, Pa.
C Y W Choice	Firth-St'rl'ng Steel Co., McK'port, Pa.
Dana	Dana & Co., Inc., New York.
Dannemora*	Edgar T. Ward's Sons, Boston, Mass.
Darwin	Darwin & Milner, Inc., New York.
Darwin 505 Cobalt	Darwin & Milner, Inc., New York.
Demmler D	Firth-Sterling Steel Co., McK'port, Pa.
Deward	Atlas Cr'c'ble Steel Co., Dunkirk, N. Y.
Diamond	Peter A. Frasse & Co., Inc., New York.
Diamond B	Joseph T. Ryerson & Son, Chicago, Ill.
Disston's	Henry Disston & Sons, Tacony, Phila.
Double Mushet	B. M. Jones & Co., Inc., Boston, Mass.
Dreadnought †	Halcomb Steel Co., Syracuse, N. Y.
D S W	George Nash Co., New York.
Duro Special	Crucible Steel Co. of A., Pittsburg.
Duror	Darwin & Milner, Inc., New York.
Dynamo	Patriarche & Bell, New York.
E H	Ellsworth Haring, New York.
Elba	Ludlum Steel Co., Watervliet, N. Y.
Empire A	Swedish Iron & Steel Co., New York.
Excelsior	Swedish Iron & Steel Co., New York.
F	Ludlum Steel Co., Watervliet, N. Y.
Fearless	Hobson, Houghton & Co., Ltd., N. Y.
F E R	A. Milne & Co., New York.
Finis	Firth-Sterling Steel Co., McK'port, Pa.
Firth's Best	Firth-Sterling Steel Co., McK'port, Pa.
F J A B	A. Milne & Co., New York.
Flying Scotsman	Peter A. Frasse & Co., Inc., New York.
Fort Pitt	Vulcan Cr'c'ble St'l Co., Aliquippa, Pa.
Frasse Electric	Peter A. Frasse & Co., Inc., New York.
F Special	Ludlum Steel Co., Watervliet, N. Y.
Girod	C. W. Leavitt & Co., New York.
Goliath	Krefeld Steel Co., New York.
Green Label	Heller Brothers Co., Newark, N. J.
Gyro	Braeburn Steel Co., Braeburn, Pa.
Gysinge	Electro Steel Co., Pittsburg, Pa.
Halco	Halcomb Steel Co., Syracuse, N. Y.
Halcomb †	Halcomb Steel Co., Syracuse, N. Y.
Hansa	Dilworth Lockwood & Co., New York.
Hawk Brand	Hawkridge Bros. Co., Boston, Mass.
Hecla	Vulcan Cr'c'ble St'l Co., Aliquippa, Pa.
Hidalgo	Hidalgo Steel Co., New York.
Hobson	Hobson, Houghton & Co., Ltd., N. Y.
Hobson's Choice XX	Hobson, Houghton & Co., Ltd., N. Y.
Howe	Crucible Steel Co. of A., Pittsburg.
Howe-Brown	Crucible Steel Co. of A., Pittsburg.
H & R	Houghton & Richards, Boston, Mass.
H S	A. Milne & Co., New York.
Hudson	Baldwin Steel Co., Charleston, W. Va.
Huron	Ludlum Steel Co., Watervliet, N. Y.
I B	A. Milne & Co., New York.
Ideal	Edgar T. Ward's Sons, Boston, Mass.
Ideor	Darwin & Milner, Inc., New York.
Imperial	Edgar Allen & Co., Ltd., Chicago, Ill.
Incassable	Milnor & Goedman, New York.
Inflexible	Milnor & Goedman, New York.
Intra	H. Boker & Co., Inc., New York.
Invaro	Firth-Sterling Steel Co., McK'port, Pa.
I R	Ingersoll-Rand Co., New York.
Iridium Cobalt	Becker Steel Co. of America, N. Y.
Janus	Hidalgo Steel Co., New York.
Jason	Carpenter Steel Co., Reading, Pa.
Jessop	Wm. Jessop & Sons, Inc., New York.
J I	John Illingworth Steel Co., Phila., Pa.
J Y	Carpenter Steel Co., Reading, Pa.
K-9	Edgar Allen & Co., Ltd., Chicago, Ill.
Ketos †	Halcomb Steel Co., Syracuse, N. Y.
Keystone	Carpenter Steel Co., Reading, Pa.
Krefeld	Krefeld Steel Co., New York.
Kronos	Peter A. Frasse & Co., Inc., New York.
Krupp	Thomas Prosser & Son., New York.
Kutkwik	Henry Disston & Sons, Tacony, Phila.
K W	Carpenter Steel Co., Reading, Pa.
La Belle	Crucible Steel Co. of A., Pittsburg.
L C T †	Halcomb Steel Co., Syracuse, N. Y.
Loco	Atlas Cr'c'ble Steel Co., Dunkirk, N. Y.
Mansil	Henry Disston & Sons, Tacony, Phila.
Maximum	Peter A. Frasse & Co., Inc., New York.
Midas	Carpenter Steel Co., Reading, Pa.
Midvale	Midvale Steel Co., Philadelphia, Pa.
Minerva	Edgar Allen & Co., Ltd., Chicago, Ill.
Misco A	McInnes Steel Co., Ltd., Corry, Pa.
Modern	Becker Steel Co. of America, N. Y.
Mohawk	Ludlum Steel Co., Watervliet, N. Y.
Monaca	Pittsb'g T'l St'l Wire Co., Monaca, Pa.
Monarch	Schrock & Squires, New York.
Mushet	B. M. Jones & Co., Inc., Boston, Mass.
N C S	H. Boker & Co., Inc., New York.
Neor	Darwin & Milner, Inc., New York.
No. 7	Colonial Steel Co., Pittsburg, Pa.
Novo	H. Boker & Co., Inc., New York.
Novo Superior	H. Boker & Co., Inc., New York.
Oildie	C'l'mb'a Tool St'l Co., Ch'c'go Hts., Ill.
Oneida	Ludlum Steel Co., Watervliet, N. Y.
Paragon	Crucible Steel Co. of A., Pittsburg.

Brand	Maker or Agent
Park	Crucible Steel Co. of A., Pittsburg.
Peerless	Heller Bros. Co., Newark, N. J.
Peerless A	Crucible Steel Co. of A., Pittsburg.
P F	Phila. Steel & Forge Co., Phila., Pa.
P H	Becker Steel Co. of America, N. Y.
Phylex	Darwin & Milner, Inc., New York.
Poldi	Peter A. Frasse & Co., Inc., New York.
Pompton	Ludlum Steel Co., Watervliet, N. Y.
Presto	Carpenter Steel Co., Reading, Pa.
Prima Mosta	Moore Bros., Sharon, Pa.
Prince	A. Milne & Co., New York.
Reading	Carpenter Steel Co., Reading, Pa.
Red Cut Cobalt	Vanadium-Alloys Steel Co., Latrobe, Pa.
Red Cut Superior	Vanadium-Alloys Steel Co., Latrobe, Pa.
Red Star	Colonial Steel Co., Pittsburg, Pa.
Red, White and Blue	George Nash Co., New York.
Regal No. 2	Vulcan Cr'c'ble St'l Co., Aliquippa, Pa.
Rekord Superior	Horace T. Potts & Co., Philadelphia.
Rex	Crucible Steel Co. of A., Pittsburg.
Royal	Milnor & Goedman, New York.
Royal Tool	Milnor & Goedman, New York.
R T	Firth-Sterling Steel Co., McK'port, Pa.
Rushitoff	Fairley-Davidson Steel Co., Inc., N. Y.
Ryolite	Joseph T. Ryerson & Son, Chicago, Ill.
Saben	Halcomb Steel Co., Syracuse, N. Y.
Sanderson	Crucible Steel Co. of A., Pittsburg.
Sandvik	J. Wilckes Co., New York.
Scott's IXL	Bourne-Fuller Co., Cleveland, Ohio.
Scott's Unique	Bourne-Fuller Co., Cleveland, Ohio.
Seneca	Ludlum Steel Co., Watervliet, N. Y.
Silver Steel	Hobson, Houghton & Co., Ltd., N. Y.
Silver Tool	Crucible Steel Co. of A., Pittsburg.
Sisco	Swedish Iron & Steel Co., New York.
Sisco-Acorn	Swedish Iron & Steel Co., New York.
Soderfors Best	Horace T. Potts & Co., Philadelphia.
Soho	Hobson, Houghton & Co., Ltd., N. Y.
Solar	George Nash Co., New York.
Solar High Duty	George Nash Co., New York.
Speedicut	Th's. Firth & S'ns., Ltd., M'treal, Can.
S R B	Halcomb Steel Co., Syracuse, N. Y.
S. & S	Schrock & Squires, New York.
Stag	Edgar Allen & Co., Ltd., Chicago, Ill.
Star	Peter A. Frasse & Co., Inc., New York.
Star Zenith	Carpenter Steel Co., Reading, Pa.
Stellite ‡	Haynes Stellite Co., Kokomo, Ind.
Stentor	Carpenter Steel Co., Reading, Pa.
Sterling	Firth-Sterling Steel Co., McK'port, Pa.
Styrian	Houghton & Richards, Boston, Mass.
Superior	Peter A. Frasse & Co., Inc., New York.
Supreme	Edgar Allen & Co., Ltd., Chicago, Ill.
Talon	Edgar Allen & Co., Ltd., Chicago, Ill.
Titan	Carpenter Steel Co., Reading, Pa.
Titanic	B. M. Jones & Co., Inc., Boston, Mass.
T K	Carpenter Steel Co., Reading, Pa.
Toledo	Jno. Hy. Andrew & Co., Ltd., N. Y.
Toledo Supra	Jno. Hy. Andrew & Co., Ltd., N. Y.
Trinity Tone	Westmoreland Steel Co., Gr'ns'b'g, Pa.
Triple Life C D	Darwin & Milner, Inc., New York.
Trojan	Horace T. Potts & Co., Philadelphia.
U B A S	George Nash Co., New York.
Ultissimus	Electro Steel Co., Pittsburg, Pa.
Ultra Capital*	Edgar T. Ward's Sons, Boston, Mass.
Ultra-Rapid	Electro Steel Co., Pittsburg, Pa.
U. S	Brown & Co., Inc., Pittsburg, Pa.
Utal	Darwin & Milner, Inc., New York.
V	McInnes Steel Co., Ltd., Corry, Pa.
Vasco Choice	Vanadi'm-Alloys St'l Co., Latrobe, Pa.
Vasco Electric	Vanadi'm-Alloys St'l Co., Latrobe, Pa.
Vasco Ideal	Vanadi'm-Alloys St'l Co., Latrobe, Pa.
Vasco Latrobe	Vanadi'm-Alloys St'l Co., Latrobe, Pa.
Vasco Marvel	Vanadi'm-Alloys St'l Co., Latrobe, Pa.
Vasco Non-Shrinkable	Vanadi'm-Alloys St'l Co., Latrobe, Pa.
Vasco Special	Vanadi'm-Alloys St'l Co., Latrobe, Pa.
Velos	F. R. Phillips & Sons Co., Phila., Pa.
Velox	Atlas Cr'c'ble St'l Co., Dunkirk, N. Y.
Victor	Crucible Steel Co. of A., Pittsburg.
Victoria Gluckenstahl	Johnson & Co., St. Louis, Mo.
Victory	Hy. Rossell & Co., Ltd., Chicago, Ill.
Viking	Crucible Steel Co. of A., Pittsburg.
Vulcan	Vulcan Cr'c'ble Steel Co., Aliquippa, Pa.
Wardlow's Tough	S. & C. Wardlow, New York.
Warranted Best	Hobson, Houghton & Co., Ltd., N. Y.
Wesco	Braeburn Steel Co., Braeburn, Pa.
Weto	Carbon Steel Co., Pittsburg, Pa.
Wolfram	Vulcan Cr'c'ble Steel Co., Aliquippa, Pa.
Wolfram Cobalt	Vulcan Cr'c'ble St'l Co., Aliquippa, Pa.
Xtof	Fairley-Davidson Steel Co., Inc., N. Y.
Xtrusion	Fairley-Davidson Steel Co., Inc., N. Y.
Yellow Label	Heller Bros. Co., Newark, N. J.
Zenith	Carpenter Steel Co., Reading, Pa.

* Also sold by the George Nash Co., New York.
† Sold by Hawkridge Bros., Boston, Mass.
‡ Stellite is not a steel, but a chromium-cobalt alloy.

LUBRICANT IN GRINDING

Some interesting facts on lubricants used in grinding are given in the December number of *Grits and Grinds*, in an article by Howard W. Dunbar of the Norton Grinding Co. He states that the term "lubrication of the work" may be a misnomer in grinding, as the use of grinding compound, oil, soda water or even clear water flowing on the work at the point where the grinding wheel comes in contact with the work being ground is known as lubrication of the work. The fluid may lubricate in a degree and reduce the friction of the cutting particles on the wheel, but it also has other functions. It entirely eliminates the grinding dust evil from the ordinary dry grinding operation, as the lubricant bears this dust away as soon as made. Lubrication keeps the temperature of the work being ground uniform over the entire surface of the cylinder, and—of most importance—it carries away the heat generated by the wheel in cutting particles from the work being ground. It dissipates the heat and in this way reduces the power required to grind.

In the early days of the grinding industry all grinding was done dry, but that time is past. It was considered that the only possibility in grinding was a polishing operation with a dry wheel. This was the conception of the engineers of thirty years ago. But as time went on, a few drops of water per minute were allowed to trickle on the wheel. Improvement was noticed, and then a small stream was allowed to run on the wheel. More work was done and now we allow a large stream of lubricating compound to flow upon the work at the point where the wheel comes in contact with the work. The results in increasing the production of grinding machines have been astonishing.

Clear water was the first agent tried, and then because of the rusting effect soda water was used. Soda, in itself, is a lubricant, and improvement was noticed. Then soapy water was tried, and finally after investigations had been made by chemists, aided by the experience of grinding engineers, compounds were made that give much better results. In these compounds, there are certain amounts of oil, soda water, soap, etc. These all have their functions to perform and contribute to the general efficiency. Perhaps even better results might be accomplished if clear oil were used for the grinding lubricant.

But we still have grinding machines used dry that should be operated as wet grinding machines. There is no reason for factories to continue to grind and snag castings dry when they should be snagged under a lubricant. Results would be greater economy and increased production. The same holds true of the tool-room and tool grinding. When work is ground dry, very light cuts must be taken in order that the heat generated will not seriously harm the work being ground. The heat generated in dry grinding causes a small section of the work to become heated, and as the revolution of the work is slow, the heat accumulates and causes warping due to expansion and contraction. It is impossible under a heavy cut to grind round and perfect cylinders. The same holds true if too little lubricating compound is used on the work. Enough must be used to dissipate the heat generated, reduce the friction and thereby keep the work at a uniform temperature throughout.

* * *

FIREPROOF STORAGE RACKS

A system of sectional fireproof storage racks used by the Ferracute Machine Co., Bridgeton, N. J., was described in *Industrial Engineering*. These racks are used for storing the finished parts of machines. They consist of a series of steel plates, mounted one above the other and held apart and supported by pieces of pipe of the required length. A steel rod or bolt, the length of which must be adapted to the number of shelves placed in the racks, extends from the end of the pipe section resting on the floor to the top of the highest shelf, where it is fastened by means of a nut and washer. Holes are drilled through the plates for these bolts. At the end of the bottom section of the pipe, where it rests on the floor, base washers are provided.

OXY-ACETYLENE WELDING OF ALUMINUM*

DIRECTIONS FOR CARRYING OUT THE WORK AND EXAMPLES FROM PRACTICE

BY S. W. MILLER†

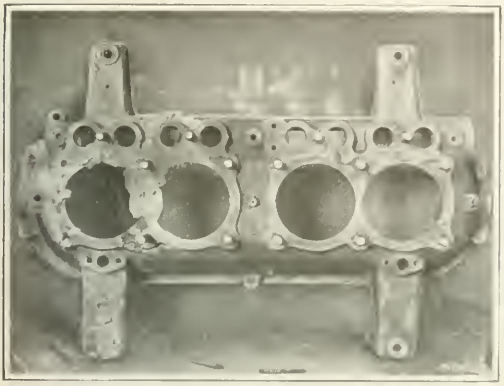


Fig. 1. Crank-case damaged by the Use of Flux and Improper Welding

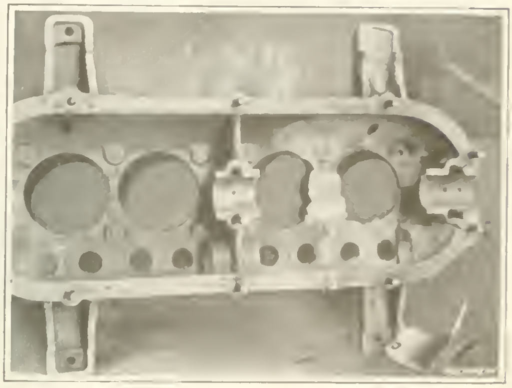


Fig. 2. Bottom View of Crank-case shown in Fig. 1

ALUMINUM is seldom used in its pure condition, as it is too soft, and in repair work only the aluminum alloys—principally in the form of crank-cases, transmission cases, and other automobile parts—are encountered. In the United States the usual alloy contains, at the present time, about 93 per cent aluminum and 7 per cent copper. In the past quite a number of parts were made from a zinc alloy containing approximately 90 per cent aluminum and 10 per cent zinc, but in foundry practice it was found that the alloy became brittle at a temperature just below solidification, so that many castings were defective on account of cracks due to shrinkage and had to be thrown out. The copper alloy, while not quite so strong at ordinary temperatures, does not have the tendency to crack that the zinc alloy has; this is fortunate for the welder, as cracking is likely to occur in many cases, particularly in a complicated piece, due to the contraction strains.

A zinc alloy is generally identified by the condensation of the white zinc oxide on the cooler part of the casting during welding, and it may be necessary to cut or break the casting at some place where it can be repaired without bad contraction strains, in order that the weld in the original break may be made. It is not very often that the zinc alloy is encountered at the present time, although when it is, it may cause the welder a great deal of trouble, and in some cases, it may be impossible to do the job. It is necessary with such zinc alloys to preheat the whole piece to as high a temperature as is safe, and handle it very carefully. Sometimes it is advisable to have an extra man to help in handling the work, as if the piece is dropped or jarred it may be damaged considerably. When the weld is rather long, it is sometimes necessary to use two welders, beginning at the center and working toward both ends, so that the variation in temperature and the resulting strains are not so great as they would be if only one torch were used. In the case of a copper alloy, this brittleness does not exist to so great an extent, and it is not necessary to take such great precautions, but in all cases where the defect extends into the body of the casting, it is advisable to thoroughly preheat and handle it carefully. Aluminum oxidizes readily, particularly at high temperatures, and as the oxide melts at a much higher temperature than the metal, and is heavier than the melted metal, it is likely to become mixed into the melted mass and produce a poor weld.

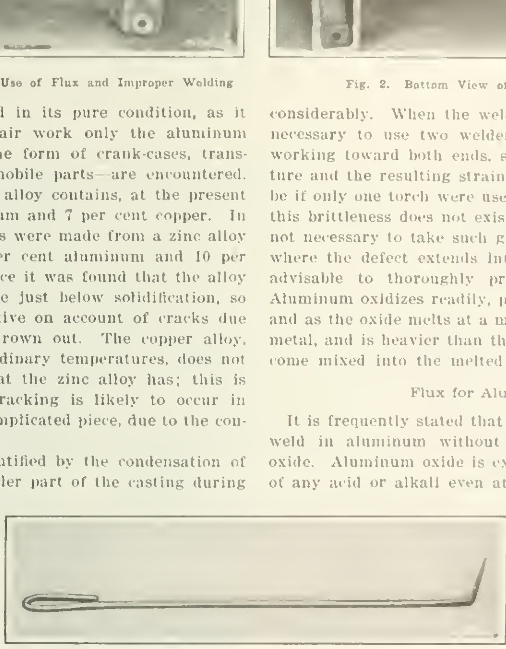


Fig. 3. Puddling Rod used when welding Aluminum

Fig. 4. Aluminum Manifold with Broken Lug

Flux for Aluminum Welding

It is frequently stated that it is impossible to make a sound weld in aluminum without a flux which will destroy the oxide. Aluminum oxide is exceedingly resistant to the action of any acid or alkali even at a high temperature. Therefore, the flux used in welding must be very severe in its action. The danger in using some kinds of flux is that an excess, unless it is removed in some way, will damage both the metal in the weld and that surrounding it. The writer has seen this action occur a number of times. It is true that the welding was done by those who were not very skillful, and who did not realize the importance of using the minimum amount of flux and brushing off the surplus in boiling water afterward. Another objection to the use of flux is that the surfaces to be joined must be thoroughly cleaned, because the flux is designed to remove oxide of aluminum and not grease and dirt, which are always present in repair work. The time occupied in cleaning the dirt out of the crack or break is considerable, and in most cases the

* For further information on oxy-acetylene welding, see "Oxy-acetylene Welding Practice," January, 1916, and articles there referred to. For welding aluminum, see "Methods of Jointing Aluminum," February, 1915, and articles there referred to.

† Address: Rochester Welding Works, Rochester, N. Y.

Fig. 5. Aluminum Inlet Manifold with Broken Carbureter Flange

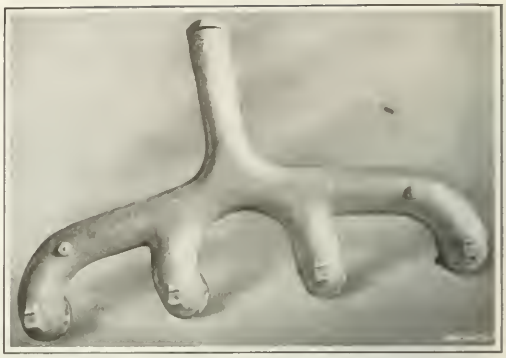


Fig. 6. Aluminum Inlet Manifold—Repairs Completed

weld can be made without flux in the time required to clean the piece thoroughly. Again, it is not possible, even by the use of a flux, to avoid some porosity in a weld; and further, in the best aluminum castings there may be, and frequently is, greater porosity than in a well puddled weld. In view of these facts, the author doubts the advisability or necessity of using flux.

The method used in the writer's shops in the case of cast aluminum is to thoroughly puddle it without any preparation, except wiping off the dirt and grease. There is an additional advantage in not making a V at the break in the case of aluminum, which is that the sections are generally thin and the contraction of the weld is better resisted by the piece being allowed to remain its full thickness, although of course the contraction is not entirely avoided.

Figs. 1 and 2 show the damage that can be done by improper treatment. While the writer is not sure of the original condition, this type of case generally is not seriously damaged when a connecting-rod or bolt gives way, which apparently was the cause of the damage. However this may be, the fact remains that whoever welded it (it was not done in the author's shops, but sent there to be properly repaired) used altogether too much flux on it, and was unable to get satisfactory results. The case was so seriously damaged by this treatment that the cost of putting it in proper shape would be much greater than if it had been properly repaired in the first place, and would be so high that it would probably be inadvisable to spend the money on it. This is a good illustration of the incidental damage that can be done by improper welding. Undoubtedly, the welder who attempted to do this job had had little, if any, experience, was using a cheap outfit, and had no instructions in the principles of the art. This is not the only piece that the writer has seen damaged in the same way, and illustrations could be multiplied without end of cases where such serious damage was caused by improper welding as to require the purchase of new parts.

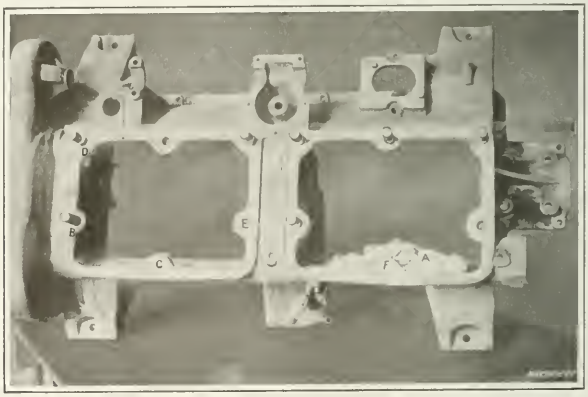


Fig. 7. Aluminum Crank-case showing Method of preventing Cracks in Welding

Procedure in Welding

A puddling rod such as shown in Fig. 3 has been found most satisfactory, although other shapes are used. In all ordinary cases, the metal should be melted with the torch until the bottom of the crack is reached, using the puddling rod all the time, and the metal should be allowed to sink below the lower surface of the crack, forming beads. These beads can be removed afterward, either by the torch and puddling rod, or by chipping or filing. In welding thick pieces, the work must be done from both sides. In this case too much of the welding should not be made on one side at once. It is better to weld, say 2 inches, on the first side, and then turn the work over and finish welding the 2 inches on the other side, then proceed along 2 inches further, and again turn the piece over and weld 2 inches more on the first side. The reason for this is that aluminum is somewhat brittle near the welding temperature, and cracks are likely to develop, particularly in a long weld, if all the weld is made on one side first, and then finished on the other. On account of this brittleness, a weld in aluminum must be made quickly.

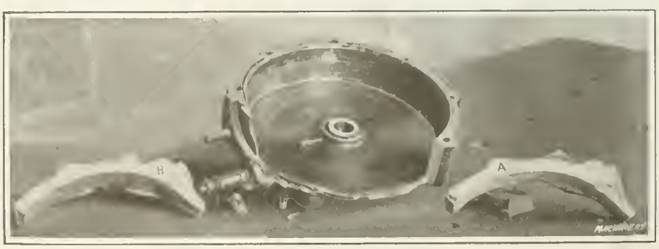


Fig. 8. Aluminum Crank-case, Defective Part used for Pattern and New Part cast from Pattern

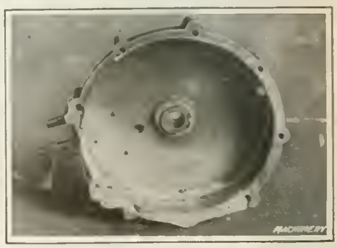


Fig. 9. Same Crank-case as shown in Fig. 8—Finished Weld on Inside

Fig. 10. Same Crank-case as shown in Fig. 8—Finished Weld on Outside

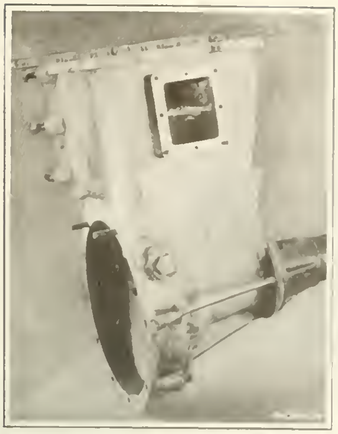


Fig. 11. Example of Badly Damaged Aluminum Casting which has been welded

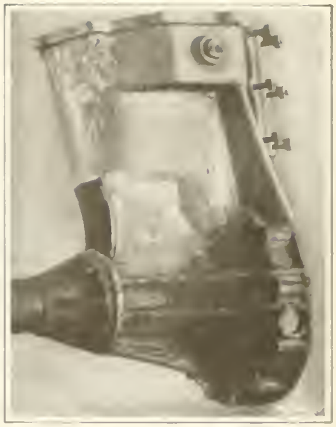


Fig. 12. Opposite Side of Aluminum Casting shown in Fig. 11

Slow work is fatal to good results., It is occasionally necessary in a long weld to have two welders start at the middle of the crack, and work toward the ends, to avoid shrinkage cracks.

On account of the tendency of aluminum to oxidize, it is advisable to use a flame with a slight excess of acetylene. Too much metal should not be added from the welding rod at one time, and what is added should be thoroughly puddled with the welding rod while it is being added and afterward, until there is a melted pool at that point and the proper union has been made with the surrounding metal. The surplus metal should be scraped off with the puddling rod while in a pasty condition, as it contains much oxide, and the welder should be sure to make a good junction at the edges of the weld.

The manipulation of the torch with one hand and the welding stick with the other, the latter having to be laid down and the puddling rod picked up at frequent intervals, is rather difficult. Some welders find it easier to hold the torch in the left hand, although ordinarily right-handed. This is the case with the writer; others find the opposite way to be the easier. In either case, the trouble is caused by the difficulty of working with both hands at once.

When adding the metal from the welding stick, it should be continually rubbed into the melted pool in order to avoid oxidation and to work the oxide to the surface. A beginner should weld and break quite a number of test pieces before he attacks any important job. He should not be discouraged at the result of his first attempts, which are certain to be unsatisfactory, much more so than with any other metal, although aluminum is the easiest metal to weld, after the difficulties in handling it have been overcome.

Examples of Aluminum Welding

Fig. 4 shows the best method of replacing a broken lug on an aluminum manifold. It should be laid on the table as shown, and a small weight put against the lug to keep it from moving. No larger tip should be used than is absolutely necessary, in order to avoid melting the lug, this being likely to occur if care is not taken. The cold table will tend to overcome part of this trouble, as it conducts an excess of heat away. After the back of the lug is welded (and the weld should be made almost entirely through from this side), the inside should be finished, being sure to remove all the crack.

It is not possible in the case of lugs on aluminum manifolds to use the block and clamps used in the case of cast iron, as aluminum would crush under the clamping strain. Immediately after welding, the lug should be tested with a straightedge to be sure that it is true with the rest of the face. If not, it can either be bent down, or a little metal added where it is low.

Fig. 13. Broken Aluminum Transmission Case

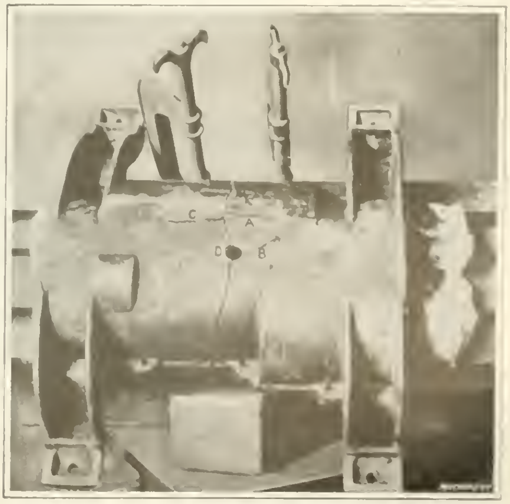


Fig. 14. Method of saving Bearings and aligning Parts of Broken Case

Fig. 15. Outside View of Completed Repair Job

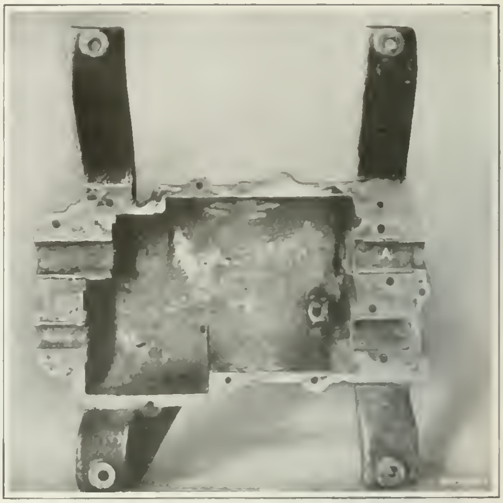


Fig. 16. Inside View of Welded Case

In the majority of cases, and especially in the case of small lugs, it does not pay to put back the old lug, and it is good practice to build up a new one. An expert welder can build up a lug without any assistance from forms, etc., but the beginner had better make a mold out of a thin piece of sheet metal, of the height and shape of the lug, and hold it in place with a small weight, filling up the mold. The body of the manifold should be raised about 1/32 inch from the table with a piece of a hack-saw blade, or something similar, to allow stock for finishing. It is necessary in this case to be particularly careful to get a good union between the new metal and the old.

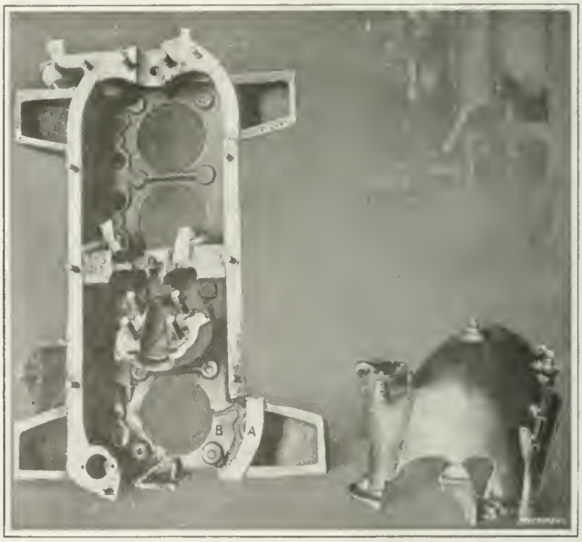


Fig. 17. Upper and Lower Halves of Crank-case as received for Repairs

Figs. 5 and 6 show the best method for repairing an inlet manifold. The original manifold was cast in one piece of aluminum. Later it was desired to change the carbureter, and as the new carbureter flange would not fit the manifold, a new flange was made of brass and screwed on. The threads on the manifold can be seen distinctly. The repair was made by casting a flange of aluminum, using the old brass flange as a pattern by filling up in places to permit its being drawn from the sand, and welding it on. The finished job is shown in Fig. 6.

Fig. 7 shows a type of crank-case that fre-

Fig. 18. Method of clamping Broken Bearing in Place

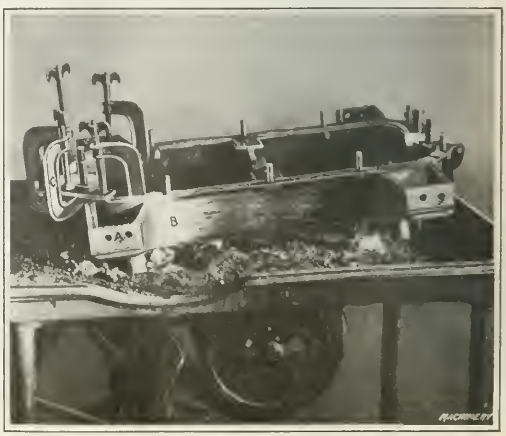


Fig. 19. Aluminum Crank-case being re-heated

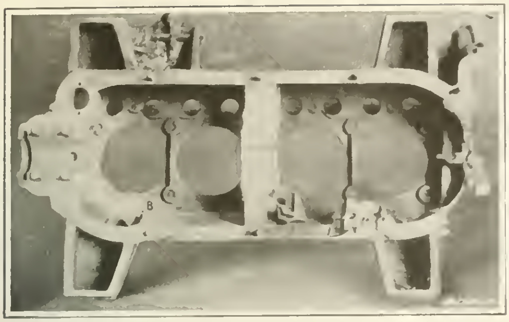


Fig. 20. End Bearing finished, Center Bearing built up, and Front Bolting Lug welded

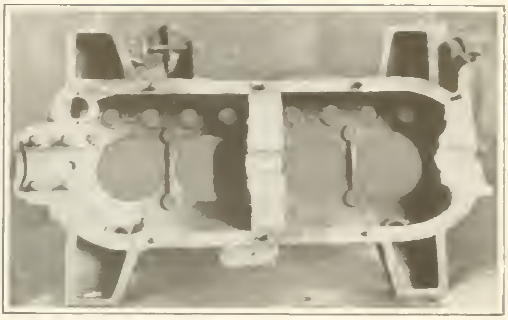


Fig. 21. Upper Half of Crank-case as shown in Fig. 20 with welding completed

quently gives trouble from the lugs breaking off. Here three of the lugs were broken when the case was received, and the shop was instructed to reinforce the others. The missing lugs were *C*, *E*, and *F*. These were built up solid. All the others were reinforced with the exception of *B*. This was not done because of the desirability, found by experience, of avoiding cracking through the end of the case which happens generally, although not always, and inasmuch as all of the other lugs for both pairs of cylinders were heavy, it was thought unnecessary to reinforce lug *B*. No precaution with which the writer is acquainted will invariably stop the cracking at this lug. However, in the majority of cases, the welding of the lugs at *C*, *F*, etc., can be done without cracking the sides, provided loose wet asbestos, as shown at *A*, be packed so as to cover the side, and be allowed to become dry while the case is preheating. This keeps the heat of the welding flame from striking the side of the case and overheating it. It should also be stated that in the majority of cases of this kind the material appears to be a zinc alloy, which is very likely to crack even with the best treatment. The foregoing method of overcoming the difficulty can be frequently applied to other cases.

Fig. 22. End Bearing partly welded in and Pieces set ready for Welding

Figs. 8, 9, and 10 show an aluminum crank-case of an old-style automobile motor, which is located on the rear axle of the car. The part removed had been at some time soldered in, and while this job was all right for a while, it eventually began to leak. Another crack also appeared which made it necessary to repair it in some way. As it would have been impossible to do any welding in the presence of the solder, the entire defective piece was cut out and used as a pattern, this being shown at *A*, Fig. 8. Enough plaster-of-paris was added on the inside and face of the piece to allow for finishing. The casting made from the pattern is shown at *B*, and the finished work in Figs. 9 and 10. This job illustrates the possibility of using the pieces removed as patterns, instead of making new plaster-of-paris patterns. Even when the parts removed are quite badly broken, they can sometimes be fastened together with plaster-of-paris much more easily than a new pattern could be made. This is particularly true where there are lugs or other projections which are difficult to reproduce in plaster-of-paris. A little ingenuity will frequently reduce the time on a job of this kind considerably.

Figs. 11 and 12 illustrate what can be done with a badly damaged aluminum casting. The process through which it was put is no different from that which has been explained before, and is of interest principally on account of the fact

Fig. 23. Lower Half of Crank-case to be repaired

Fig. 24. Plaster-of-paris Pattern for Missing Part and Rear-end Bearing Cap

Fig. 25. Lower Half of Crank-case shown in Fig. 23 as repaired

Fig. 26. Inside View of Repaired Lower Half of Crank-case

that there was over six feet of cracks in the piece. In this particular case the pre-heating was done with two Bunsen burners which were kept lit while the piece was being welded. The Bunsen burners were used on account of the difficulty of handling the piece in the fire. While it is generally unnecessary to use a helper to handle a piece of this size, in this case, on account of the location of the breaks and the large number of times the work had to be turned over, time was saved by using a helper.

Figs. 13 to 16 show a badly broken aluminum transmission case of an old design with babbitt bearings. It is quite difficult to re-babbitt such bearings so as to preserve the center distances between the shafts, unless a jig is available; hence it was decided to save them. It so happened that the width of the face of the crankshaft jig was just right to permit of the face of the transmission case being laid on it and clamped in position as shown in Fig. 14. This does not show, however, all the clamps that were applied. The two clamps shown are simply to hold the pieces in place while the photograph was taken. The first operation was to weld the cracks *A*, *B*, and *C*, while the two halves were separated. The case was then lined up, and in order to prevent uneven contraction, two welders did the work, beginning at the hole *D* in the center. When the first man had welded about 2 inches on his side, the other man started in, and they finished the case together. The result was complete alignment and a very satisfactory job. The finished work is shown in Figs. 15 and 16, after it had been rough-ground. In order to save the bearings, they were filled with plaster-of-paris as shown in Fig. 13. This was allowed to dry thoroughly, and was then warmed over a gentle charcoal fire to drive out the moisture. The plaster-of-paris was scraped off level with the face of the aluminum in order that the cold base of the crankshaft jig might come into as close contact as possible with the babbitt and thus keep it cool while welding. Pre-heating was done with two Bunsen burners, one on each side. All the babbitt was saved, except the small corner in one bearing as shown in Fig. 16, at *A*. The alignment of the bearings and face was perfect.

Figs. 17 to 26 show that no matter how bad the damage may appear, it is possible to repair a crank-case, provided a little ingenuity and forethought be used. One of the frame lugs is entirely broken off and another cracked on both sides, and all three bearings are broken out; in addition, most of the end of the bottom half is missing. This damage was caused by allowing the center bearing to become loose, which caused the crankshaft to break and resulted in the damage shown. An examination of the crank-case made it evident that it would be very difficult, and certainly inadvisable, to replace the pieces of the center and front-end bearings. At the time Fig. 17 was photographed, it was not noticed that the top-end bearing was as badly broken as shown in Fig. 20, although it was known to be cracked. The first operation was to warm the crank-case in a rather small charcoal fire, as shown in Fig. 19, and weld the frame lug *A*, Figs. 17, 18, and 19, in place, taking care to put it in line as closely as possible. This weld is shown at *B*, Figs. 19 and 20. The next operation was to set the rear-end bearing *C*, Figs. 18, 19, and 22, in place, clamping it as shown in Figs. 18 and 19. Planed blocks were used to hold it true, the surfaces of the body of the crank-case on which these blocks rest having been previously tested with a straightedge to make sure that they were true. It is generally desirable in the case of a crack in the side or end of a crank-case to do all the welding except one crack, and then begin with one end of that crack, as for instance at *D*, Fig. 22, and end up at the other end.

In this case this is not advisable, because the important point is to have the rear-end bearing accurately in position, and this can be done better by setting the fractures together, than would have been possible if any shrinkage had taken place from the prior welding-in of piece *E* and filling up at *F*, Fig. 22, which latter part was missing. It is evident that it would have been difficult to make the bearing straight and true under these conditions.

In Fig. 22, when welding in the end bearing, the two side welds were not finished quite up to the ends of the breaks at *H* and *J*. This was to permit of an easier fitting of the piece *E*, and is a practice that should also be followed where several pieces have to be put in separately. It might be stated that the end bearing fitted in place very nicely as may be seen from Fig. 18. Piece *E* was then welded and hole *F* filled up, as was also a stud hole in boss *B*, Fig. 17. It is not advisable generally to attempt to preserve the thread in a hole through which a crack runs. The job is much more solid if it is filled up.

The next operation was the welding of the center bearing, which, as explained above, was built up new. Then the other frame lug was welded as shown in Fig. 20, and finally the front-end bearing was built up, the finished job being shown in Fig. 21.

Some thought and knowledge of the shape of the rear end of the bottom half of the crank-case were needed in order to make the pattern shown in Fig. 23. It so happened that the welders were familiar with what had to be done, or it would have been necessary to examine a similar part in good condition. The bearing cap was put in place on the upper half of the crank-case and used as a guide in the preparation

Fig. 27. Both Halves of Crank-case Machined and ready for Assembling

of the pattern. It was necessary to remove that part of the pattern which occupied the space *A*, Fig. 23, as, if it had been left, it could not have been drawn out of the sand. Stock was allowed for finishing at *D*, Fig. 23, and *B* and *C*, Fig. 24.

Figs. 25 and 26 show the lower half of the crank-case welded, while Fig. 27 shows both halves of the crank-case machined and ready for service, except for the drilling and tapping of the holes for the center and front-end bearing cap studs. This could not be done, as the caps were not at hand.

No special precautions had to be observed in welding this case, the main considerations being the measuring of the diameters of the bearings before doing the work, as no two of them are the same size; keeping the crank-case quite warm while doing the work; and doing it as quickly as possible, which is a necessity in all aluminum welding. Of course, the machining of such a job requires considerable care and is best done, as far as the bearings are concerned, in a horizontal boring machine. If this tool is not at hand, as generally it is not, it can bo done in a lathe by clamping the case on the carriage and using a boring-bar between the centers. The job can be done in one-half the time or less on a horizontal boring machine, as it can be set up with greater ease and accuracy. Of course, the cylinder face of the upper half was milled off at the weld, but it was not found necessary to bore the rear-end bearing, nor to mill off any of the faces of the crank-case, except where stock had been allowed for the purpose, or where the welds had been made; so that it is perfectly possible, by taking due care, to avoid much of the machine work that is frequently done.

This example of welding is given in considerable detail, because it covers a great number of instances which do not have all of the different kinds of damage sustained by this one. It was not a particularly difficult job, although considerable time was consumed in doing it. The comparative simplicity is largely accounted for by the fact that there was no trouble from contraction, the damage being so great that the strains were easily taken care of.

It might be well to mention here the necessity of obtaining good castings for such repair work. It will not do to use the material frequently furnished by small foundries, which they claim to be aluminum. The writer uses nothing but No. 12 metal, which can be purchased from aluminum manufacturers in pigs. No scrap whatever is permitted, nor any other alloy. In case of serious difficulty in obtaining castings of the proper quality, or if it should be necessary to send a long distance for them, it is recommended that a small crucible be obtained and pig metal melted in it in a small furnace designed for the purpose. This furnace can be connected with any flue ordinarily used in a stove. It is not satisfactory to melt this metal in an iron ladle, as it is too much exposed to the action of the air. As soon as the metal is melted, it should be covered with a layer of fine charcoal to prevent oxidation as much as possible. A small flask made of wood and some fine molding sand are easily obtained, and will be found very convenient for many purposes.

Care should be taken in melting aluminum not to get it too hot, and it should be well skimmed while pouring to prevent the oxide from passing into the mold. The shrinkage of aluminum is considerable, about 7/32 inch per foot, and the pattern should be well rapped in order to allow for this, or else the necessary stock should be added to the pattern to take care of it. A novice will probably have some trouble at the start, but a little care, and if possible, the observation of the various processes at some foundry, will help a great deal. Of course, a greater amount of pig metal should be melted than is needed for the casting, and any surplus should be poured into a mold or into a hollow made in the sand pile. It should not be left in the crucible.

* * *

Invar metal, which is an alloy of nickel and steel having a very low coefficient of expansion—about one-twenty-fifth that of steel within the ordinary limits of temperature—has not hitherto been manufactured commercially in the United States. Invar tapes used for base measurements in surveying have been obtained from England, but now the alloy is obtainable from the Midvale Steel Co., Nicetown, Philadelphia.

WHO OWNS THE PATENT RIGHTS?*

There seems to be a misconception among working men and business men in general, of the respective legal rights of employer and employe to inventions originated by the employe. These rights, while not defined by federal status, have been definitely established by a long series of judicial decisions which constitute a part of what is technically termed "The Fixed Law of Patents." These decisions, although rendered at widely varying times and by courts scattered throughout the country, agree in recognizing the rights of the employe as well as those of his employer. But, instead of according the entire rights to one or the other, they apportion these rights in a manner which would seem to be both reasonable and equitable.

Briefly stated, the general ruling is this: Where an employe makes an invention in the course of his occupation, the fact that the employer paid for his time and that the invention was developed with the aid of tools and materials furnished by the employer gives the latter a definite, although limited interest in the invention. This interest is commonly called a "shop right," being the employer's unrestricted right to manufacture, use and sell this invention in and from the particular shop or factory in which the invention was made. However, the employer cannot claim any exclusive rights; he has no right to license others to manufacture the invention, nor can he control its duplication by other parties. All rights outside of the factory in which the invention was made belong to the employe. The patent must be taken out in the name of the latter, if it is to be valid, and this patent then is automatically subject to the above-described "shop right," although otherwise controlling the field. If the employer wants the entire market control of the invention, he must acquire the balance of the patent rights from the inventor either by buying the patent outright or by securing an exclusive license under the same.

In other words, the law says that in return for the facilities afforded by the employer and the money paid for the inventor's time while making the invention, the employer shall have a license under the inventor's patent rights, but this license shall not be exclusive. Nor can the employer sell this license (*i. e.*, his "shop right") to some other concern; if he ceases doing business, it becomes void. Thus, each party is recognized as having a distinct share of the rights to the invention and the employer can only lawfully obtain the entire control of the patent right by acquiring the same from his employe. The latter, through ignorance of the law or through a misunderstanding of the same, may part with his share for a mere pittance. That has often occurred in the past and probably will recur in the future so long as but few men are aware of their rights, but it shows no defect in the laws. The real shortcoming lies in the carelessness or indifference of the employes, most of whom make no effort whatever to ascertain their real rights.

Moreover, the above-mentioned division of rights holds only where the invention was made on the employer's time, or with the employer's tools and materials, or by the use of both. It does not apply to inventions which the employe may make after working hours and which he makes and perfects at his own expense, unless the employe has signed a contract to the contrary. In case of such a contract, an adequate compensation or "consideration" must be shown for the rights to such inventions and, generally speaking, these must be in the lines for which the employe is hired. In other words, the fact that an employe is hired and paid for a certain occupation does not give his employer a blanket mortgage on the employe's brains, although no one can prevent the employe from giving away his rights if he chooses to do so. Indeed, loyalty to his employer may demand a liberal attitude on the part of the employe in such matters, but in order to be even reasonably liberal the employe must first learn just what rights he actually has. Unfortunately, too few men are in earnest when it comes to ascertaining their exact rights and undoubtedly many suffer as the result, but the law should not be blamed for this.

* Albert Scheible in the "Iron Tradesman."

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FEBRUARY, 1916

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LOOKING AHEAD

The placing of war orders for machine tools culminated in December and a gradual decline is in effect; not necessarily because the Allies have sufficient equipment ordered, but because they are not now in such urgent need that they are forced to place orders here at the present high prices, with deliveries from six to twelve months. A gradual decline in war orders, such as now appears to be taking place, instead of a sudden drop, especially as it is being followed by increasing home demand, is as near an ideal condition as any manufacturer can ask. With a reduction in the price of machine tools from the present high levels, and with reasonable deliveries, the home demand should continue to increase. Such a change will be welcomed by domestic dealers and users, who have been almost at a standstill on what is called "normal" business; for while machine tool builders are still booking orders on six to twelve months' delivery, the conditions are unsatisfactory both to them and to their customers.

The prosperity of the machine tool industry is of course dependent on the prosperity of manufacturers generally; and the true test of the future is to be found in general conditions rather than in special ones dependent on war orders. If our industries generally are busy it goes without saying that prosperity is general—that even railroads will make money, and with the changed public sentiment in regard to them and the enormous amount of liquid capital, it will be easy to finance their requirements for new equipment, which as every one knows is badly needed. Active railroad buying alone will exert an even more powerful influence on the general situation than the automobile industry has done and is now doing. But railroads will hardly begin buying actively at prevailing prices.

A careful and extended inquiry among representative firms covering the entire country indicates a general industrial revival—slow in some sections, active in others. Industries dependent upon material made in Germany are the exceptions. Manufacturers who sell to enterprises of widely varied character, in no way connected with war business, report a steady and increasing demand for their products. They say that many plants not turning out war material have a large amount of business booked which they are unable to go on with because they cannot get the raw material, and this applies to domestic as well as imported supplies. They also say that the activity due to war business will slowly decrease, that domestic business is waiting to take its place, and that as this process goes on "the habit of prosperity will become established and we will go on at a good pace."

Manufacturers generally are wisely resisting temptation to overbuild; the great extensions being put up by concerns who have obtained enormous war contracts have been figured on a basis that insures the manufacturers a return sufficient to include the cost of additional plant as well as a profit on the product. Those who are extending plants on any other basis are taking big risks, and this is particularly true of machine tool plants. The output of machine tools before the war was ample for all requirements, and will be no less when the war ends. Outsiders who are anxious to join the war game are advised to proceed with caution. Those already in are familiar with its drawbacks, the first of which is the scarcity and high price of material and the difficulty of getting satisfactory labor. Something like a famine now exists in certain domestic materials, and only a let-up in demand will remedy that.

Everyone expects a period of readjustment to follow the war; and the length of that period will depend upon the impetus our industries have attained before peace comes. As the continuance of our prosperity is dependent to a considerable extent on the duration of the war, the longer it does continue the better we should be prepared for its close. There is unfortunately no indication of peace before another winter, and in the interval it seems to us that the production of all kinds of war material in this country will gradually slacken, while our home demand will steadily increase, so that the speed of both these movements will more nearly approach normal. This readjustment period has already begun, and when peace comes and with it changed conditions, we should be in a great measure prepared for them.

* * *

CHANNELING MACHINES

The general use of inflammable building materials is one cause of the appalling annual fire waste of the United States. In the larger cities, measures have been taken to prevent the destruction of buildings by requiring them to be of slow-burning construction, or semi-fireproof. No building even though made of non-inflammable material can be regarded as fireproof if it contains large quantities of wooden furniture or inflammable goods. The intensity of heat generated in a conflagration is so great as to destroy concrete, steel and other non-inflammable building materials. But the use of these materials in buildings greatly reduces the fire risk.

The demand for steel window sashes, window frames and doors has developed a new industry in sheet metal working, that is, the forming of sheet metal into hollow sections of varied cross-sectional shapes by the so-called channeling machines. These machines are of the rolling mill type, ingeniously devised to laterally fold sheet metal stock into a great variety of moldings, ogees, fillets and other shapes by a continuous process. The metal is fed to the machine in long strips, and is shaped by the rolls, leaving the machine perfectly formed. The advantages of the channeling process are rapidity of manufacture, saving of material, simplicity of equipment and ease with which patterns can be changed.

While beading, folding or seaming of sheet metal by rolls was developed very early in the tinsmith's trade, the design of channeling rolls such as are required in the manufacture of architectural shapes is something with which comparatively few designers are familiar. The rolls are required to bend the material laterally and to draw it through the machine by their tractive effort. Variations in diameter must be compensated for in gearing ratios, and other expedients resorted to in order to accomplish the desired end with a minimum of friction.

The uses to which sheet metal shapes produced by the channeling process are put are many. Not only may shapes peculiar to architecture be cheaply made, but many other shapes useful in machine construction, furniture manufacture, concrete molding and other lines as well. Channeling may be regarded as a special development of press work in which bending rolls, working the piece progressively, take the place of reciprocating tools in the punch press.

THE EXPORTATION OF AMERICAN MACHINE TOOLS

BY GEORGE R. WOODS*

Europe is our best export market for machine tools, the volume of business jumping from $4,800,000 in 1910 to $12,260,000 in 1913. The grand total of our machine tool exports throughout the world in 1913 amounted to $16,100,000, this being 5.35 per cent of the total of our iron and steel exports. For the year 1915 (December estimated) our machine tool exports will total about $39,000,000, this being 13.33 per cent of our iron and steel exports in 1913 and equal to our total exports of agricultural implements for that year.

Our machine tool exports this year will also exceed our automobile exports in 1913 and come within $13,000,000 of equalling the exports of cotton manufacturers in 1913.

To show the relative importance of export fields, reference should be made to Table I showing the consumption of machine tools in 1913 by continents. This table also shows the volume of business done by Germany in the same period.

TABLE I. EXPORTS OF MACHINE TOOLS IN 1913 BY THE UNITED STATES AND GERMANY

	United States	Germany
Europe	$12,268,677	$17,992,539
North America	2,554,420	453,568
South America	571,919	842,457
Asia	202,620	364,903
Australia	460,825	54,978
Africa	37,031	......
	$16,095,492	$19,708,445

Before analyzing the European market, which is of most importance, brief comment should be made on the situation elsewhere. Before the war Germany led the United States in South America and in Asia, but notwithstanding the appeals made by industries in that territory during the war no special effort has been made by American manufacturers to intrench themselves in these German fields because of the enormous volume of our European business. Consequently, the conclusion of the war will not find the American machine tool industry in any better position in Asia or in South America. Inquiries from China, Japan and Argentina are being ignored today because no deliveries can be made; Europe takes practically all machine tools now exported. If American machine tool builders continue to make themselves dependent on Europe for their export business, it is expedient, to say the least, that a careful study be made of that field and reference is invited to Table II, which gives an analysis of the European market by countries. This table also shows the volume of business done by Germany during the same period.

TABLE II. EXPORTS OF METAL WORKING MACHINERY TO EUROPE DURING 1913

	From Germany	From United States
Austria-Hungary	$ 3,047,775	$ 600,593
Belgium	1,798,104	786,679
Bulgaria	23,177	13
Denmark	288,634	84,753
Finland	66,420	24,947
France	3,208,936	1,936,908
Germany	......	3,175,188
Greece	......	2,310
Italy	1,545,043	437,910
Netherlands	981,249	260,893
Norway	192,962	79,366
Portugal	61,715	1,391
Roumania	143,374	110
Russia in Europe	3,524,251	1,088,751
Spain	405,687	109,624
Sweden	462,731	241,373
Switzerland	698,274	17,108
Turkey in Europe	37,460	3,105
United Kingdom	1,486,582	3,417,655
	$17,972,374	$12,268,677

* Address: National City Bank, 55 Wall St., New York City.

Among the many questions that assert themselves upon studying this table, we give for instance:

Assuming that the Central Powers are prejudiced against American machine tools, will Germany be able to supply the $3,700,000 worth of machine tools which she and Austria purchased in America in 1913?

Assuming that Germany attempts to regain her position in Russia, will she find the United States prepared to diminish the annual business of $3,500,000 which Germany did there before the war?

Will the United States be prepared to get any part of Germany's share of Belgium's machine tool business which, in 1913, amounted to $1,800,000?

Assuming that the Central Powers, which purchased $3,700,000 worth of American machine tools in 1913 are not prejudiced against the United States, will we be able to take care of Germany and Austria as well as other nations who will all probably want more machines than heretofore?

Considering that Switzerland, because of the war, has not been able to make her annual purchases, amounting to about $1,000,000 worth of machine tools, will Americans be prepared for the sudden and heavy demand from that country?

In conclusion, mention should be made of the economic changes which are taking place today. No manufacturer can afford to wait for the next census of 1920 to ascertain the condition of our commercial growth, for the moving finger of the statistician is daily recording significant facts which merit the earnest consideration of every machine tool builder.

One fact which demands attention is that this country is becoming a manufacturing nation; in the year 1914 our exports of food stuffs were 18 per cent as against 44 per cent in 1894, and our manufacturing products were 47 per cent of our exports in 1914 as against 23 per cent in 1894. Many other figures are available showing the growth of this country as a manufacturing nation, and having reached such a period it is necessary for us to study intensively our foreign markets and prepare to obtain that amount of export business which is indispensable to our prosperity.

* * *

PLATINUM $100 AN OUNCE

The demand for platinum for utensils used in the manufacture of acids has created such a shortage that the price has risen to $100 an ounce, and very little is to be obtained at any price. The Russian, French and German governments have placed an embargo on the exportation of platinum, because of the great need of it at home. The acids that make the use of platinum utensils necessary are used in great quantities in the manufacture of war munitions. At the present price, platinum costs more than four times as much as gold. The development of chemical industries in which platinum is used, and its popularity for jewelry are two great contributing causes for the demand. During the period following the Civil War platinum was comparatively cheap. It could then be obtained for from $5 to $10 an ounce, and as late as 1905 the price was only $18.50 an ounce; in 1911 it had jumped to $46 an ounce, and in 1914 it had dropped to $42 an ounce. Since then the price has been going steadily upward, until it has reached the present unprecedented price of $100 an ounce.

* * *

Howard W. Dunbar of the Norton Grinding Co., calls attention in the October number of *Grits and Grinds* to the importance of providing belts on grinding machines of uniform thickness throughout their length. The slightest variation in thickness either where an "endless" belt is joined together or where a lacing or other material is used will set up a vibration in the parts with which the belts are connected. This vibration if of sufficient magnitude will be transmitted to the wheel or the work and the result will be chatter or [illegible]. This applies especially to the belts in close proximity to the wheel and work. Never replace an endless belt with one carrying wire lacing or any other form of lacing that gives a "bump" as it passes over the pulley, if smooth work is desired in finishing. Belts should be of the proper width to transmit the power required and must be maintained at a constant uniform tension. Care must be taken to prevent oil and grease from getting on the belts. Poor belting should be avoided, as it stretches in spots, resulting in uneven thicknesses and un-uniform tension.

Fig. 1. Transfer Truck, Auxiliary Table, Bench Truck and Stock Rack

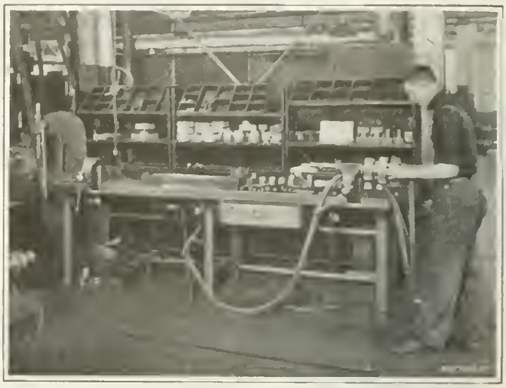

Fig. 2. Shaft Assembling Bench with Three Stock Racks in Place

ASSEMBLING METHODS OF THE JONES & LAMSON MACHINE CO.

APPLICATION OF THE HIGHLY SYSTEMATIZED METHODS OF AUTOMOBILE FACTORIES IN MACHINE TOOL WORK

BY EDWARD K. HAMMOND*

THE machine tool builder who is being shown through one of the large automobile factories is bound to be impressed by the results obtained from the highly systematized assembling methods employed in these plants. But he is likely to regard this merely as a case in which scientific management has produced gratifying results and fail to see any possibility of applying similar methods in his own shops. However, these methods are capable of wide application—after making suitable modifications to adapt them to existing conditions. It is the purpose of the present article to describe the way in which such highly systematized assembling methods were applied in the factory of the Jones & Lamson Machine Co., Springfield, Vt., and the conditions which led to their employment. Credit for the development of this plan is due to Ralph E. Flanders, general manager of the firm.

It is an axiom of factory administration that the greatest return will be obtained from labor by arranging working conditions in such a manner that the men will be required to move about the shop as little as possible. The method of assembling which is to be described in the following article is employed on all parts which go to make up the headstocks of Jones & Lamson flat turret lathes, including the shafts for the lathe headstocks. A study of the methods of assembling formerly employed in the factory revealed the fact that a large amount of time was spent by the men in going to the store-room for supplies, in delivering the work which they had completed to the next department, and in various wasteful ways which were fostered by the conditions existing in the shop. A further defect lay in the fact that it was difficult to keep an accurate record of the supplies used.

With the view of overcoming these difficulties it was decided to develop a method which would provide for delivering the necessary parts to each man employed in the assembling department, so that he could carry on his work without the necessity of going to the stock-room. There are two obvious advantages in such a plan; the possible loss of parts is avoided and the time of the assembler is saved, as the delivery of parts from the stock-room can be looked after by a boy whose time is of little value. The assembling department was then laid out in such a way that the work would move in a continuous circuit, and its transfer be simplified as far as possible.

It has been mentioned that the method is employed in assembling lathe headstocks, and in the department where this work is done each employe is assigned to a bench fitted with a vise, arbor press and the necessary tools. The parts are transferred from the stock-room to the assembling department in bins, each of which carries all the necessary gears and other parts required for one or more complete shafts or other unit assemblies. The bin in which these parts are contained is supported on a small truck carried on the stand shown in Fig. 1, which is made so that it

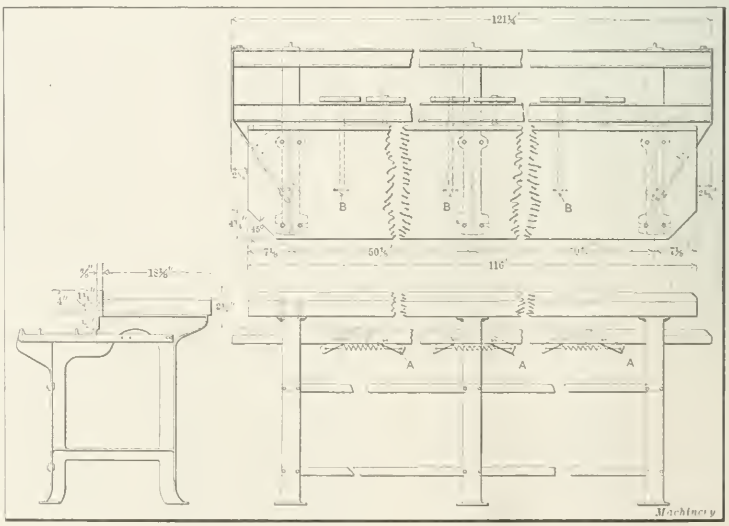

Fig. 3. Design of Shaft Assembling Bench—note Locking Device for holding Bench Trucks in Place

* Associate Editor of MACHINERY.

may be conveniently moved by an elevating truck.

Fig. 2 shows a view of one of the shaft assembling benches; the truck carrying a bin full of supplies is backed up so that the tracks on the stand are in line with tracks located at the back of the assembling bench. The latch which holds the small truck in place on the stand is then released and this "bench truck," as it is called, is then run onto the tracks on the bench and locked in place. At the time a bin full of parts is delivered to the assembling bench, a truck and empty bin is run off at the opposite end of the bench and returned to the stock-room where it is filled with parts ready for delivery. Each bin full of parts is delivered from the stock-room against a signed order from the foreman of the assembling department.

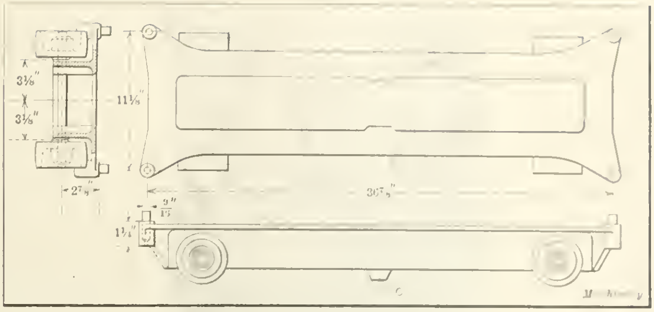

Fig. 4. Design of Bench Truck used for supporting Stock Racks

Construction of Assembling Benches and Bench Trucks

Fig. 3 shows a plan view, and front and end elevations of one of the assembling benches. It will be seen from this illustration that the tracks for the bench trucks are located slightly below the working surface of the bench for the purpose of bringing the lowest compartments of the stock bins level with the bench and placing all compartments within easy reach of the operator. It will be evident that some provision must be made for securing each of the bench trucks in place. This is effected by latches *A* which engage each side of a lug cast on the bottom of the truck body. When a truck is run into place on the bench or moved from one station to another, the latches *A* are released by turning handles *B* which cause the latches to drop to a horizontal position and release the lug on the truck. Plan, elevation and cross-sectional views of one of the bench trucks are shown in Fig. 4, and the lug provided for locking the truck in place on the bench is shown at *C*.

It will be seen that the front corners of the bench are beveled off, the purpose being to enlarge the opening between adjacent benches so that it is an easy matter to back the elevating trucks into place. Cleats are provided on the floor at the end of each bench which engage the legs of the stands on which the bins are brought out from the stock-room, thus locating them in such a position that the tracks are in line with the tracks on the assembling bench. Fig. 1 shows a stand with two sets of tracks, it being originally intended to send out two bins full of parts at a time, but subsequent experience showed this idea to be impractical, and new stands are now being made which only provide for carrying a single bin. These stands will be arranged with wheels so that the use of the elevating truck will be dispensed with.

Taking the Machine to the Work

The idea of making it unnecessary for the workmen to leave their places in the factory has been carried a step further by providing portable drilling machines for use in the assembling department. One of these machines is shown in Fig. 7, and reference to this illustration will show that the equipment consists of an "Avey" bench drill, made by the Cincinnati Pulley Machinery Co., which is mounted on a stand used in connection with an elevating truck. It will be evident that the individual motor drive makes it possible to connect with the electric circuit in any part of the shop where the machine is to be used. The need of a drilling machine in the assembling department is due to the fact that it is necessary to drill pin holes in the shafts at the time the assembling is done in order to get exactly the required relation between the different parts for the machines.

In the single-spindle Jones & Lamson lathe there are five shafts in the headstock and these shafts are not only of different sizes, but some of them are of different sizes at opposite ends. On this account, special arrangements must be made for supporting each of the shafts in a horizontal position on the drill press table. A universal V-block fixture, shown in Fig. 7, provides for holding all classes of shafts, the arrangement consisting of V-blocks which may be adjusted vertically in order to bring them to the required position; and before starting to drill a hole the position of the work is tested with a spirit level to see that the shaft is exactly horizontal. It has been mentioned that the stands on which these drilling machines are mounted are so designed that an elevating truck may be used for moving the machine about the factory; but as in the case of the stands for the stock bins, it is intended to apply wheels so that the use of a truck will be unnecessary.

The head assembling department of the Jones & Lamson Machine Co. occupies one complete bay in the factory and is arranged with a row of benches down each side. There are two types of lathe heads to be assembled, i. e., the heads of the single-spindle and double-spindle machines, and the assembling of these two types of heads is done on benches located at opposite sides of the bay. The conditions are essentially the same in both cases, so it will merely be necessary

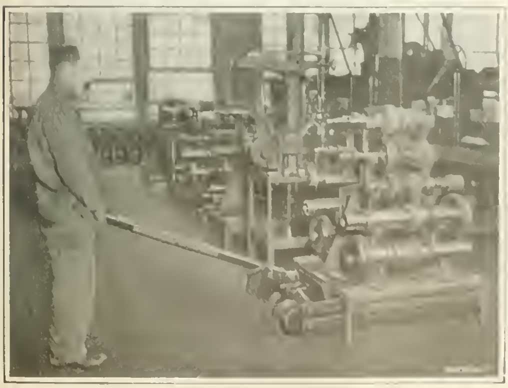

Fig. 5. Rack which holds Assembled Shafts for Two Complete Headstocks

Fig. 6. Head Assembling Stand with Headstock in Place

to refer to one class of work; the assembling of headstocks for the single-spindle machines has been selected for the purpose of description. There are two benches on which are assembled all the shafts for the lathe heads, and two benches for the use of the men employed in fitting and assembling these shafts and other parts into the headstock castings.

The method by which the parts are delivered from the stock-room has already been referred to, and there is little more to be said about the work of assembling the shafts beyond the fact that special stands are provided on which the complete shafts are stacked pending their delivery to the men who assemble them in the headstocks. One of these racks is shown in Fig. 5, from which it will be seen that brackets are provided for holding the shafts, these brackets being faced with soft brass to prevent scoring the bearings. Each rack has a capacity for holding the shafts required for two complete headstocks, and represents a normal day's work of one assembler. As the factory is at present turning out four single-spindle lathes a day, it will be obvious that it is necessary to have two men employed in assembling shafts. The output of these two men is passed along to the two head assemblers where the bearing linings are fitted into the headstock castings and the shaft is assembled in place. Special assembling stands are used to support the work, as shown in Fig. 6, and electric hoists are provided on each side of the assembling department to assist the men in lifting heavy parts, one of these hoists being shown in Fig. 8. These hoists are arranged on I-beam trolleys which extend the whole length of the bay directly over the space in which the assembling stands and shaft racks are located, so that the hoists may be used if necessary at any bench. It should be noted, however, that they are in general use only at those benches where the headstock castings themselves are handled, as shown in Fig. 8, inasmuch as every item of the equipment, with the exception of the assembling benches, is arranged to be moved by elevating trucks.

Fig. 7. Portable Drilling Machine with Adjustable V-block Fixture for holding Shafts

Testing the Assembled Headstocks

After each headstock has been completely assembled, it is left in position on the stand and taken to the testing department, which is located at the end of the bay where the lathe heads are assembled. In the testing department there are electric motors on the floor, to which the headstocks are belted to provide for making running tests. The legs of the stand carrying the headstock are brought into contact with cleats on the floor which locate the stand and headstock in the proper relation to the driving motor. Each headstock is driven for three or four hours to "run in" the bearings and gears, and to be sure that all parts of the mechanism operate smoothly. The headstock is then ready to be taken on to the department in which the assembling of the machines is conducted.

Criticisms of scientific management are often made on the grounds that the cost of installation is high, that it complicates the routine work of the factory, and that the benefits obtained do not justify the trouble and expense that have been involved. In some cases these contentions are undeniably true, but in the present instance it will be evident that the cost of installing the method was relatively low and the work of assembling has been greatly simplified rather than complicated. A concrete idea of the actual benefits resulting will be gathered from the fact that four men are now able to do the work for which ten were formerly required.

It will be noted that, with the exception of the bench top, all the equipment is of metal throughout. It could have been made very much more cheaply and quickly in wood, but it is the policy of the shop to taboo wood wherever possible, from the standpoint of avoiding all fire risks. The shaft racks, in particular, are somewhat heavier than conditions require, and in making further additions to the equipment they would be considerably lightened.

It is the hope to extend this method of handling the assembling still further as opportunity offers, possibly to the handling of the machines themselves, as well as to the handling of the component parts.

* * *

INGENIOUS FLASHING SIGNS

An ingenious and effective development of electric signs is now appearing in the larger cities. The signboard is composed of horizontal and vertical rows of incandescent lights closely spaced. Any letter, figure or device can be shown in light by switching in the lamps in the required area on the board. This feature of the sign, of course, is old, but the novel feature is that the words travel along the sign, appearing at the right and sliding off at the left. The effect is startling and fascinating. Words, phrases and sentences appear, the letters moving at a rate that easily enables one to follow the meaning until the legend is completed.

Fig. 8. Head Assembling Bench and Hoist provided for lifting Castings

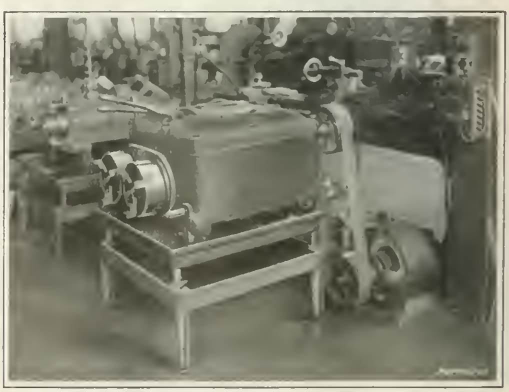

Fig. 9. Stand located by Cleats on Floor to align Headstock and Motor

BENDING SHEET METAL FOR METAL FURNITURE

DATA FOR MAKING CORRECTIONS IN CUTTING BLANKS FOR REVERSED AND SQUARE BENDS

BY K. GEORGE SELANDER*

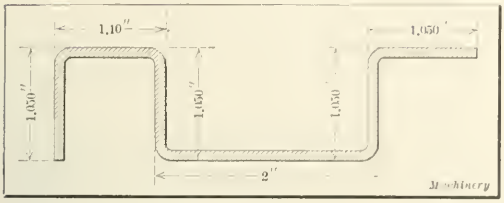

Fig. 1. Cross-section of Sheet Metal Bend dimensioned according to Old Method

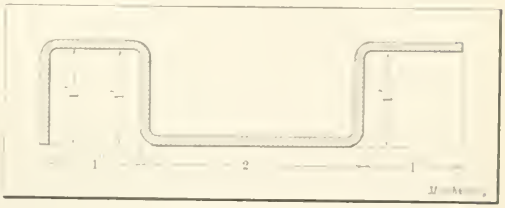

Fig. 2. Cross-section of Sheet Metal Bend dimensioned according to New Method

IN the May, 1911, number of MACHINERY, I contributed an article entitled "Bending Sheet Metal for Metal Furniture," in which a table was presented that gave the proper allowances to make for the bends when cutting up sheet metal. Since that time I have compiled new tables that give data on allowances for square and reversed bends, which will be found particularly valuable in the metal furniture trade on account of the great variety of bends that have to be made and the different gages of metal that are used. The data presented in these tables are based upon the same formula that was used in calculating the results presented in May, 1911. This formula is as follows:

$$1.67 \times \text{number of bends} \times \text{gage} = X$$

where X is the amount to be deducted from the sum of the outside bend dimensions, to compensate for elongation.

Using the table presented in my previous article, it would be necessary to know the dimensions shown in Fig. 1 and to deduct for five bends in sheet metal of the proper gage, in order to arrive at the required length of blank to cut off. Fig. 2 shows the dimensions given in accordance with the method followed in the present tables, and it is important that the dimensions should not be given as shown in Fig. 1, owing to the system which is now employed. Bends on the side the dimensions are given on in Fig. 2 are considered square bends, and those on the opposite side reversed bends. It is immaterial on which side the dimensions are placed, as the result will be the same in either case. In determining the required length of stock to cut off, the method of procedure is as follows: Count the number of bends on the dimension side of the illustration, which is two in the case of the work shown in Fig. 2. Next count the number of bends on the opposite side, which is three. The total sum of all dimensions given is 7 inches. Now referring to the first vertical column of Table II for the horizontal line 2-3, and for the vertical line for 18 gage stock, it will be found that 1/8 inch must be deducted from 7 inches, making the proper cutting length for the blank 6 7/8 inches.

As a further example in the use of this method, consider the case of the bend shown in Fig. 3. Here the sum of the dimensions given is 8 inches, and there are two "square" bends and four "reversed" bends. Referring to Table II for 2-4 and 13 gage stock, it will be found that 3/16 inch allowance for bending must be deducted from 8 inches, making the required length of blank 7 13/16 inches. The tables are figured out in the following manner: The sum of the dimensions in Fig. 3 is 8 inches and to this we add twice the thickness of 13 gage stock for four bends, which is found to be 8 × 0.0938 = 0.7504 inch. This amount is next added to 8, which makes the length 8.7504 inches.

* Address: Care of Art Metal Construction Co., Jamestown, N. Y.

TABLE I. CORRECTIONS FOR BENDS IN CUTTING BLANKS FOR SHEET METAL WORK

Square and Reversed Bends	Gage of Metal and Thickness in Inches								
	0.025 24	0.0313 22	0.0375 20	0.05 18	0.0625 16	0.0781 14	0.0938 13	0.1094 12	0.125 11
1—1	1/32	1/32	3/64	1/16	3/32	[illegible]	1/8	[illegible]	3/16
2—1	3/32	3/32	1/8	5/32	3/16	7/32	[illegible]	5/16	3/8
3—1	1/8	5/32	3/16	1/4	5/16	11/32	[illegible]	1/2	[illegible]
4—1	5/32	3/16	1/4	5/16	13/32	15/32	[illegible]	11/16	[illegible]
5—1	3/16	1/4	5/16	13/32	1/2	19/32	3/4	7/8	1
6—1	1/4	9/32	3/8	1/2	[illegible]	23/32	29/32	1 1/16	1 [illegible]
7—1	9/32	11/32	13/32	9/16	23/32	[illegible]	1 1/16	1 7/32	1 13/32
8—1	..	..	..	..	..	..	..	.	

Square and Reversed Bends	Gage of Metal and Thickness in Inches								
	0.025 24	0.0313 22	0.0375 20	0.05 18	0.0625 16	0.0781 14	0.0938 13	0.1094 12	0.125 11
1—2	1/32	[illegible]	1/32	1/16	[illegible]	1/16	[illegible]	[illegible]	1/8
2—2	1/16	3/32	3/32	1/8	3/16	[illegible]	1/4	[illegible]	[illegible]
3—2	1/8	5/32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4—2	5/32	3/16	[illegible]	5/16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5—2	3/16	1/4	[illegible]	3/8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6—2	1/4	[illegible]	[illegible]	1/2	[illegible]	[illegible]	[illegible]	1	1 [illegible]
7—2	9/32	11/32	[illegible]	[illegible]	[illegible]	[illegible]	1 [illegible]	1 [illegible]	1 [illegible]
8—2	5/16	3/8	[illegible]	[illegible]	[illegible]	1	1 [illegible]	1 [illegible]	1 [illegible]

TABLE II. CORRECTIONS FOR BENDS IN CUTTING BLANKS FOR SHEET METAL WORK

Square and Reversed Bends	Gage of Metal and Thickness in Inches								
	0.025 24	0.0313 22	0.0375 20	0.05 18	0.0625 16	0.0781 14	0.0938 13	0.1094 12	0.125 11
1—3	1/64	1/64	1/64	1/32	1/16	1/16	[illegible]	[illegible]	[illegible]
2—3	1/16	3/32	3/32	1/8	5/32	5/32	[illegible]	1/4	[illegible]
3—3	3/32	1/8	3/32	3/16	1/4	9/32	[illegible]	[illegible]	1/2
4—3	5/32	3/16	7/32	9/32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5—3	3/16	7/32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6—3	7/32	9/32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1 [illegible]
7—3	[illegible]	5/16	13/32	[illegible]	[illegible]	[illegible]	1	1 [illegible]	1 [illegible]
8—3	..	..	..	..	..	..	..	..	..
9—3	..	..	..	..	..	..	.		.

Square and Reversed Bends	Gage of Metal and Thickness in Inches								
	0.025 24	0.0313 22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1—4	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2—4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3—4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4—4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5—4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6—4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1 [illegible]
7—4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1 [illegible]	1 [illegible]
8—4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1 [illegible]	1 [illegible]	1 [illegible]
9—4									

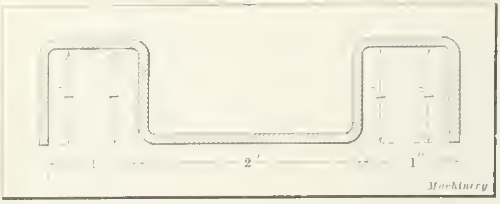

Fig. 3. Cross-section of Sheet Metal Bend considered in Second Example

From this we deduct the elongation allowance for six bends in 13 gage stock—as given in the table previously published—which is found to be 0.9375 inch. The remainder of 7.8129, or 7 13/16 to the nearest fraction, is the proper cutting length. Subtracting 7 13/16 from 8 gives a remainder of 3/16 inch, which is the allowance given in the table. The preceding examples show the advantage of the use of a table of this character, and in this connection it may be stated that the results are reasonably correct for sheet steel, brass, bronze, and aluminum plates. It is assumed that the bending will be done under ordinary pressure conditions and that a V-die will be used. In calculating regular "square" bends, the table presented in my previous contribution should be used; this table will also be found in MACHINERY'S HANDBOOK.

TABLE III. CORRECTIONS FOR BENDS IN CUTTING BLANKS FOR SHEET METAL WORK

Square and Reversed Bends	Gage of Metal and Thickness in Inches								
	0.025 24	0.0313 22	0.0375 20	0.05 18	0.0625 16	0.0781 14	0.0938 13	0.1094 12	0.125 11
1—5	0	0	0	0	0	0	0	0	0
2—5	1/32	3/64	1/16	3/32	3/32	1/8	5/32	3/16	7/32
3—5	3/32	1/8	1/8	3/16	7/32	1/4	5/16	11/32	13/32
4—5	1/8	5/32	3/16	1/4	5/16	13/32	15/32	17/32	5/8
5—5	5/32	7/32	1/4	11/32	13/32	17/32	5/8	23/32	27/32
6—5	3/16	1/4	5/16	13/32	17/32	21/32	25/32	29/32	1 1/32
7—5	1/4	5/16	3/8	1/2	5/8	25/32	15/16	1 3/32	1 1/4
8—5	9/32	3/8	7/16	19/32	23/32	29/32	1 3/32	1 1/4	1 15/32

Square and Reversed Bends	Gage of Metal and Thickness in Inches								
	0.025 24	0.0313 22	0.0375 20	0.05 18	0.0625 16	0.0781 14	0.0938 13	0.1094 12	0.125 11
1—6	0	0	0	0	0	0	+1/32	+1/32	+1/32
2—6	1/32	1/32	3/64	1/16	3/32	1/8	1/8	5/32	3/16
3—6	1/16	3/32	1/8	5/32	3/16	1/4	9/32	5/16	3/8
4—6	3/32	5/32	3/16	1/4	9/32	3/8	7/16	1/2	19/32
5—6	5/32	3/16	1/4	5/16	3/8	1/2	19/32	11/16	25/32
6—6	3/16	1/4	5/16	13/32	1/2	5/8	3/4	7/8	1
7—6	1/4	5/16	3/8	1/2	5/8	3/4	29/32	1 1/16	1 7/32
8—6	9/32	3/8	13/32	9/16	11/16	27/32	1 1/16	1 1/4	1 13/32

Machinery

* * *

"CLEARANCE" AND "ALLOWANCE"

The expressions "clearance" and "allowance" may generally be used interchangeably as terms signifying the difference between working parts to admit of motion and lubrication. In other words, the clearance or allowance is the space between adjacent parts, whether this space is allowed merely to avoid interference or in order to obtain different classes of fits. The clearance allowed between different parts is governed by the conditions under which the parts work. In the best drafting-room practice, the clearance is taken into account when giving the dimensions of individual parts, and is indicated on the drawing as the actual size of the part. For example, if the hole for a shaft is 2 inches in diameter and the clearance or allowance on the shaft is to be 0.002 inch, then the diameter of the shaft should be given as 1.998 inch. If it is permissible for the diameter of the shaft to be 0.0005 inch larger or smaller than this dimension, then the latter value indicates the *limit* of accuracy, and the dimension is given as 1.998 ± 0.0005 inch.

* * *

EFFECT OF VIBRATION ON MACHINE EFFICIENCY

It is generally recognized that machinery of all kinds, and machine tools especially, operate most efficiently when set on solid foundations. Where it is necessary to place machinery on the upper floors of factory buildings, great care must be taken to have the working parts in balance, as otherwise the working of the machine will set up vibrations destructive to efficient cutting action and finish. In some cases, it is necessary to provide false foundations in the form of large masses of concrete or other dense material that deadens the vibrations.

Recognizing that higher speed, greater work and human efficiency are promoted by a condition of stability, as compared with that of constant vibration in buildings, but that exact data proving this fact are difficult to obtain, the Aberthaw Construction Co., Boston, Mass., has undertaken an exhaustive investigation in the effort to bring together conclusive evidence. The company will greatly appreciate any suggestions or reports of experience that would be useful in this connection. Experiences on any aspect of the case will be accepted if they will assist in the reaching of definite conclusions.

* * *

BROACHING SQUARE TAPER HOLES IN A BRAKE LEVER

The brake lever in the Pierce-Arrow motor car is secured to its shaft by a square taper seat, being bolted in place. The method by which this square taper hole is cut at the plant of the Pierce-Arrow Mfg. Co. in Buffalo, N. Y., is interesting. The operation is performed on a J. N. Lapointe broaching machine, as illustrated in the view shown herewith. A faceplate fixture, having four slots equi-distantly spaced around the circumference, is clamped on the head of the machine at the proper angle of the taper. The brake lever is first drilled with as large a hole as possible, and before being put on the machine is fitted with a removable steel key that engages one of the four slots just mentioned. The broaching cut is started with the lever in one of the four positions. A cut is taken that cleans out one corner of the hole at the required taper, and the lever is then shifted to the next position and a second cut taken. This procedure is followed until the four cuts have been made, when the lever is removed from the faceplate and the key taken off and fitted to another lever. The result is an extremely clean and well finished hole. The operation does not require a skilled operator.

C. L. L.

Square Taper Broaching Operation

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Discharge of Agent for Acceptance of Gratuities from Seller

(Missouri) There is believed to exist among manufacturers a custom of offering more or less slight tokens of appreciation to buyers representing concerns purchasing their wares. There is reason to believe also that frequently such gratuities are accepted. While the moral phase of the question has doubtless been much debated, the courts have seldom been called upon for their view of the proposition.

In the case of Wade v. William Barr Co., reported from the St. Louis Court of Appeals, the question is, "Can an agent, intrusted with discretionary power in the purchasing of machinery for his principal's account, accept, without his principal's knowledge and consent, presents or gratuities of substantial value, consistently with the confidence reposed in him?" and is declared to be a question for the jury.

"The jury had the evidence of the whole transaction before them, the amount of the gifts, the amount of the dealings of plaintiff with those from whom he purchased for defendant, as well as the times when, and circumstances under which, they were given. They were all given at Yuletide; were Christmas gifts; given at the time when all the world is full of charity and good will; when, as we are told, even soldiers in opposing trenches and in deadly struggle stop and make gifts. Who would say that in such acts these soldiers were disloyal to their cause? All the facts being present as here, the issue tendered as here, in an action at law as here, it was for the jury to say whether, on these facts, they, 'as reasonable men,' 'acting reasonably,' would say the gifts were 'substantial gifts' and were bribes; whether under color of gifts at such a time and of such character, a corrupting motive lay back of their giving or receipt. We decline to say here, as a matter of law, that, on the evidence, the receipt of such gifts, under like circumstances, is to be conclusively held to be an act justifying the discharge of the agent. In brief, we hold that, on its facts and issues made, this was a case for the jury." *(Wade v. William Barr Co., 177 S. W. 668.)*

New York Smoke Nuisance Law Not Effective in New Jersey

(New York) The resulting effect in New York of a nuisance in another state is not punishable in New York according to the holding in Richmond Co. court in People v. International Nickel Co.

Smoke and noxious vapors from defendant's factory in New Jersey were blown over to New York "injuring a considerable number of persons."

In disposing of the case the court said: "The serious question presented here is whether or not the acts constituting the crime as defined by this section occurred within the limits of the state of New York. The indictment clearly sets forth that all of the acts complained of, as a result of which the gases and other deleterious fumes were wafted by the winds to the county of Richmond, occurred in the city of Bayonne, state of New Jersey. I fail to find from a close examination of the indictment that the defendant has done or failed to do any act or acts within the boundaries of the state of New York that would give this court jurisdiction.

"It is undoubtedly true, as contended by the learned district attorney, that the result or effect of the acts of the defendant corporation done in the state of New Jersey is felt in the county of Richmond and state of New York, and causes annoyance to the inhabitants thereof, which acts, resulting in the same annoyance, if committed within the county of Richmond or the state of New York, would constitute a nuisance as defined by this section of the Penal Law. Can the defendant, therefore, be indicted for the effect or results of its acts irrespective of the acts themselves? I think not. *(People v. International Nickel Co., 155 N. Y. S. 156.)*

No Property Rights in Machine Patent

(Federal) Where plaintiff contracted to invent and manufacture certain special bottling machinery for defendants, the contract providing that the defendants should have an interest in the machines or in any patents thereon only when such machines conformed with the contract, and they did not come within the stipulations, either in output capacity or operative cost, the contract further providing that upon such failure it should be deemed ended, there being no provision giving the defendants an interest in any machines, except upon compliance with the stipulations and payment for fifteen sets, a conveyance of any letters patent, drawings, etc., from plaintiff being expressly conditional upon the payment of a royalty, defendants, declining to accept the completed machinery as a compliance with the contract, could claim no property right in it, or in patents covering it. *(Burpee v. Guggenheim, 226 Fed. 214.)*

Machinery must be Moved with Proper Appliances

(Alabama) Where the superintendent of a machine shop knew that a servant was inexperienced in handling, or assisting in handling, heavy machinery—the work in which he was engaged—such superintendent was under duty to instruct the servant as to the proper mode of working.

The servant may recover for injuries received by the crushing of his foot under heavy machinery which he was assisting to move. Such recovery is on the theory that an employe is entitled to a safe place in which to work. The machinery in this case was moved by use of a tie and wedge instead of rollers which the court believed would have been the proper method. *(Alabama Fuel & Iron Co. v. Ward, 69 S. 621.)*

Use of Defective Appliance

(Nebraska) Where a transportation company employed for a consideration to move a heavy machine from the factory of a manufacturer to the freight depot of a railroad furnishes a broken or defective appliance for that purpose, by reason of which one of the servants of the manufacturer is injured while assisting in an effort to place the machine on the wagon of the transportation company, the last-named company is liable for damages to the person injured. *(Wiseblood v. Omaha Merchants' Express & Transfer Co., 154 N. W. 538.)*

Suitable Power Machinery must be Provided

(North Carolina) The rule that the master must exercise ordinary care to provide a reasonably safe place to work in and furnish safe and suitable tools and appliances applies chiefly to power machinery, and not to simple tools or to ordinary conditions requiring no special care or provision, where the defects are readily observable and where there is no good reason to suppose that injury will result.

Where a car repairer was injured by the falling of a box car in which he was replacing a rotten sill, he and his associate being in full control with power to choose their own methods of doing it, that the company did not remove rubbish accumulated around the car, not being the proximate cause of the injury, constituted no breach of duty of furnishing a safe place to work in. *(Bunn v. Atlantic Coast Line R. R., 86 S. E. 503.)*

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ENAMEL FOR PRESERVING STEEL AGAINST RUST

Bitumastic enamel is a compound which is considered one of the best preparations available for the preservation of steel against the influence of the weather in bridges, cranes, roofs and ships, and other structures of iron and steel. The only manufacturer of this compound is Wailes, Dove & Co., Newcastle-on-Tyne, England. Bitumastic enamel was selected by the engineers of the Panama Canal out of three hundred compositions which were submitted to endurance tests, to protect the steel lock gates and other steel structures used in connection with the canal. The total area of steel surfaces covered by this compound is equal to about 70 acres.

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German silver, also known as nickel silver, is an alloy of copper, nickel and zinc, the best quality consisting of 50 per cent copper, 25 per cent nickel, and 25 per cent zinc. This quality, however, is the most difficult to work, but it takes a fine polish and is frequently used for tableware to imitate silver. When the proportion of copper is somewhat higher, the alloy is suitable for rolling and for drawing into wire.

ROUGHING OUT FELLOWS GEAR SHAPER CUTTER BLANKS

MODIFICATIONS IN CONSTRUCTION OF GRIDLEY AUTOMATIC TO ADAPT IT FOR WORK WHICH WOULD OTHERWISE BE BEYOND ITS RANGE

BY EDWARD K. HAMMOND*

WHEN it becomes necessary to modify the construction of a machine tool in order to adapt it for handling a specific machining operation, the shop management should always limit the changes as far as possible. The reason for this is that it may be desired to use the machine for standard work again, and the original design is the one best suited to the requirements of general classes of work. In some cases it is possible to modify the design in such a way that the change does not limit the scope of the machine, and this is the ideal method.

A typical example of the necessity which sometimes arises for making changes in machine construction in order to provide for handling some specific operation is seen in the case of the Gridley automatic turret lathes which are used by the Fellows Gear Shaper Co., Springfield, Vt., for roughing out the blanks from which cutters are made for the Fellows gear shaper. Dissatisfaction was felt with the results obtained from the method formerly employed for roughing out these cutters, and in considering various methods which seemed to have features to commend them, the use of the Gridley automatic for roughing out the blanks appeared to have the greatest number of points in its favor. But when the subject was taken up with the firm that manufactures this machine—the Windsor Machine Co., Windsor, Vt.—it was found that the standard design did not provide sufficient capacity for producing the cutter blanks. Here was a case in which it was required to modify the construction of the machine in order to adapt it for a special class of work, and the method of making the necessary changes has been so cleverly worked out and applied that practically no limitations have been imposed upon the scope of general work which can be handled.

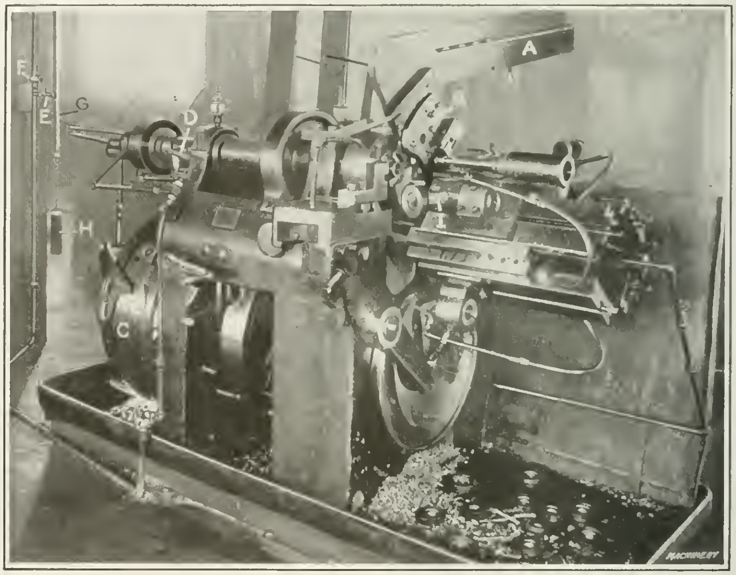

Fig. 1. Gridley Automatic equipped for roughing out Blanks for Cutters used on the Fellows Gear Shaper

Multiple-blade hacksaw machines are used to cut off the steel cutter blanks from bar stock, and in order to provide for holding these pieces it was necessary to equip the Gridley automatic with a suitable form of chuck. A Garvin three-jaw air chuck was finally selected for this purpose, but it at once became evident that if it was attempted to set this chuck up in the spindle of the machine there would be insufficient capacity between the spindle and the tool-slides. This difficulty was overcome by cutting off the nose of the spindle and mounting the chuck so that it came right back into contact with the flange on the spindle. But this change still left the machine with insufficient capacity; this was remedied by cutting off the end of each tool-slide to prevent interference between the slides and the three-jaw air chuck in which the work is held. So far as we know, this use of an air chuck on automatic machines was the forerunner of subsequent applications which have been made on a strictly commercial scale. Arranged in this way, the Gridley automatic is capable of roughing out all sizes of Fellows gear shaper cutter blanks which range from $3\frac{1}{2}$ to 5 inches in diameter.

Equipment of the Gridley Automatic

The Gridley automatic equipped for this work is shown in Fig. 1; it will be seen that the blanks are held in a hopper *A* which delivers them to transfer chuck *B* carried by the regular cut-off arm on the machine. A lock-bar holds the surplus blanks back while one blank is being moved from the transfer chuck to the three-jaw air chuck on the spindle of the machine; and during the return movement of the cut-off arm, a fresh blank drops from the hopper into the transfer chuck, when it is ready to be delivered to the machine. A regular length stop of the type used when the machine is working on bar stock is employed for pushing the blank into the air chuck carried in the spindle, at the time when the blank is released from the transfer chuck. This stop is backed up by a spring plunger, instead of having its position rigidly fixed, so that means are provided to compensate for irregularities in the thickness of the cutter blanks as they are cut off from the bar. Another noteworthy feature of the set-up of this machine is that the air chuck is controlled by a cam on the drum *C* instead of being operated by hand in the usual way. This method of operating the chuck is essentially the same as that commonly employed for the control of a collet chuck for handling bar stock; and as a result, the action of the machine is entirely automatic. It will be seen from Fig. 1 that the cam is so arranged as to throw up the lever *D* which operates the valve on the air line, when it is desired to either release the work or grip a fresh blank in the chuck.

The chuck is operated by air at a pressure of 90 pounds per square inch, and the service conditions are such that it will continue to hold if the pressure drops as low as 40 pounds per inch. But it will be evident that the failure of the air pressure during the time that the machine is in operation would result in the release of the work and probable damage of the tools. Danger of trouble from this source has been overcome by the provision of an automatic belt shifting device which is controlled by the air pressure. This mechanism is shown at the extreme left in Fig. 1, where it will be seen to consist of a pointed plunger *E* which is actuated by the piston

*Associate Editor of MACHINERY.

carried in a small air cylinder F. As long as the pressure remains above 55 pounds per square inch—which allows a liberal factor of safety—the pointed plunger is held in place in the notched bar G and the machine continues to operate, but should the pressure fall below the specified limit, the plunger will be drawn back by the action of a spring, thus releasing the notched bar and allowing counterweight H carried by it to operate the belt shifter and stop the machine.

Sequence of Operations Performed on Gridley Automatic

The transfer of the work to the machine spindle has already been described, and the subsequent operations performed by the Gridley automatic are as follows: (1) drill center hole; (2) counterbore hole; (3) ream hole; (4) remove work from chuck; (5) face across entire blank; this is done during the time that the preceding cycle of operations is being performed.

In handling these operations the method of procedure is as follows: The drilling of the center hole in the cutter blank is performed by a special twist drill which is made in the factory from hot twisted stock. The second operation, counterboring the hole, is done with a regular Gridley offset boring tool. In the third operation, which consists of reaming the center hole, a Kelly reamer is employed that is provided with a boring tool set in advance of the reamer for the purpose of taking a roughing cut and relieving the reamer blades of the greater part of the strain. The regular stock feed is used to operate an ejector rod which performs the fourth operation of removing the work from the air chuck. The finished piece is pushed out of the chuck onto a pin I carried by the fourth tool-slide, and it will be seen that this pin is hinged in such a way that it drops down as the turret revolves to bring the next station into the working position, thus dropping the finished product. As the turret continues to revolve, this hinged pin swings back to the starting position, when it is ready to have the next cutter blank pushed out of the chuck onto it.

The side of the blank which is faced off on the Gridley automatic will be the top of the finished cutter, and is required to have a rake angle of 5 degrees, this result being obtained by making the required setting of the head which carries the facing tool. The feeding of the tool over the work is effected by the usual type of cam used on the Gridley automatic; this cam is illustrated in Fig. 3, and has been laid out in such a way that a uniform rate of feed is obtained for the facing tool regardless of the speed of rotation of the cam-shaft. The importance of this point will be appreciated when it is remembered that the speed of the cam-shaft varies considerably, according to whether one of the turret tools is at work or the turret is being indexed to the next working position. It will be seen that in designing this cam, the usual method of procedure was followed, *i. e.*, that of considering the complete sequence of operations as a circle. This circle was then di-

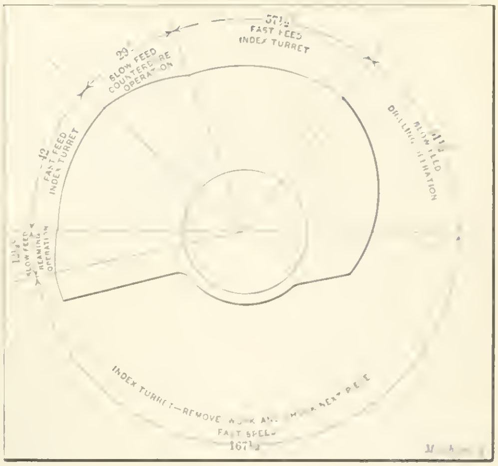

Fig. 3. Facing Cam designed to give a Uniform Rate of Feed, which is independent of Speed Changes of Cam-shaft

vided up into angles representing the different operations constituting the cycle, and the magnitude of each angle was made proportional to the length of time occupied by the operation which it represents. In order to develop the outline of a cam which will provide a uniform feed for the facing tool, it was merely necessary to make the throw of the cam, as laid off on each radial line, inversely proportionate to the speed of the cam-shaft, and then connect the points located in this way.

Equipment of Lathe for Turning Back and Edge of Blanks

In the condition in which they leave the machine, the cutter blanks are finished on one side, and the hole and counterbore have also been completely finished. It is still necessary to form the edge of the blanks and face off the under side, and for this purpose an old Jones & Lamson turret lathe was converted into a single-purpose machine. Here we have another example of the problem which the shop management faces in adapting standard machine tools for handling specific operations, but in the present case the requirements of the work were such that it was necessary to make changes which restricted the machine to handling a single class of work. The machine equipped for this purpose is illustrated in Fig. 2, and Fig. 4 shows a detailed view of the type of draw-back expanding arbor on which the work is held. In setting the work up on this arbor, the blank is slipped into place, after which the screw A is tightened up; this results in forcing the tapered section of the screw into its seat, thus expanding the jaws to give them the desired grip on the work. The jaws are serrated to increase their holding power as far as possible.

It will be evident that the work is quite narrow to be carried by this form of holding device, and as it is necessary to maintain a definite relation between the face of the work that was finished on the Gridley automatic and the edge of the cutter which still remains to be machined, it is necessary to provide a more positive method of location than could be obtained from the expanding arbor. This means of location is afforded by the lever B which governs the longitudinal movement of the arbor in the lathe spindle. To provide for setting up the work on the arbor, lever B is pulled back so that it forces ar-

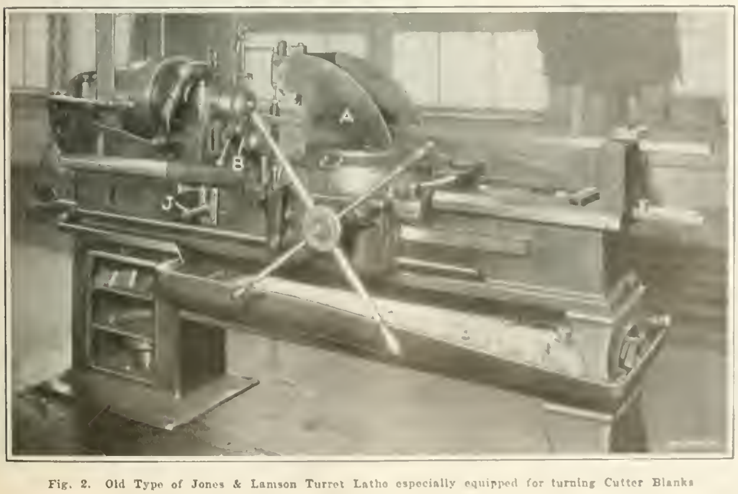

Fig. 2. Old Type of Jones & Lamson Turret Lathe especially equipped for turning Cutter Blanks

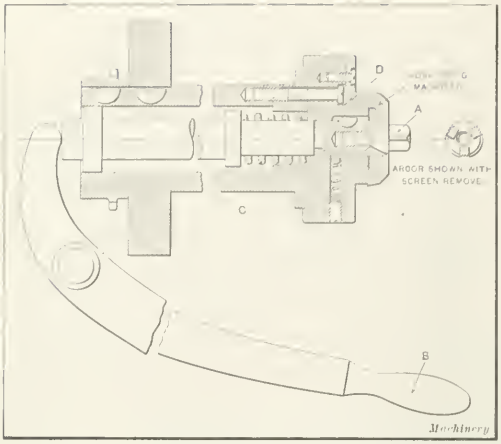

Fig. 4. Expanding Draw-back Arbor on which Cutter Blanks are mounted

bor A out against the resistance offered by compression spring C; and when lever B has been pulled back to the end of its travel, it is engaged by a lock which holds it in that position. The cutter blank is then tightened on the arbor by the method previously described, and after this the lock is disengaged from lever B, allowing the compression spring C to pull the arbor back into the lathe spindle. In so doing, the angular face of the work is drawn into contact with a corresponding face on work-holding fixture D, which results in adjusting the position of the work so that the subsequent machining operations will give the cutter blank exactly the required form.

There are three faces on the work, which still have to be finished, *i. e.*, the two beveled edges and the back face of the cutter. For this purpose two special cutter-heads are provided on the machine; the head A, Fig. 2, which is mounted on the turret carries two tools which finish the two edges of the cutter blank; and a special facing head B is provided which carries a tool for taking a finishing cut over the back face of the blank. A better idea of the way in which the machine is tooled up for the second sequence of operations will be obtained from referring to Fig. 5, which shows a close view taken from the back of the machine. It will be seen that the cutter-head A which is mounted on the turret is fitted with two slides C and D, in which the tools are carried for finishing the edges of the work. The movements of the slides which carry these tools are controlled by cams E and F which are of the proper form to provide for obtaining the required clearance and bevel on the cutter. The arrangement of the feed for the facing tool is also clearly shown in Fig. 5, where it will be seen that a horizontal shaft G at the back of the machine is belted to the cone pulley, and this shaft transmits motion to a worm H, through a pair of bevel gears. The worm meshes with a segment gear I carried at the bottom of the facing cutter-head B, and when the handle shown at J in Fig. 2 is raised to bring the worm into contact with the segment gear, it results in feeding the facing cutter across the work. This equipment gives very satisfactory results, both as regards the quality of finish obtained and the rate of production, and was made by rebuilding a machine that was too old to be an efficient producer in its original form.

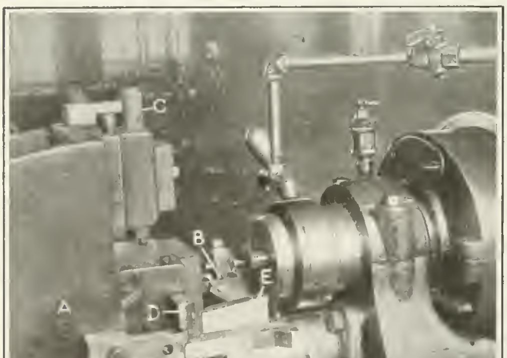

Fig. 5. Partial Rear View of Machine showing Special Feed Mechanism for Facing Tool and Means of controlling Forming Tools

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HARMONY IN MOTOR CAR DESIGN

The rapid development of motor cars during the past twenty years is one of the startling and wonderful phases of the growth of our industrial life. Starting with one-cylinder engines of three or four horsepower, we have today cars with eight- and twelve-cylinder engines, capable of developing sixty to eighty horsepower and having wonderful flexibility of control. The time is not far distant apparently when the gear shift mechanism for changing speed will no longer be needed, as the engine will have sufficient flexibility to drive the car from the slowest to the fastest speeds without gear change.

Notwithstanding this wonderful mechanical development, one cannot help feeling, after an examination of many cars shown at the recent automobile show in the Grand Central Palace, New York City, that considerable can be done yet on the lower-priced cars to improve the appearance and harmony of engine design. The difficulty of harmonizing the component parts of the motor car power plant lies in the fact that they are in many cases designed and manufactured independently. Each concern strives to make its own product as cheaply and efficiently as possible. While these units are related in purpose, they are sadly unrelated in appearance in some cases, and are incongruous when assembled. Take, for example, the vacuum feed system that is being generally adopted in order to avoid the necessity of maintaining pressure in the fuel tank. This apparatus includes a cylindrical reservoir of considerable size located near the engine. This form, of course, is the cheapest and simplest to make, but it does not harmonize at all with the rest of the apparatus under the cylinder hood. The same may be said of some other accessories that have become indispensable in modern car design.

The tendency undoubtedly will be to reconcile the design of accessories used in a group so that eventually we shall see motor car plants with harmonious lines, the various accessories fitting in appropriately and appearing to be really part of the engine and not like excresences.

* * *

PLATINUM DISCOVERED IN SPAIN

The unprecedentedly high prices for platinum that have obtained lately, because of the embargo laid on its exportation by Russia, Germany and France, gives much interest to the announcement that platinum has been discovered in Spain. Prof. Ouerta, who has examined the platinum deposits, recently made an address before the Society of Civil Engineers of Spain in Madrid, in which he stated that the deposits are of greater extent and richness than those of the Ural Mountains in Russia, from which is obtained about 90 per cent of the world's supply.

HOW MACHINERY MATERIALS AND SUPPLIES ARE SIZED*

A REVIEW OF COMMON METHODS OF SIZING SHEET METAL, WIRE, SECTIONAL SHAPES, FASTENINGS, PIPES AND FITTINGS, BELTS, ROPES, CHAINS, GEARING, ETC.

BY FRED HORNER†

THE manner in which the numerous metals, alloys, materials, fabrics, and fittings used in mechanical engineering are sized or rated for purposes of reference and ordering is an interesting subject. There is so much variation and so many apparent anomalies that the problem is somewhat confusing. Methods of sizing have in many instances been evolved in peculiar ways that have persisted to the present day, while in others more obvious and straightforward methods have been employed. Standardization, either national or sectional (that is, among certain trade associations for their own special goods) has cleared up much confusion and greatly simplified sizes, reduced their multiplicity, and made a rigid standard or limit admitting of no possible dispute. The standards for wire or sheet, and for screw threads have so revolutionized practice that it would be difficult for a machinist of this generation to believe what frightful confusion prevailed when every manufacturer had his own pet wire or sheet gage, and his own standard for screw threads. Yet this was the case in England, and to a lesser extent in the United States. Now there are recognized standard gages and threads, and ordering by number or diameter is sufficient indication to secure uniformity. In the event of dispute (due perhaps to the use of a worn gage) the micrometer caliper can always be referred to as a final appeal, since the standards are referable to decimal sizes. The micrometer is also handy for reaching over a burred or otherwise damaged edge to ascertain the true average thickness of a sheet.

The use of order numbers for goods is either of national value or is only applicable to individual firms' products. In the latter case, its utility is restricted, but it is nevertheless highly convenient for orders delivered orally or by letter or wire, and for entering upon drawings or specifications. It saves the time and trouble of writing diameters or other dimensions, sometimes indicating one principal size, or it indicates the whole thing without further specifying. In national standard sizes, as for taper pins, machine and wood screws, etc., a number always means the same identical size.

It must be remembered that sizes are not necessarily to exact standard; it depends upon the mode of manufacture of the goods, the kind of material, and very often upon the particular use to which the article is to be put. "Diameter," for example, is a very elastic term. It may be approximate, as in rough iron, in rough bolts, and in some kinds of cast work. In the case of bright-drawn steel a very close approximation to absolute dimensions is met with (considering the mode of manufacture) or in steel balls an extremely close limit is found, say 1/10,000 inch. Some screws on the other hand are purposely made over size or under size, and split cotter-pins are slightly under size to enter standard drilled holes easily.

As distinct from sizes applied in inches or numbers, a great many materials and supplies are sold in definite quantities which are always standard, comprised in some convenient form or in a receptacle or package. Substances sold by drams, ounces, pounds, hundredweights, tons or by quarts or gallons are, for purposes of sale, usually placed in receptacles containing a definite quantity, or are cast into bars, ingots, or pigs. Other materials, sold by weight or size, are collected or otherwise bundled together in suitable forms. Often a definite quantity is assembled so that it is sufficient to order by barrel, kipp, firkin, box, packet, can, bottle, sack, bale, coil, ball, hank, bundle, stone, reel, spool, etc., according to practice. Or in some cases amounts are divided into one-half or one-quarter of the specified ways of assembling. When handling loose articles, as nails, bolts, spikes, and suchlike, reference to a table will show the quantity of a certain size contained in the bulk, in keg or other container.

* For material on the sizing of machine tools and appliances, see "How Machine Tools and Appliances are Sized," in MACHINERY, February, 1915.
† Address: 13 Forester Ave., Bath, England.

The following covers the materials and supplies commonly utilized in mechanical engineering practice.

SHEETS

Material	How Sized
Iron and Steel:	By thickness in fractional or decimal parts, using some form of caliper, but more usually by standard gage, as By U. S standard gage, for sheet and plate iron and steel (Note A series of Roman numerals is used for rating tin plate. Corrugated sheets are listed by number of corrugations and pitch in width of sheet, expressed by symbols, as 7/4, meaning seven corrugations of 4 inch pitch; 10/3, meaning ten corrugations of 3 inch pitch.)
Brass, Copper, Bronze, Phosphor-Bronze, German Silver, and Aluminum:	By American (Brown & Sharpe) standard Copper sometimes by English (Birmingham) gage. (Note: Copper sheet is rated per ounce weight per square foot; as 8 ounces, or 15 ounces, or 64 ounces, etc.)
Rubber, Canvas, Various Fabrics, Paper, etc.:	Rated, like metals and alloys, by the square foot or other recognized size, or per roll of recognized width. Pieces of drawing paper are rated by sheets of certain names. Cap, 13 by 17 in Demy, 15 by 20 in Medium, 17 by 22 in Royal, 19 by 24 in. Super Royal, 19 by 27 in Imperial, 22 by 30 in Atlas, 26 by 34 in Double Elephant, 27 by 40 in Antiquarian, 31 by 53 in Bristol board is made in various sizes, including some of the above standards, and also in patent office sizes. U. S. standard, 10 by 15 in English standard, 15 by 20 in Some fabrics, as asbestos cloth, are rated by ounce weight per square yard. Tapes of rubber, cotton, etc., only need width specified

RODS AND WIRE

Material	How Sized
Square, Hexagon, or Octagon Rods:	Always measured across flats, or "diameter." Twisted square rod similarly
Rectangular Sections:	By width and thickness.
Bessemer Rods, Brass or Copper Rods:	By fractional sizes.
Drill Rods:	By Stubs steel wire gage, or by Morse twist drill gage
Wire:	By various standards, according to material
Bessemer Steel Wire:	By Washburn & Moen or American Steel & Wire Co (U S) steel wire gage
Steel (music) Wire:	By steel music wire gage (American Steel & Wire Co) See also MACHINERY'S Handbook, page 391
Brass, Copper, Bronze, Phosphor-Bronze, German Silver, Aluminum Wire:	By Brown & Sharpe gage But practice is not yet consistent, since some firms make use of other standards, including the Stubs and the Old English or London gage
Wire Cloth:	By "mesh" and gage of wire The "mesh" is a term representing the number of openings per lineal inch, measurement being taken from center to center of wires The Washburn & Moen gage is standard for iron, steel, galvanized, and coppered wire; the Old English gage for brass, copper, and bronze
Wire Netting:	Also by mesh and gage

SECTIONAL SHAPES

Material	How Sized
Angles:	By length of each leg, and thickness of web
Tees:	By length, width and thickness
Zee-Bars:	By length, length of each leg, and thickness
Deck Bulbs:	By length and thickness.
Channels:	By length of web, and flange, and thickness of web.

Material	How Sized
I-Beams:	By depth, width, and thickness of web.
Copes and Half-Rounds:	By width and depth.
Half-Rounds (hollow):	By width, depth, and thickness.
Convex Sections:	By width and depth at center.
Rails:	By pound weight per yard. (Certain sections are sometimes specified also by pound weight per foot; this is instead of stating thickness.)
Various Sections:	When these are quite varied in contour or thickness, rating for simple identification is best understood by giving the longest width. (Note: Many ordinary sections may be most briefly specified by the longest width, i. e., a 2-inch angle, a 14-inch channel, etc.) Thickness of webs is usually measured in fractional or decimal parts, but in brass or bronze work, the Brown & Sharpe gage may be used.

FASTENINGS

Material	How Sized
Screws, Bolts and Various Threaded Articles:	The diameter of screw is the primary dimension, and is referable to one of the standard threads, but what are termed "machine screws," and also the wood screws are specified by a series of standard numbers. These are less than ½ inch diameter. As regards length, there is much variety as to the precise locations from which this dimension is determined, as follows:
Bolts:	
Hexagon, Square, Round and Ball Heads:	Length under head.
Countersink Heads:	Length over all.
Boiler Patch (cup head):	Length under head.
Boiler Patch (bevel head):	Length from largest diameter of bevel.
Hanger, Rag, and Plow Bolts:	Length over all.
Eye Bolts:	Length under neck, sometimes over all, and sometimes to center of eye.
Studs and Bolt Ends:	Length over all. (The thread on the short end of a stud is usually a little over size to make a tight fit in the hole.)
Expansion Bolts:	These are rated by the diameter of the bolt itself, not of the casing.
Machine Screws:	
Cap and Set-Screws: Collar and Thumbscrews:	Length under head (as the point of a set-screw often projects some distance beyond the threaded part, the length is always measured to the extreme point). (Note: No screw which has a head more than 1/16 inch larger in diameter than the body is classed as a "set-screw.")
Countersink:	Length over all.
Oval-Head Countersink:	Length from top of countersink to end.
Washers for Bolts or Screws:	Size of screw only need be specified if washer is standard diameter.
Wood Screws:	Diameter always rated by the screw gage.
Flat Head:	Length over all.
Round Head:	Length including about half the head (sometimes under head).
Fillister Head:	Length from under rim of head.
Coach or Lag Screws:	Length under head.
Hand-Rail Screws:	Length over all.
Screw Hooks and Screw Eyes:	Length over all.
Hooks and Eyes:	Length of hook.
Rivets:	Usually measured by English standard gage. Large sizes by fractions or decimals. (Note: Some kinds, as tinners' and coopers' rivets, are listed by numbers representing the ounce or pound weight per nominal thousand).
Ordinary Heads:	Length under head.
Countersink:	Length over all.
Oval Countersink:	Length from top of countersink.
Belt Rivets:	The length is taken to a short distance from the end (⅛ inch or more, depending on the size) or about where the burr sets after riveting.
Nails:	
Wire and Cut Nails:	By length, and in the case of wire nails, by the Washburn & Moen gage for diameter. But for convenience, all the various sizes are specified by a figure (with "d" after it), representing the weight in pounds per nominal thousand.
Railroad Spikes:	Length taken under head.
Wire Staples:	Length, and gage of wire.

MISCELLANEOUS FASTENINGS

Material	How Sized
Turnbuckles:	Size of screws and length between heads.
Belt Fastenings:	Dependent on type; sometimes by size of belt suited for, or length and width of fastening, many by number in standard sizes. Hooks and eyes for gut band rated by the diameter of band suited for.
Pipe Hooks:	By size of pipe used for. May be the "nominal bore" in the case of iron pipe sizes.
Rings for Various Purposes:	Inside diameter usually.
Keys for Shafting:	Width primary dimension, then length, usually under head for headed kinds. Thickness is taken close up at thick end.
Woodruff Keys:	Width, and thickness. (In this system each key and the cutter for milling its keyway is designated by a number or symbol).
Gibs:	Total length, and width. Depth is often taken midway, in conjunction with key.
Cotters and Spring Keys:	Width, and length from point to neck (occasionally over all).
Split Cotters:	Length under eye.
Taper Pins:	Diameter taken at large end. But ordered by numbers which also denote the standard reamers for the holes.

PIPES AND FITTINGS

Material	How Sized
Pipes and Fittings in General:	According to material and use. In what are termed the wrought iron pipe series, the rating is by nominal inside diameter, and brass tubes made to iron pipe sizes are also rated similarly. But otherwise, brass and copper tubes are measured by outside diameter. Cast-iron and steel mains are specified by internal diameter. But some kinds of steel tube, such as boiler tube, is rated outside.
Rubber, Leather, Canvas, Fiber and Flexible Metallic Tubing:	By internal diameter. (Note: When dealing with canvas or leather hose, it is convenient to refer to a table showing measurement when laid flat, such as: 1¼-inch internal diameter is 2 inches flat; 3 inches internal diameter is 5 inches flat.
Gage Glasses:	External diameter.
Elbows:	Size of pipe ("nominal iron pipe size," or actual bore for non-threaded work) and angle of openings, if not at right angles.
Offsets:	Pipe size, and amount of offset.
Nipples:	Pipe size, and length.
Various Fittings:	Primarily by pipe size, and if of flanged type (i. e., not screwed joints) by actual passage or bore.
Reducing Fittings:	Size of each outlet. (Note: When reducing sockets or other fittings, reduce to the next nearest size; it is sufficient to state the main size).
Return Bends:	Pipe size, and distance of bores, center to center.
Cross-overs:	Pipe size, and size of pipe crossed.
Tees and Branch Tees:	Size of "run" and of outlets. (Note: In specifying any class of fitting with a main passage and one or more outlets, the main passage—called "run"—is always written down first.)
Flanges:	Diameter. Pipe size sometimes stated.
Pipe Saddles and Clamps:	Pipe size.
Roller-Brackets:	Maximum size pipe carried.
Hooks and Hook-Plates:	Maximum size pipe carried and number of hooks.
Pipe Stands:	Pipe size and distance apart of centers.
Expansion Joints:	Pipe bore, and over-all dimensions.
Siphon Boxes:	Capacity, in quarts or gallons.
Water-Gages:	External diameter of glass, usually.
Pressure-Gages:	Diameter of dial, and maximum pressure.
Pyrometers:	Maximum capacity in degrees.
Oil-Cups and Lubricators:	Diameter of body.
Sight-Feed Lubricators:	Capacity in pints or gallons.
Glass Needle Lubricators:	Capacity in ounces, liquid measure.

BELTS, ROPES, CHAINS

Material	How Sized
Belting (flat or vee):	By width and thickness.
Belting (round leather or catgut):	By diameter in fractional or decimal parts. Catgut sometimes sized by Brown & Sharpe gage.
Belt Lacing:	By width.
Ropes:	By diameter.
Rope Fittings (wire rope):	Rated by size of rope used for; excepting hooks, which are listed by safe working load in tons.
Crane Chain:	By diameter of iron used in links.
Jack Chain (and similar small kinds):	By width, or by numbers, which may or may not coincide with the gage of wire used in making.
Cable Chain (for suspension and counterweighting purposes):	By width and thickness, or by safe working load.
Machine Chains (for driving):	By pitch (center to center of rivets), and width. The latter is inside the links in the case of block or roller type, but outside in the rocker-joint type.
GEARING	
Spur Wheels and Pinions:	By pitch diameter and width of face. Sometimes outside diameter is taken, with pitch and number of teeth specified.
Bevel, Miter Wheels and Pinions:	Pitch diameter in this case is taken at the large end.
Worms:	By pitch diameter, pitch and width of face.
Worm-Wheels:	The pitch diameter in this case is taken in the central plane.
Pinion Wire:	By pitch, number of teeth, and length.
Ratchet Wheels:	By pitch diameter and pitch, or outside diameter and pitch.
Racks:	By pitch, depth, and width.
Friction Spurs, Bevels, and Miters:	By largest diameter and width of face.
Gear Blanks:	By outside diameter, and width of face, but it is often just as convenient to refer to them in terms of pitch diameter, if a system is established on this basis.
Shaft Fittings:	Most fittings used in connection with shafts are sized by the diameter of latter, but pulleys are rated by diameter and width of face, and some kinds of clutches by diameter of same, or per H. P. transmitted.
MISCELLANEOUS SUPPLIES	
Lead Wire Ribbon:	By diameter of the wires.
Copper Jointing Rings:	By size of pipe, or inside and outside dimensions.
Pipe Coverings:	By outside diameter of pipe.
Flange Covers:	By diameter of pipe and of flange.
Gage-Glass Washers and Cones:	By size of glass used for.
Hydraulic Leathers:	By outside diameter in the case of cup and U-leathers, the latter sometimes inside. Flange or hat leathers by inside diameter.
Leather Fillet (for patterns):	By the radius, with a series of numbers corresponding to sixteenths of an inch, thus: No. 1. 1/16-inch radius. No. 2. 1/8-inch radius. No. 3. 3/16 inch radius. No. 4. 1/4-inch radius, etc.
Pattern Letters:	Length of face (as letters are beveled, the length at base is in excess of this, by 1/16 inch or more).
Pattern Dowels:	Diameter of peg.
Dowel Plates:	Length of plate.
Rapping Plates:	Length and width. Or sometimes by the size of tapped hole.
Stars (for tumbling):	Distance from point to point.
Fire-Bricks:	Length, width, and thickness. Curved (for cupola linings) by radii of outside and inside, and the depth.

* * *

PRODUCTION OF ELECTRIC STEEL IN GERMANY

During 1914, there were twenty plants in operation in Germany for producing electric steel. The total output was close to 90,000 tons. About one-half of this amount was produced in furnaces controlled by the firm of Siemens & Halske. Of the twenty plants mentioned, eight are producing high-grade steel of the same class as crucible steel. The output of crucible steel in 1914 was 95,000 tons, or only slightly in excess of the output of electric steel.

DEVELOPMENT OF THE AEROPLANE

One of the results of the European war will be a great increase in the size, weight and capacity of the aeroplane and the bringing of it up to the condition where it may be seriously considered for commercial use. The Curtiss Aeroplane Co., Buffalo, N. Y., which built the *America*, is building hydroaeroplanes of the "Canada" type, having a span of 133 feet, and three planes, each 10 feet wide, and spaced 10 feet apart. It weighs, fully equipped, over 21,000 pounds, and is driven by three twin-six internal combustion engines of 320 horsepower each. There are three propellers, two in front and one in the rear, each having a length of about 15 feet. In addition, this gigantic air craft will have an auxiliary engine of 40 horsepower, which will be used as a starting engine and for driving a screw propeller for propelling the craft when in the water. It is six times larger than any yet tried, and has a cruising radius of nearly 700 miles at a speed of 75 miles an hour. The weight of the hull is 8000 pounds and that of the motors 4000 pounds. It will carry a crew of eight men Albert Santos Dumont, the famous Brazilian aviator, predicts that in the course of a very few years, giant aeroplanes will be built capable of traveling at the rate of 175 to 250 miles an hour and that regular aeroplane service will be established between the United States and South America. The time required now for the trip from New York to Buenos Ayres is about twenty days, but with the high-speed aeroplane, it will require only about two days.

* * *

DETERMINING INDEXING MOVEMENTS FOR ANGLES

The accompanying tables will be found useful for quickly determining the movements of the indexing crank that are necessary when indexing for angles in minutes and seconds. The tables are used as follows: Reduce the angle to seconds and divide the value thus obtained by 32,400. The quotient gives the number of complete turns and decimal fraction of a turn required. Then find the decimal (or nearest decimal) to this decimal fraction in the tables. Opposite this decimal will be found the fractional number indicating the movement to be made on most of the leading milling machines. The first figure, or the numerator, in this fraction gives the number of holes to be moved, and the second figure, or denominator, the index circle used. As an example, assume that an angle of 10 degrees, 32 minutes, 12 seconds is to be indexed. Then,

$$10 \text{ deg. } 32 \text{ min. } 12 \text{ sec.} = 37{,}932 \text{ seconds.}$$

$$\frac{37{,}932}{32{,}400} = 1.1707$$

From this, it will be seen that this indexing can be made by one complete turn and 0.1707 part of a turn. Looking in the table, we find that 0.1707 part of a turn may be made on all the milling machines listed by moving seven holes in the forty-one hole circle.

The number of holes in the index circles of the indexing head made by the Brown & Sharpe Mfg. Co., Becker Milling Machine Co., Hendey Machine Co., Kearney & Trecker Co., and the Rockford Milling Machine Co. are the same. The index circles in the index head made by the Cincinnati Milling Machine Co. differ from these, hence, a separate column is given in the table for the "Cincinnati" index head. The R. K. LeBlond Machine Tool Co.'s dividing head has the same index circles as that of the Cincinnati Milling Machine Co. except that the LeBlond index head does not have the 24-, [illegible] 28-, and 30-hole circles, but has, instead, 36-, 48-, and [illegible]-hole circles. The movements in the 24- and 28-hole circles of the Cincinnati index head may be made on the LeBlond index head by taking double the number of holes in the 48-hole and 56-hole circles, respectively. In this way, the table can also be used for practically all movements in the LeBlond milling machines. The index heads of the Garvin Machine Co., the Oesterlein Machine Co., and the Kempsmith Mfg. Co. have special index plates, and the table does not apply to these machines.

TABLE FOR FINDING INDEXING MOVEMENTS FOR ANGLES—I

Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*
0.0152	...	1/66	0.0930	4/43	4/43	0.1739	4/23	8/46	0.2564	10/39	10/39	0.3387	...	21/62	0.4211	8/19	16/38
0.0161	...	1/62	0.0943	...	5/53	0.1754	...	10/57	0.2576	...	17/66	0.3390	...	20/59	0.4211	...	24/57
0.0169	...	1/59	0.0952	2/21	4/42	0.1765	3/17	6/34	0.2581	8/31	16/62	0.3396	...	18/53	0.4237	...	25/59
0.0172	...	1/58	0.0968	3/31	6/62	0.1765	...	9/51	0.2586	...	15/58	0.3404	16/47	16/47	0.4242	14/33	28/66
0.0175	...	1/57	0.0976	4/41	4/41	0.1774	...	11/62	0.2593	7/27	14/54	0.3415	14/41	14/41	0.4255	20/47	20/47
0.0185	...	1/54	0.0980	...	5/51	0.1786	...	5/28	0.2609	6/23	12/46	0.3421	...	13/38	0.4259	...	23/54
0.0189	...	1/53	0.1000	2/20	3/30	0.1795	7/39	7/39	0.2619	...	11/42	0.3448	10/29	20/58	0.4286	...	12/28
0.0196	...	1/51	0.1017	...	6/59	0.1818	6/33	12/66	0.2632	5/19	10/38	0.3469	17/49	17/49	0.4286	9/21	18/42
0.0204	1/49	1/49	0.1020	5/49	5/49	0.1839	9/49	9/49	0.2632	...	15/57	0.3478	8/23	16/46	0.4286	21/49	21/49
0.0213	1/47	1/47	0.1026	4/39	4/39	0.1842	...	7/38	0.2642	...	14/53	0.3485	...	23/66	0.4310	...	25/58
0.0217	...	1/46	0.1034	3/29	6/58	0.1852	5/27	10/54	0.2647	...	9/34	0.3488	15/43	15/43	0.4314	...	22/51
0.0233	1/43	1/43	0.1053	2/19	4/38	0.1860	8/43	8/43	0.2653	13/49	13/49	0.3500	7/20	...	0.4324	16/37	16/37
0.0238	...	1/42	0.1053	...	6/57	0.1864	...	11/59	0.2667	4/15	8/30	0.3509	...	20/57	0.4333	...	13/30
0.0244	1/41	1/41	0.1061	...	7/66	0.1875	3/16	...	0.2683	11/41	11/41	0.3514	13/37	13/37	0.4340	...	23/53
0.0256	1/39	1/39	0.1064	5/47	5/47	0.1887	...	10/53	0.2703	10/37	10/37	0.3519	...	19/54	0.4348	10/23	20/46
0.0263	...	1/38	0.1071	...	3/28	0.1892	7/37	7/37	0.2712	...	16/59	0.3529	6/17	12/34	0.4355	...	27/62
0.0270	1/37	1/37	0.1081	4/37	4/37	0.1897	...	11/58	0.2727	9/33	18/66	0.3529	...	18/51	0.4359	17/39	17/39
0.0294	...	1/34	0.1087	...	5/46	0.1905	4/21	8/42	0.2742	...	17/62	0.3548	11/31	22/62	0.4375	7/16	...
0.0303	1/33	2/66	0.1111	2/18	...	0.1915	9/47	9/47	0.2745	...	14/51	0.3559	...	21/59	0.4386	...	25/57
0.0323	1/31	2/62	0.1111	3/27	6/54	0.1930	...	11/57	0.2759	8/29	16/58	0.3571	...	10/28	0.4390	18/41	18/41
0.0333	...	1/30	0.1129	...	7/62	0.1935	6/31	12/62	0.2766	13/47	13/47	0.3571	...	15/42	0.4394	...	29/66
0.0338	...	2/59	0.1132	...	6/53	0.1951	8/41	8/41	0.2778	5/18	15/54	0.3585	...	19/53	0.4400	...	11/25
0.0345	1/29	2/58	0.1163	5/43	5/43	0.1957	...	9/46	0.2791	12/43	12/43	0.3590	14/39	14/39	0.4407	...	26/59
0.0351	...	2/57	0.1176	2/17	4/34	0.1961	...	10/51	0.2800	...	7/25	0.3600	...	9/25	0.4412	...	15/34
0.0357	...	1/28	0.1176	...	6/51	0.1970	...	13/66	0.2807	...	16/57	0.3617	17/47	17/47	0.4419	19/43	19/43
0.0370	1/27	2/54	0.1186	...	7/59	0.2000	3/15	5/25	0.2821	11/39	11/39	0.3621	...	21/58	0.4444	8/18	...
0.0377	...	2/53	0.1190	...	5/42	0.2000	4/20	6/30	0.2826	...	13/46	0.3636	12/33	24/66	0.4444	12/27	24/54
0.0392	...	2/51	0.1200	...	3/25	0.2034	...	12/59	0.2830	...	15/53	0.3659	15/41	15/41	0.4468	21/47	21/47
0.0400	...	1/25	0.1207	...	7/58	0.2037	...	11/54	0.2857	...	8/28	0.3667	...	11/30	0.4474	...	17/38
0.0408	2/49	2/49	0.1212	4/33	8/66	0.2041	10/49	10/49	0.2857	14/49	14/49	0.3673	18/49	18/49	0.4483	13/29	26/58
0.0417	...	1/24	0.1220	5/41	5/41	0.2051	8/39	8/39	0.2857	6/21	12/42	0.3684	7/19	14/38	0.4490	22/49	22/49
0.0426	2/47	2/47	0.1224	6/49	6/49	0.2059	...	7/34	0.2879	...	19/66	0.3684	...	21/57	0.4500	9/20	...
0.0435	1/23	2/46	0.1228	...	7/57	0.2069	6/29	12/58	0.2881	...	17/59	0.3696	...	17/46	0.4510	...	23/51
0.0454	...	3/66	0.1250	2/16	3/24	0.2075	...	11/53	0.2895	...	11/38	0.3704	10/27	20/54	0.4516	14/31	28/62
0.0465	2/43	2/43	0.1277	6/47	6/47	0.2083	...	5/24	0.2903	9/31	18/62	0.3710	...	23/62	0.4524	...	19/42
0.0476	1/21	2/42	0.1282	5/39	5/39	0.2093	9/43	9/43	0.2917	...	7/24	0.3721	16/43	16/43	0.4528	...	24/53
0.0484	...	3/62	0.1290	4/31	8/62	0.2097	...	13/62	0.2927	12/41	12/41	0.3725	...	19/51	0.4545	15/33	30/66
0.0488	2/41	2/41	0.1296	...	7/54	0.2105	4/19	8/38	0.2931	...	17/58	0.3729	...	22/59	0.4561	...	26/57
0.0500	1/20	...	0.1304	3/23	6/46	0.2105	...	12/57	0.2941	...	15/51	0.3750	6/16	9/24	0.4565	...	21/46
0.0508	...	3/59	0.1316	...	5/38	0.2121	7/33	14/66	0.2941	5/17	10/34	0.3774	...	20/53	0.4576	...	27/59
0.0513	2/39	2/39	0.1321	...	7/53	0.2128	10/47	10/47	0.2963	8/27	16/54	0.3784	14/37	14/37	0.4583	...	11/24
0.0517	...	3/58	0.1333	2/15	4/30	0.2143	...	6/28	0.2973	11/37	11/37	0.3788	...	25/66	0.4595	17/37	17/37
0.0526	1/19	2/38	0.1351	5/37	5/37	0.2143	...	9/42	0.2979	14/47	14/47	0.3793	11/29	22/58	0.4615	18/39	18/39
0.0526	...	3/57	0.1356	...	8/59	0.2157	...	11/51	0.2982	...	17/57	0.3810	8/21	16/42	0.4630	...	25/54
0.0541	2/37	2/37	0.1364	...	9/66	0.2162	8/37	8/37	0.3000	6/20	9/30	0.3824	...	13/34	0.4634	19/41	19/41
0.0556	1/18	3/54	0.1372	...	7/51	0.2174	5/23	10/46	0.3019	...	16/53	0.3830	18/47	18/47	0.4643	...	13/28
0.0566	...	3/53	0.1379	4/29	8/58	0.2195	9/41	9/41	0.3023	13/43	13/43	0.3846	15/39	15/39	0.4651	20/43	20/43
0.0588	1/17	2/34	0.1395	6/43	6/43	0.2203	...	13/59	0.3030	10/33	20/66	0.3860	...	22/57	0.4655	...	27/58
0.0588	...	3/51	0.1404	...	8/57	0.2222	4/18	...	0.3043	7/23	14/46	0.3871	12/31	24/62	0.4667	7/15	14/30
0.0606	2/33	4/66	0.1429	...	4/28	0.2222	6/27	12/54	0.3051	...	18/59	0.3878	19/49	19/49	0.4677	...	29/62
0.0612	3/49	3/49	0.1429	3/21	6/42	0.2241	...	13/58	0.3061	15/49	15/49	0.3889	7/18	21/54	0.4681	22/47	22/47
0.0625	1/16	...	0.1429	7/49	7/49	0.2245	11/49	11/49	0.3065	...	19/62	0.3898	...	23/59	0.4694	23/49	23/49
0.0638	3/47	3/47	0.1452	...	9/62	0.2258	7/31	14/62	0.3077	12/39	12/39	0.3902	16/41	16/41	0.4697	...	31/66
0.0645	2/31	4/62	0.1463	6/41	6/41	0.2264	...	12/53	0.3095	...	13/42	0.3913	9/23	18/46	0.4706	8/17	16/34
0.0652	...	3/46	0.1471	...	5/34	0.2273	...	15/66	0.3103	9/29	18/58	0.3922	...	20/51	0.4706	...	24/51
0.0667	...	2/30	0.1481	4/27	8/54	0.2281	...	13/57	0.3125	5/16	...	0.3929	...	11/28	0.4717	...	25/53
0.0678	...	4/59	0.1489	7/47	7/47	0.2308	9/39	9/39	0.3137	...	16/51	0.3939	13/33	26/66	0.4737	9/19	27/57
0.0690	2/29	4/58	0.1500	3/20	...	0.2326	10/43	10/43	0.3148	...	17/54	0.3947	...	15/38	0.4746	...	28/59
0.0698	3/43	3/43	0.1509	...	8/53	0.2333	...	7/30	0.3158	6/19	12/38	0.3953	17/43	17/43	0.4762	10/21	20/42
0.0702	...	4/57	0.1515	5/33	10/66	0.2340	11/47	11/47	0.3158	...	18/57	0.3962	...	21/53	0.4783	11/23	22/46
0.0714	...	2/28	0.1522	...	7/46	0.2353	4/17	8/34	0.3171	13/41	13/41	0.3966	...	23/58	0.4800	...	12/25
0.0714	...	3/42	0.1525	...	9/59	0.2353	...	12/51	0.3182	...	21/66	0.4000	6/15	10/25	0.4814	...	26/54
0.0732	3/41	3/41	0.1538	6/39	6/39	0.2368	...	9/38	0.3191	15/47	15/47	0.4000	8/20	12/30	0.4815	13/27	...
0.0741	2/27	4/54	0.1552	...	9/58	0.2373	...	14/59	0.3200	...	8/25	0.4032	...	25/62	0.4828	14/29	28/58
0.0755	...	4/53	0.1569	...	8/51	0.2381	5/21	10/42	0.3208	...	17/53	0.4035	...	23/57	0.4839	15/31	30/62
0.0758	...	5/66	0.1579	3/19	6/38	0.2391	...	11/46	0.3214	...	9/28	0.4043	19/47	19/47	0.4848	16/33	32/66
0.0769	3/39	3/39	0.1579	...	9/57	0.2400	...	6/25	0.3220	...	19/59	0.4048	...	17/42	0.4865	18/37	18/37
0.0784	...	4/51	0.1600	...	4/25	0.2407	...	13/54	0.3226	10/31	20/62	0.4054	15/37	15/37	0.4872	19/39	19/39
0.0789	...	3/38	0.1613	5/31	10/62	0.2414	7/29	14/58	0.3235	...	11/34	0.4068	...	24/59	0.4878	20/41	20/41
0.0800	...	2/25	0.1622	6/37	6/37	0.2419	...	15/62	0.3243	12/37	12/37	0.4074	11/27	22/54	0.4884	21/43	21/43
0.0806	...	5/62	0.1628	7/43	7/43	0.2424	8/33	16/66	0.3256	14/43	14/43	0.4082	20/49	20/49	0.4894	23/47	23/47
0.0811	3/37	3/37	0.1633	8/49	8/49	0.2432	9/37	9/37	0.3261	...	15/46	0.4091	...	27/66	0.4898	24/49	24/49
0.0816	4/49	4/49	0.1667	3/18	11/66	0.2439	10/41	10/41	0.3265	16/49	16/49	0.4103	16/39	16/39	0.4902	...	25/51
0.0833	...	2/24	0.1667	...	9/54	0.2449	12/49	12/49	0.3276	...	19/58	0.4118	7/17	14/34	0.4906	...	26/53
0.0847	...	5/59	0.1667	...	7/42	0.2453	...	13/53	0.3333	6/18	8/24	0.4118	...	21/51	0.4912	...	28/57
0.0851	4/47	4/47	0.1667	...	5/30	0.2456	...	14/57	0.3333	5/15	10/30	0.4130	...	19/46	0.4915	...	29/59
0.0862	...	5/58	0.1667	...	4/24	0.2500	4/16	6/24	0.3333	13/39	13/39	0.4138	12/29	24/58	0.5000	8/16	12/24
0.0870	2/23	4/46	0.1695	...	10/59	0.2500	5/20	7/28	0.3333	7/21	14/42	0.4146	17/41	17/41	0.5000	9/18	14/28
0.0877	...	5/57	0.1698	...	9/53	0.2542	...	15/59	0.3333	...	17/51	0.4151	...	22/53	0.5000	10/20	15/30
0.0882	...	3/34	0.1702	8/47	8/47	0.2549	...	13/51	0.3333	9/27	18/54	0.4167	...	10/24	0.5000	...	17/34
0.0909	3/33	6/66	0.1707	7/41	7/41	0.2553	12/47	12/47	0.3333	...	19/57	0.4186	18/43	18/43	0.5000	...	19/38
0.0926	...	5/54	0.1724	5/29	10/58	0.2558	11/43	11/43	0.3333	11/33	22/66	0.4194	13/31	26/62	0.5000	...	21/42

Machinery

* See article for explanatory matter relating to use of table for the R. K. LeBlond milling machines.

TABLE FOR FINDING INDEXING MOVEMENTS FOR ANGLES—II

Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*	Movement in Decimal of a Turn	B. & S., Becker, Hendey, K. & T. and Rockford	Cincinnati and LeBlond*
0.5000	...	23/46	0.5814	25/43	25/43	0.6667	10/15	20/30	0.7447	35/47	35/47	0.8293	34/41	34/41	0.9090	30/33	60/66
0.5000	...	27/54	0.5833	...	14/24	0.6667	26/39	26/39	0.7451	...	38/51	0.8298	39/47	39/47	0.9118	...	31/34
0.5000	...	29/58	0.5849	...	31/53	0.6667	14/21	28/42	0.7458	...	44/59	0.8302	...	44/53	0.9123	...	52/57
0.5000	...	31/62	0.5854	24/41	24/41	0.6667	...	34/51	0.7500	12/16	18/24	0.8305	...	49/59	0.9130	21/23	42/46
0.5000	...	33/66	0.5862	17/29	34/58	0.6667	18/27	36/54	0.7500	15/20	21/28	0.8333	15/18	20/24	0.9138	...	53/58
0.5085	...	30/59	0.5870	...	27/46	0.6667	...	38/57	0.7544	...	43/57	0.8333	...	25/30	0.9149	43/47	43/47
0.5088	...	29/57	0.5882	10/17	20/34	0.6667	22/33	44/66	0.7547	...	40/53	0.8333	...	35/42	0.9153	...	54/59
0.5094	...	27/53	0.5882	...	30/51	0.6724	...	39/58	0.7551	37/49	37/49	0.8333	...	45/54	0.9167	...	22/24
0.5098	...	26/51	0.5897	23/39	23/39	0.6735	33/49	33/49	0.7561	31/41	31/41	0.8333	...	55/66	0.9184	45/49	45/49
0.5102	25/49	25/49	0.5909	...	39/66	0.6739	...	31/46	0.7568	28/37	28/37	0.8367	41/49	41/49	0.9189	34/37	34/37
0.5106	24/47	24/47	0.5918	29/49	29/49	0.6744	29/43	29/43	0.7576	25/33	50/66	0.8372	36/43	36/43	0.9194	...	57/62
0.5116	22/43	22/43	0.5926	16/27	32/54	0.6757	25/37	25/37	0.7581	...	47/62	0.8378	31/37	31/37	0.9200	...	23/25
0.5122	21/41	21/41	0.5932	...	35/59	0.6765	...	23/34	0.7586	22/29	44/58	0.8387	26/31	52/62	0.9211	...	35/38
0.5128	20/39	20/39	0.5946	22/37	22/37	0.6774	21/31	42/62	0.7593	...	41/54	0.8400	...	21/25	0.9216	...	47/51
0.5135	19/37	19/37	0.5952	...	25/42	0.6780	...	40/59	0.7600	...	19/25	0.8421	...	32/38	0.9231	36/39	36/39
0.5152	17/33	34/66	0.5957	28/47	28/47	0.6786	...	19/28	0.7609	...	35/46	0.8421	16/19	48/57	0.9242	...	61/66
0.5161	16/31	32/62	0.5965	...	34/57	0.6792	...	36/53	0.7619	16/21	32/42	0.8431	...	43/51	0.9245	...	49/53
0.5172	15/29	30/58	0.5968	...	37/62	0.6800	...	17/25	0.7627	...	45/59	0.8448	...	49/58	0.9259	25/27	50/54
0.5185	14/27	28/54	0.6000	9/15	15/25	0.6809	32/47	32/47	0.7632	...	29/38	0.8462	33/39	33/39	0.9268	38/41	38/41
0.5200	...	13/25	0.6000	12/20	18/30	0.6818	...	45/66	0.7647	13/17	26/34	0.8475	...	50/59	0.9286	...	26/28
0.5217	12/23	24/46	0.6034	...	35/58	0.6829	28/41	28/41	0.7647	...	39/51	0.8478	...	39/46	0.9286	...	39/42
0.5238	11/21	22/42	0.6038	...	32/53	0.6842	13/19	26/38	0.7660	36/47	36/47	0.8485	28/33	56/66	0.9298	...	53/57
0.5254	...	31/59	0.6047	26/43	26/43	0.6842	...	39/57	0.7667	...	23/30	0.8491	...	45/53	0.9302	40/43	40/43
0.5263	10/19	20/38	0.6053	...	23/38	0.6852	...	37/54	0.7674	33/43	33/43	0.8500	17/20	...	0.9310	27/29	54/58
0.5263	...	30/57	0.6061	20/33	40/66	0.6863	...	35/51	0.7692	30/39	30/39	0.8511	40/47	40/47	0.9322	...	55/59
0.5283	...	28/53	0.6071	...	17/28	0.6875	11/16	...	0.7719	...	44/57	0.8519	23/27	46/54	0.9333	14/15	28/30
0.5294	9/17	18/34	0.6078	...	31/51	0.6897	20/29	40/58	0.7727	...	51/66	0.8529	...	29/34	0.9348	...	43/46
0.5294	...	27/51	0.6087	14/23	28/46	0.6905	...	29/42	0.7736	...	41/53	0.8537	35/41	35/41	0.9355	29/31	58/62
0.5303	...	35/66	0.6098	25/41	25/41	0.6923	27/39	27/39	0.7742	24/31	48/62	0.8548	...	53/62	0.9362	44/47	44/47
0.5306	26/49	26/49	0.6102	...	36/59	0.6935	...	43/62	0.7755	38/49	38/49	0.8571	...	24/28	0.9375	15/16	...
0.5319	25/47	25/47	0.6111	11/18	33/54	0.6939	34/49	34/49	0.7759	...	45/58	0.8571	18/21	36/42	0.9388	46/49	46/49
0.5323	...	33/62	0.6122	30/49	30/49	0.6949	...	41/59	0.7778	14/18	...	0.8571	42/49	42/49	0.9394	31/33	62/66
0.5333	8/15	16/30	0.6129	19/31	38/62	0.6957	16/23	32/46	0.7778	21/27	42/54	0.8596	...	49/57	0.9412	16/17	32/34
0.5345	...	31/58	0.6140	...	35/57	0.6970	23/33	46/66	0.7797	...	46/59	0.8605	37/43	37/43	0.9412	...	48/51
0.5349	23/43	23/43	0.6154	24/39	24/39	0.6977	30/43	30/43	0.7805	32/41	32/41	0.8621	25/29	50/58	0.9434	...	50/53
0.5357	...	15/28	0.6170	29/47	29/47	0.6981	...	37/53	0.7826	18/23	36/46	0.8627	...	44/51	0.9444	17/18	51/54
0.5366	22/41	22/41	0.6176	...	21/34	0.7000	14/20	21/30	0.7838	29/37	29/37	0.8636	...	57/66	0.9459	35/37	35/37
0.5370	...	29/54	0.6190	13/21	26/42	0.7018	...	40/57	0.7843	...	40/51	0.8644	...	51/59	0.9474	18/19	36/38
0.5385	21/39	21/39	0.6207	18/29	36/58	0.7021	33/47	33/47	0.7857	...	22/28	0.8649	32/37	32/37	0.9474	...	54/57
0.5405	20/37	20/37	0.6212	...	41/66	0.7027	26/37	26/37	0.7857	...	33/42	0.8667	13/15	26/30	0.9483	...	55/58
0.5417	...	13/24	0.6216	23/37	23/37	0.7037	19/27	38/54	0.7872	37/47	37/47	0.8679	...	46/53	0.9487	37/39	37/39
0.5424	...	32/59	0.6226	...	33/53	0.7059	12/17	24/34	0.7879	26/33	52/66	0.8684	...	33/38	0.9492	...	56/59
0.5435	...	25/46	0.6250	10/16	15/24	0.7059	...	36/51	0.7895	15/19	30/38	0.8696	20/23	40/46	0.9500	19/20	...
0.5439	...	31/57	0.6271	...	37/59	0.7069	...	41/58	0.7895	...	45/57	0.8704	...	47/54	0.9512	39/41	39/41
0.5455	18/33	36/66	0.6275	...	32/51	0.7073	29/41	29/41	0.7903	...	49/62	0.8710	27/31	54/62	0.9516	...	59/62
0.5472	...	29/53	0.6279	27/43	27/43	0.7083	...	17/24	0.7907	34/43	34/43	0.8718	34/39	34/39	0.9524	20/21	40/42
0.5476	...	23/42	0.6290	...	39/62	0.7097	22/31	44/62	0.7917	...	19/24	0.8723	41/47	41/47	0.9535	41/43	41/43
0.5484	17/31	34/62	0.6296	17/27	34/54	0.7105	...	27/38	0.7925	...	42/53	0.8750	14/16	21/24	0.9545	...	63/66
0.5490	...	28/51	0.6304	...	29/46	0.7119	...	42/59	0.7931	23/29	46/58	0.8772	...	50/57	0.9565	22/23	44/46
0.5500	11/20	...	0.6316	12/19	24/38	0.7121	...	47/66	0.7941	...	27/34	0.8776	43/49	43/49	0.9574	45/47	45/47
0.5510	27/49	27/49	0.6316	...	36/57	0.7143	...	20/28	0.7949	31/39	31/39	0.8780	36/41	36/41	0.9583	...	23/24
0.5517	16/29	32/58	0.6327	31/49	31/49	0.7143	15/21	30/42	0.7959	39/49	39/49	0.8788	29/33	58/66	0.9592	47/49	47/49
0.5526	...	21/38	0.6333	...	19/30	0.7143	35/49	35/49	0.7963	...	43/54	0.8793	...	51/58	0.9600	...	24/25
0.5532	26/47	26/47	0.6341	26/41	26/41	0.7170	...	38/53	0.7966	...	47/59	0.8800	...	22/25	0.9608	...	49/51
0.5556	10/18	...	0.6364	21/33	42/66	0.7174	...	33/46	0.8000	16/20	20/25	0.8810	...	37/42	0.9623	...	51/53
0.5556	15/27	30/54	0.6379	...	37/58	0.7179	28/39	28/39	0.8000	12/15	24/30	0.8814	...	52/59	0.9630	26/27	52/54
0.5581	24/43	24/43	0.6383	30/47	30/47	0.7193	...	41/57	0.8030	...	53/66	0.8824	15/17	30/34	0.9643	...	27/28
0.5588	...	19/34	0.6400	...	16/25	0.7200	...	18/25	0.8039	...	41/51	0.8824	...	45/51	0.9649	...	55/57
0.5593	...	33/59	0.6410	25/39	25/39	0.7209	31/43	31/43	0.8043	...	37/46	0.8837	38/43	38/43	0.9655	28/29	56/58
0.5600	...	14/25	0.6415	...	34/53	0.7222	13/18	39/54	0.8049	33/41	33/41	0.8868	...	47/53	0.9661	...	57/59
0.5606	...	37/66	0.6429	...	18/28	0.7234	34/47	34/47	0.8065	25/31	50/62	0.8871	...	55/62	0.9667	...	29/30
0.5610	23/41	23/41	0.6429	...	27/42	0.7241	21/29	42/58	0.8070	...	46/57	0.8889	16/18	...	0.9677	30/31	60/62
0.5614	...	32/57	0.6441	...	38/59	0.7255	...	37/51	0.8085	38/47	38/47	0.8889	24/27	48/54	0.9697	32/33	64/66
0.5625	9/16	...	0.6452	20/31	40/62	0.7258	...	45/62	0.8095	17/21	34/42	0.8913	...	41/46	0.9706	...	33/34
0.5641	22/39	22/39	0.6471	11/17	22/34	0.7273	24/33	48/66	0.8103	...	47/58	0.8919	33/37	33/37	0.9730	36/37	36/37
0.5645	...	35/62	0.6471	...	33/51	0.7288	...	43/59	0.8108	30/37	30/37	0.8929	...	25/28	0.9737	...	37/38
0.5652	13/23	26/46	0.6481	...	35/54	0.7297	27/37	27/37	0.8113	...	43/53	0.8936	42/47	42/47	0.9744	38/39	38/39
0.5660	...	30/53	0.6486	24/37	24/37	0.7317	30/41	30/41	0.8125	13/16	...	0.8939	...	59/66	0.9756	40/41	40/41
0.5667	...	17/30	0.6491	...	37/57	0.7333	11/15	22/30	0.8136	...	48/59	0.8947	17/19	34/38	0.9762	...	41/42
0.5676	21/37	21/37	0.6500	13/20	...	0.7347	36/49	36/49	0.8140	...	35/43	0.8947	...	51/57	0.9767	42/43	42/43
0.5686	...	29/51	0.6512	28/43	28/43	0.7353	...	25/34	0.8148	...	44/54	0.8966	26/29	52/58	0.9783	...	45/46
0.5690	...	33/58	0.6515	...	43/66	0.7358	...	39/53	0.8158	...	31/38	0.8974	35/39	35/39	0.9787	46/47	46/47
0.5714	...	16/28	0.6522	15/23	30/46	0.7368	14/19	28/38	0.8163	40/49	40/49	0.8980	44/49	44/49	0.9796	48/49	48/49
0.5714	12/21	24/42	0.6531	32/49	32/49	0.7368	...	42/57	0.8182	27/33	54/66	0.8982	...	53/59	0.9804	...	50/51
0.5714	28/49	28/49	0.6552	19/29	38/58	0.7381	...	31/42	0.8205	32/39	32/39	0.9000	18/20	27/30	0.9811	...	[illegible]
0.5741	...	31/54	0.6579	...	25/38	0.7391	17/23	34/46	0.8214	...	23/28	0.9020	...	46/51	0.9817	...	[illegible]
0.5745	27/47	27/47	0.6585	27/41	27/41	0.7407	20/27	40/54	0.8226	...	51/62	0.9024	37/41	37/41	0.9825	...	56/57
0.5758	19/33	38/66	0.6596	31/47	31/47	0.7414	...	43/58	0.8235	14/17	28/34	0.9032	28/31	56/62	0.9828	...	57/58
0.5763	...	34/59	0.6604	...	35/53	0.7419	23/31	46/62	0.8235	...	42/51	0.9048	19/21	38/42	0.9831	...	[illegible]
0.5789	11/19	22/38	0.6610	...	39/59	0.7424	...	49/66	0.8246	...	47/57	0.9057	...	48/53	0.9839	...	61/62
0.5789	...	33/57	0.6613	...	41/62	0.7436	29/39	29/39	0.8261	19/23	38/46	0.9070	39/43	39/43	0.9848	...	65/66
0.5806	18/31	36/62	0.6667	12/18	16/24	0.7442	32/43	32/43	0.8276	24/29	48/58	0.9074	...	49/54	...	...	...

Machinery

* See article for explanatory matter relating to use of table for the R. K. LeBlond milling ma[illegible]

SOME PUNCH AND DIE TROUBLES*

REMEDIES THAT HAVE PROVED EFFECTIVE FOR COMMON PUNCH AND DIE TROUBLES

BY JOSEPH M. STABEL†

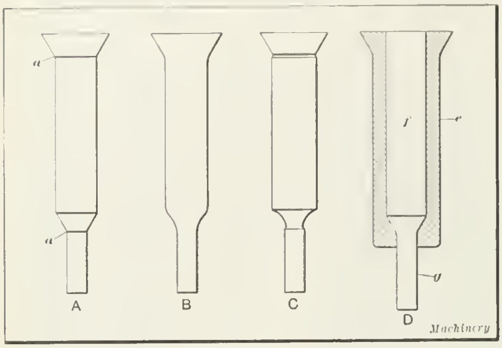


Fig. 1. Methods of making Perforating Punches

We all profit by experience, especially if time is taken to go to the root of any trouble in order to determine its cause. There are many, however, who do not take the time. For instance, if a punch breaks, it is simply regarded as a matter of course and another one substituted. The same punch may be replaced a dozen times without an attempt being made to discover *why* it breaks. As some of the most valuable information is that which has been acquired by noting defects and causes in actual practice, the writer will endeavor to explain a few of the many troubles which he has encountered in connection with different classes of die work, and suggest remedies which experience has proved to be effective.

Punch Troubles and Remedies

Small perforating punches which have annular marks left on them from turning or polishing are much more likely to fracture than those having marks which run parallel with the punch, especially when perforating heavy stock. This is due to the fact that the metal presses into the minute lines or grooves, thus increasing considerably the force required for stripping. As is generally known, most punches when used on heavy metal are broken while stripping the stock and not while perforating it; therefore, the stripping should be made as easy as possible. Another way to reduce the friction when stripping is by making the hole in the die larger than the punch, thus causing a tapering hole to be pierced in the stock. The stripping can also be facilitated by making the punch slightly tapering toward the top, although this is not practicable for small punches, because the strength would be reduced too much.

When the face of a punch which is used on heavy metal tends to chip off, it is caused either by the punch being too hard or the diameter of the die hole being too near the diameter of the punch. If the stripper plate is not parallel with the die, this will also cause broken punches. Even though the error in alignment is small, the constant bending action that the punches must undergo every time the stock is stripped tends to shorten their life. A spring stripper should also be held parallel to the die face. Sometimes the stripping is much harder on one end of the die than on the other, because more holes are perforated at one end. In such cases, special care should be taken to see that the stripper plate starts the stock from the punches evenly and uniformly.

The making of small perforating punches requires attention to minute details in order to secure the best results. For instance, the punch *A*, Fig. 1, has sharp corners, as shown at *a*. A punch should not be made in this way, but rather as shown at *B* with rounded corners. It should never be undercut, as indicated at *C*, because even if it is scored very slightly this will establish a breaking point. It is also a mistake to make small punches longer than is necessary, because it is difficult to temper them properly thoughout their length. When long perforating punches are necessary, as in compound dies, the arrangement shown at *D* is often resorted to. Part *e* is an auxiliary sleeve which acts as the main body of the punch, whereas *f* is a piece of hardened drill rod, and *g* the punch, which can be replaced at small cost. These small punches *g* are pieces of drill rod that have been upset to form a head while held between the vise jaws.

When a die has a number of large and very small punches, it is often advisable to make the large ones long enough to perforate the stock and just enter the die before the small ones touch the metal, especially if the stock is heavy, because the jar resulting from the action of the large punches may shift the stock slightly, which would tend to break the smaller punches, provided they entered the stock at the same time. This method of varying the lengths of punches has often been used to advantage in dies having a large number of punches, because a certain press could be used which otherwise would have lacked the necessary capacity, inasmuch as the pressure required for punching is distributed somewhat.

When locating punches in the holder, one of the principal points to consider is that the stripping strain should be as equally divided in relation to the punch-holder shank as possible; the surface of the holder which bears against the slide of the press should also be of such a size that the face of the slide will not be injured. Punches often shear themselves because a depression has been worn in the face of the slide and for that reason the holder is not properly supported. Inaccuracy in laying out pilot holes in punches and the use of eccentric pilots in order to make them register properly has also been the cause of much spoiled work. The trouble is that when the punch is sharpened, the pilot has to be removed, and it is often not replaced in the same position; consequently it does not engage properly with the pierced holes in the stock.

It sometimes happens that the blanking punch or certain perforating punches are of such a shape that they tend to incline to one side and cause shearing when passing through the metal, thus injuring the edge of both punch and die. This is caused by the shearing thrust not being equal on all sides, as illustrated by the diagram *A*, Fig. 2. In this case the shearing strain from the two long sides tends to crowd the punch over toward the shorter side, as indicated by arrow *a*. To prevent this trouble the face of the punch should be ground to a slight angle so that it enters the shorter side first; then this side will be backed up by the die to take the thrust when cutting the remaining part of the blank.

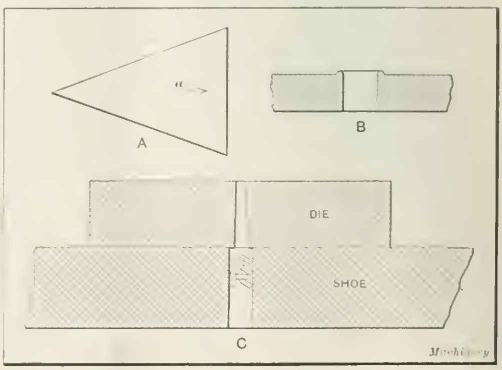


Fig. 2. Diagrams illustrating Troubles connected with Blanking and Piercing Dies

* For additional information on punch and die work, see "Rectangular Drawing and Trimming," September, 1915, and articles there referred to.
† Address: 1053 Main St., Rochester, N. Y.

Location of Stop-pins

When punches are equipped with pilots the stop-pin in the die should be so located that when the pilots enter the pierced holes they will tend to move the stock slightly away from the stop-pin. If the stock were crowded against the stop-pin, a sheared die or a burred hole where the pilot enters would be the result. The location of the stop-pin in a lateral direction should be varied in accordance with the shape of the blank; that is, it is essential to have the stop-pin bear against the stock at such a point that as the stock is fed forward the tendency will be to force it over against the back gage. Fig. 3 illustrates this point. The upper illustration *A* shows the stop-pin in the proper position relative to the back gage, whereas the lower view *B* shows it in such a position that the tendency is to crowd the stock away from the back gage as it is fed forward.

As to the scrap allowance or width of the "bridge" between the blank openings, it is common to allow the thickness of the stock, but this rule should not always be applied. For instance, when narrow strips, 1/4 inch wide by 3 inches long, were blanked out crosswise of the strip, it was found that by allowing only the thickness of the metal the punch sheared off toward the scrap side because the end cuts were so narrow that they did not support the punch against the thrust resulting from the shear on the solid side of the strip. When using dies of the general shape referred to, it is advisable to allow at least 1 1/2 times the thickness of the stock between the blanks.

Clearance—Cause of Slugging

Another trouble often encountered with compound dies, as well as other types, is due to roughness and lack of proper clearance in the die holes, especially if they are small. The surface of a hole should be very smooth and the taper reamer that is used in finishing it should produce a smooth finish free from circular ridges. Some of the first indications of "slugging" (as diemakers term the plugging up of a perforated hole) are as follows: First, the breaking of punches; second, the punches being upset or pushed back so that the hole is not quite punched through; third, the appearance of a burr on the top side of the blank around the hole, as indicated at *B*, Fig. 2. When the punch is of such a temper that it will neither burr nor break but will flatten out the slug before there is pressure enough exerted on the remaining slugs of the die to push them downward, the top slug expands, thus forcing the metal out and forming the burr as shown. Slugging may be caused by too much clearance in the hole through the shoe beneath the die. This may seem strange to many, but it has caused much difficulty when perforating small holes. The diameter of this clearance hole should be such that the slugs cannot clog into it by forming a bridge as indicated at *C*, Fig. 2. If the clearance hole is a little too large, sometimes the oil on the slugs will cause them to stick to the sides of the hole so that they become jammed and form a bridge.

A blank having a burr around the edge is not always a sign that the punch does not fit the die properly. The trouble may be that the die has not the proper amount of clearance, so that forcing a blank through such a die forms a burr. By examining the edge of the blank one can easily tell whether the die clears itself properly or not. Thus, if some parts of the edge are polished or burnished, it indicates that clearance is lacking at these points.

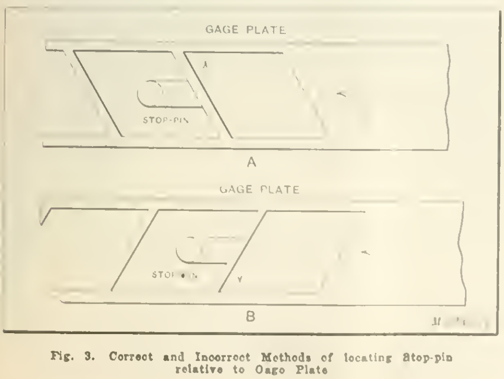


Fig. 3. Correct and Incorrect Methods of locating Stop-pin relative to Gage Plate

Bending and Forming Dies

It is important to know something about the action of metal when it is being bent or formed in different types of dies. Two distinct classes of bending dies are illustrated in Fig. 4. One is an open die without a pressure pad, whereas the other has a pressure pad to prevent the blank from creeping. The metal has a natural action in the open die, whereas with a pressure pad type the tendency is to draw it, especially if it is squeezed rather hard between the die and punch, which is often necessary in order to form a square shape. When metal is given a right-angle form it shortens up the blank an amount equal to one-half the thickness of the stock. Referring to *A*, Fig. 4, part *a* is 1/8 inch thick and each side has an inside length of 1 inch; hence the blank for this part would have a length equal to 2 inches plus half the thickness of the stock, or 2 1/16 inches. If the blank should have more than one right-angle bend simply multiply the number of such bends by half the thickness of the stock, plus the inside measurement of all the sides, to obtain the total length of the blank.

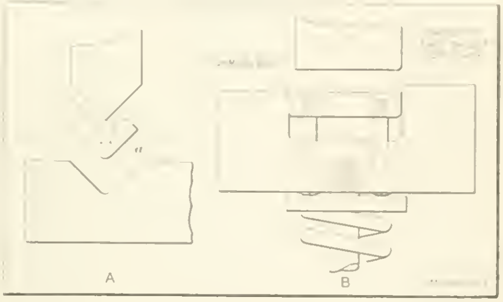


Fig. 4. Two Forms of Bending or Forming Dies

The radius formed on the outside of any right-angle bend, which has a sharp corner inside, is about 1 1/4 times the thickness of the stock. This radius, however, will vary slightly in accordance with the hardness of the material. When making dies to form metal that is of a hard temper, such as German silver, hard brass or steel, it is advisable to allow the punch to strike harder at the forming point, as this tends to set the metal, thus producing greater uniformity in the pieces formed. A slow acting press will not act a form as well as one with more speed, although a slow action will often form metal that is too hard to be formed in a quick-acting press, without fracturing.

When parts are to be blanked preparatory to bending, it is advisable to make the blanking die so that the grain of the metal in the blank will be at right angles to the bend. When working German silver, or metal of a hard temper, this is important and if ignored there will be a large percentage of loss as the result of fracturing. If the blanking die should be laid out incorrectly as regards the grain, the defect may be remedied by cutting the stock from the sheets so that the grain will run properly in the blank.

Pointers on Drawing Die Construction

Some of the most common causes of trouble in the operation and construction of drawing dies will now be considered. Care should be taken that a shell which is the first of a series of operations, is uniform in height all around, because a little unevenness will multiply as it passes through succeeding dies, thus requiring a larger blank than is necessary. This defect is often caused by the blanking ring not being concentric with the drawing die; the blank holder may also bear harder on one side than on the other, or a bad burr on one side of the blank may result in holding that side back. If the bottom of the shell breaks out, this may be caused by

using a die that is too small in relation to the blank diameter. The rule usually employed for cylindrical work is that a shell may be drawn to a depth equal to its diameter. Very often this depth may be exceeded somewhat, but the strength of the bottom of the shell will be reduced for succeeding draws. Other causes of fracture at the bottom of the shell are: too small a drawing radius, insufficient clearance between the punch and die, excessive blank-holder pressure, excessive friction between the blank-holder and die caused by grinding marks on either die or blank-holder, and inferior quality of drawing metal.

The straight or cylindrical surface below the curved drawing edge of the die should not be too long because the pressure exerted on the metal when it is being drawn over the rounded edge tends to remove most of the lubrication, thus leaving very little for the straight surface; consequently, a scored shell is likely to be the result if the cylindrical part of the die is too long. The length of this straight part usually varies from 1/4 to 1/2 inch. The diameters of the punch and die should be measured occasionally to determine the width of the clearance space. If, as the result of wear, this clearance becomes excessive, the metal will thicken to such an extent that there will be difficulty in connection with succeeding drawing operations.

Any taper of the punch in an upward direction naturally would make it difficult to strip the drawn part. A vent hole through the center of the punch, opening to the atmosphere at some point above the top of the shell, is also very important, as it prevents the formation of air pockets and facilitates stripping. The punch should always be polished in a lengthwise direction, as this also aids in stripping the work.

When determining the size of the blank for an irregular or rectangular shape, always begin by making the blank a little smaller than what is expected to be the required size. Then if fracturing occurs, it is very evident that a larger blank cannot be used, whereas if the blank is over size a fracture may occur, thus leading to the conclusion that the draw is not practicable, although a proper size blank might be drawn without difficulty. The corners of a rectangular shaped punch and die should be very hard, because most of the wear is in the corners. Care should be taken that the metal does not thicken perceptibly during any one draw if others are to follow, but it is advisable to allow the corners to thicken slightly if there is only one operation or during the final operation of a series.

To draw a cylindrical projection from a hole pierced in a flat blank, the hole should first be reamed out to prevent the lower edge *a*, Fig. 5, from splitting. This splitting at the edge when a hub is drawn without reaming the hole is doubtless due to the compression of the metal by the action of the punch, which causes splitting when the hole is expanded. When this compressed surface, however, is cut away by reaming, the stretching action does not have the same effect.

Effects Produced by Trapped Oil, Air and Water

Forming the piece shown at *A*, Fig. 6, which is made from 1/8-inch sheet brass, requires three operations, the last of which is done with a drop-hammer. After this part is formed, it has to be machined all over. One day a complaint was received that the thickness *x* was below size and that the parts could not be trued up. The stock was measured and also the piece before it went to the drop-hammer and both measurements indicated that it was O. K. Finally, the trouble was located and it was found to be due to the fact that the operator used too much oil in swabbing out the dies. This oil was trapped in the die and when the blow was struck, the pressure was so high as to reduce the original thickness from 0.005 to 0.008 inch. The surface of the metal was also made quite rough. The use of a light coating of oil eliminated the trouble.

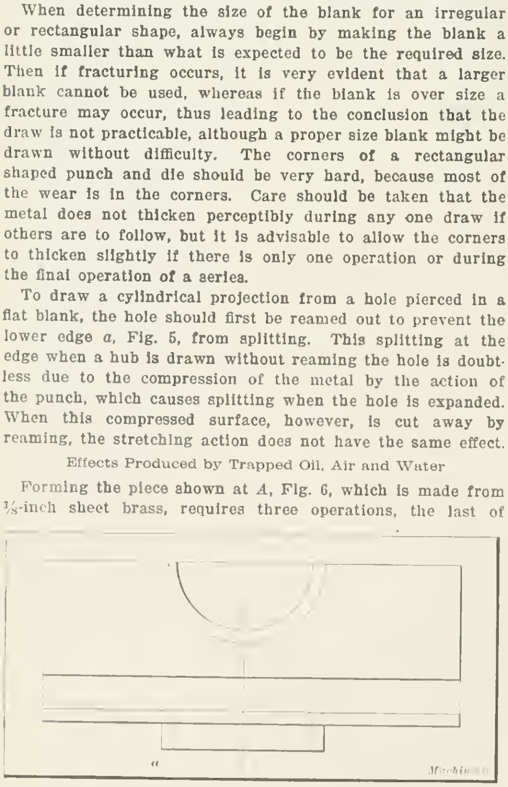


Fig. 5. Method of forming a Hub from a Hole pierced in Flat Stock

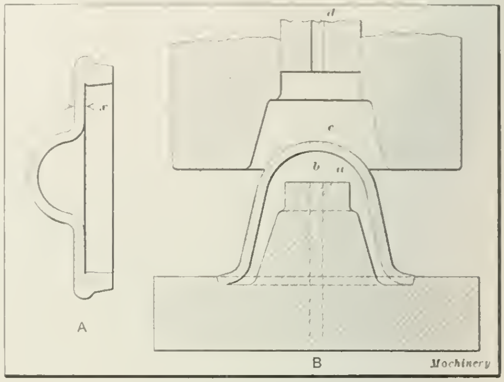


Fig. 6. (A) Part which was unintentionally reduced in Thickness by Oil Pressure; (B) Die which pierced Hole at c by Pressure of Air trapped at b

Another unusual incident happened in connection with a compound blanking and drawing die. This was used in a press having an automatic roll feed and a compressed air pipe extended down from the ceiling. This air was used to blow the drawn cups away from the die into a box back of the press. One night the shut-off cock on the air pipe was not closed completely and water which had condensed in the line dropped onto the die and flowed under the pressure pad, which was entirely housed in. When the press was first tripped the next morning the shoe was pushed through the hole in the bolster plate because the water could not flow out quickly enough.

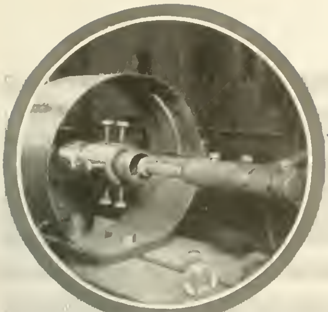
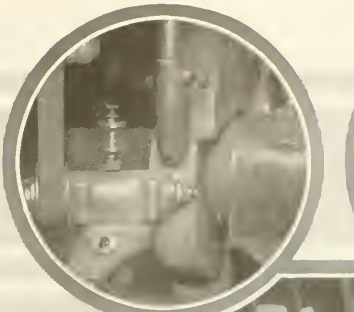
The action of air under high pressure is illustrated by another example. In making the die shown at *B*, Fig. 6, the diemaker failed to drill a vent hole through the punch, as indicated by the dotted lines *a*. The result was that when the press was tripped the air in space *b* was compressed to such a degree that a slug *c* was forced out into vent hole *d* in the knockout. The material was No. 8 brass, B. & S. gage, and a hole was made as neatly as though it had been pierced by a punch. This indicates in a rather striking way how the lack of necessary vent holes increases the load on both the die and press.

* * *

The annual convention of the American Foundrymen's Association and the American Institute of Metals will be held in Cleveland, Ohio, during the week of September 11. The annual exhibition of foundry equipment and supplies to be held concurrently with the meetings of these organizations will be conducted under the auspices of the American Foundrymen's Association and the American Institute of Metals. The exhibition will be held in the Cleveland Coliseum which contains 60,000 square feet of floor space on one level and is admirably adapted for a foundry show. A. O. Backert, 12th and Chestnut Sts., Cleveland, Ohio, is the secretary and treasurer of the association.

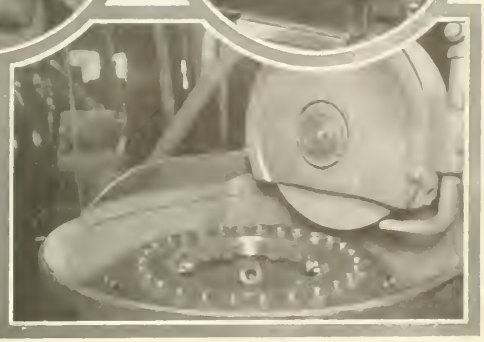
* * *

According to the *Scientific American* there has appeared, in England, a new telephone device which renders possible the summoning of a subscriber back to the telephone after he has been asked to "hold the wire" while the party at the other end is looking up some desired information. The device is in reality a loud-speaking horn. If the subscriber called does not wish to hold the receiver to his ear, he can place it over the horn and go about his duties. The calling party's voice is so amplified that it may be heard throughout a room.


Methods of Holding Work for Grinding

Douglas T. Hamilton



THE correct method of holding work for grinding is governed largely by the character of the work, its shape, and other considerations, such as accuracy, production, etc. The methods that are in use in different plants and on various classes of work are so diversified that it is impossible to describe them all, but in order to make the following article comprehensive a few of the more common ones involving standard principles will be illustrated. Most of the devices shown are those used in connection with the manufacture of automobile parts. These have been chosen first, because of their ease of operation, which is necessary to insure rapid production; and second, because of the accuracy required in this work.

Conditions which Govern the Type of Work-holding Device used for Grinding

In designing a work-holding device for carrying a certain piece of work while grinding, there are a number of points that should receive consideration. In the case of bushings having thin walls, for instance, it is essential that the work be held so that it is not put under tension or subjected to clamping strains; in holding irregular shaped work, other conditions are encountered; while in holding work which has only one end centered, a device for holding the "blind" end must be provided. Crank- and cam-shafts for gas engines present other points in work-holding devices that are worthy of consideration. For the average run of work, the points that must be considered can be summed up as follows:

1. Shape of work, whether hollow, provided with centers, or "blind" on one end.
2. Location of surface to be ground, whether concentric, as in long, plain shafts, or eccentric as in crankshafts.
3. Slenderness of work, such as thin bushings, sleeves, etc.
4. Relation of ground surfaces to previously finished parts.
5. Convenience of operation as regards accessibility for removing or clamping the work.
6. Accuracy and production required. Aside from the character of the work, this last point, on the average run of work, is the most important.

Holding Work on Centers

The common method of holding and driving work while grinding externally, when the work is provided with centers, is shown in Fig. 1. This is used on the plain or universal cylindrical grinding machines, and is well known. The shape of the center is governed by the conditions of the work. *A* in Fig. 2 shows the common plain 60-degree center, *B*, a center cut down to clear the wheel to permit small diameter work to be ground; *C*, another method of reducing the body of the center for holding small work; and *D*, a center for supporting tubing or work having a large hole in the end. The center shown at *E* is known as a female center and is used to support work that has no center but is pointed on the end.

Where the work is provided with a center in one end only and a large hole in the other, like a gas engine piston, the method shown in Fig. 3 can be used. Here a plate *A* is fitted into the hole in the open end of the piston, and a pin *B* passes through rod *D*, fitting the wrist-pin hole. When the wrist-pin hole has been bored and reamed in perfect alignment and at right angles to the axis of the piston, the pin *B* should be a good fit for it, but when this has not been done previous to grinding, it should be a loose fit, as illustrated. The piston is held on the plate *A* by nut *C* that draws the pin *B* against the wrist-pin hole and clamps the piston rigidly. The arbor is driven by a pin *E* that comes in contact with the driving pin held in the faceplate of the grinding machine.

Another method of holding work on centers is shown in Fig. 4. Here the work has a center in one end and a slot in the other, and the requirements are that the axis of the shank and body be ground at right angles to the center of the pin hole. In order to handle this work satisfactorily, a close fitting pin *A* is placed in the hole in the work as indicated. The headstock center *B* is provided with a V-slot to contact with pin *A*, and is slabbed down to fit the slot in the work. It will therefore be seen that this type of center, in addition to holding the work central, also drives it.

Still another method of holding work when grinding externally is shown in Fig. 5. In this case the work is a multi-throw crankshaft, and for grinding the crankpin it is necessary to offset the crankshaft, as illustrated. A large variety of fixtures have been devised for handling crankshafts, but this device has been chosen because of its simple construction. In this case it will be noticed that two blocks, held in place by set-screws, are fitted to the ends of the crankshaft. With a plain fixture of this type, it is necessary to line the blocks up properly with the work before clamping, and to do this the bottoms of the blocks are made square so that they can rest on the surface plate; then the crankshaft and blocks

For information on grinding previously published in MACHINERY, see "Grinding Wheel Truing Devices," November, 1915, and articles there referred to.

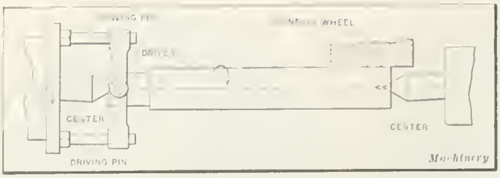


Fig. 1. Common Method of holding and driving Centered Work when grinding externally

are squared up from the surface plate with an ordinary machinist's square, and clamped in position. Other work of an eccentric nature is handled in a similar manner, the type of fixture used, of course, depending on the character of the work and the number of eccentrics or amount of eccentricity.

Holding Work on Solid Mandrels

The class of work held on mandrels is not confined to bushings, but includes any work that can be conveniently held in this manner. The common method of holding work on a mandrel is shown at *A* in Fig. 6, in which the part being ground is an ordinary plain bushing. This should not be used for holding work which has not previously been ground in the holes, because if the hole is not true and straight, it will not bear evenly on the mandrel and when it becomes heated will take the shape of the arbor; then when the work is removed, it will be found to be untrue. Mandrels of this

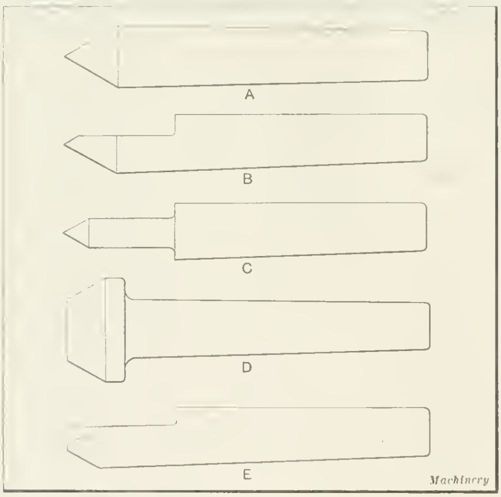


Fig. 2. Collection of Different Shaped Centers for supporting Work in Cylindrical Grinding Machines

type, which in reality are friction mandrels, should never have the work driven tight on them. They should be provided with a very slight taper, about 0.002 to 0.005 inch to the inch. For holding thin-wall bushings, the better practice is to clamp the work from the ends, as will be illustrated and described later. At *B* is shown the common method of holding a tapered bushing; the information given in the foregoing applies also to this case, with the exception that the taper on the mandrel should be the same as the hole in the work.

Another example illustrating the use of solid mandrels for holding work is shown in Fig. 7. This mandrel is used for holding a cream separator bowl shell *F* while grinding the straight and tapered surfaces. As is shown in the illustration, the mandrel consists of a two-diameter sleeve *A* driven into the tapered mandrel *B*. The center flange *C* supports the shell internally, whereas flange *D* supports it externally, the shell being chamfered to catch under a projecting rib on this flange. The work is clamped in place by nut *E*. The rear face of flange *D* is provided with a rib that contacts with the driving pin in the faceplate and serves to drive the work.

Fig. 8 shows a simple and effective mandrel for holding a ball race cup. This, it will be noticed, is a difficult piece to hold. The mandrel consists of a central stud *A* hardened and ground, and threaded to receive the knurled bushing *B*. This is also hardened and ground internally as well as on those points where it contacts with the ball race cup. The work is held in position by adjusting sleeve *B* which forces the cup against split washer *C*. The mandrel is rotated by pin *D*, which is driven through it and comes in contact with the driving pin on the faceplate of the machine.

Spring Bushing Mandrels for Holding Work for Grinding

The grinding of bushings having thin walls presents considerable difficulty especially when hardened, as the hole is us-

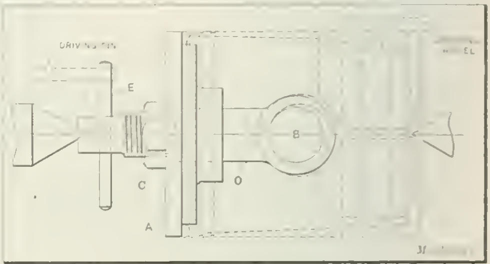


Fig. 3. Method of holding Gas Engine Piston for External Grinding

ually sprung out of round and consequently cannot be depended upon as an accurate point from which to locate for grinding the external diameter. The hollow piston pin shown in Fig. 9 is a good illustration of this point. This piston pin is made from Shelby tubing having a 5/32-inch wall, is carbonized 0.030 inch deep, and hardened. In carbonizing and hardening, the tubing is distorted considerably, and to place it on a solid mandrel to grind the external diameter would mean that it would only bear on the high points, and when the scale was removed would be distorted.

Fig. 9 shows a special mandrel designed for this purpose, which handles the work satisfactorily. It comprises a central mandrel *A*, hardened and ground all over, and carrying two sleeves *B* and *C*, as well as two cone-shaped work supports *D* and *E*, these being backed up by open-wound springs *F* and *G*. It will be noticed that the work is merely located by sleeves *D* and *E* and is clamped from the ends by sleeves *B* and *C* and nut *H*. The method of using this type of mandrel is as follows: Two or three of these mandrels are made up at one time so that while one piece is being ground in the machine, the operator can be loading another, thus making production practically continuous. To insert the work on the mandrel, nut *H* is removed and sleeves *C* and *E* withdrawn. It will be noticed that sleeve *E* carries a pin fitting in a slot in sleeve *C* so that the coil spring cannot force it out when the sleeve is removed from the mandrel. The work is now placed on the mandrel, being centered by the end of the stationary sleeve *D*, as well as pin *I*. Then the sleeves are replaced and the nut tightened sufficiently to hold the work

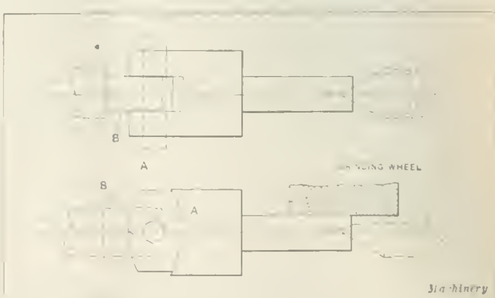


Fig. 4. Method of holding Piece having a Center Hole in One End and a Slot in the Other

rigidly in position. This method of holding the work eliminates strains and insures an accurate job.

In Fig. 10 is shown another "floating" mandrel that differs slightly from that previously described. This mandrel is also made in duplicate or triplicate, and comprises a center bar *A*, hardened and ground, and carrying a bushing cup *B* that is pinned to it. Cup *B* is counterbored to receive the spring-controlled work-holder *C* which is prevented from being forced out by the four coil springs *D*, by means of fillister-head screws *E*. In this case it will be noticed that the flange on one end of the work is of sufficient width to permit of the bushings being squared up by the use of one cone sleeve *C*, the other being simply a face sleeve *F* that holds the bushing tightly up against the bushing cup *B*. The mandrel is also provided with a slotted washer *G* and nut *H*. To remove the work, the

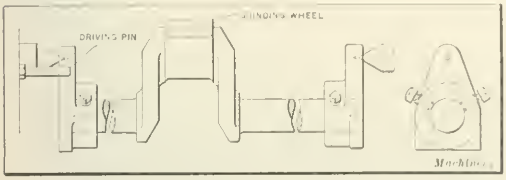


Fig. 5. Method of holding and driving a One-throw Crankshaft when grinding Crankpin

nut *H* is released and washer *G* withdrawn, enabling sleeve *F* to be removed, whereupon the work can be taken off and a rough piece put on.

Expanding Work-holding Mandrel

The holding of a ball bearing race accurately to grind the external diameter is a difficult proposition, and to accomplish this satisfactorily the race should be located from the inner cone or circle that the balls subsequently run in. The expanding mandrel, therefore, is the only satisfactory solution. Fig. 11 shows a special mandrel designed for this purpose that incorporates some interesting features. It comprises a tapered bar *A* carrying three segment work supports *B*, which are prevented from turning on the bar by pins held in them that work in the slots shown. These segments are held together by two "bracelet" coil springs *C* and *D* that completely surround them. To place the work on the mandrel, the three segments are drawn to the smallest end, the work slipped over them, and then the segments are pushed back to the larger diameter, causing them to expand and grip the work.

An important point in connection with this mandrel is the amount of taper given to it. The first mandrel that was tried out had an included taper of 15 degrees—about 3⅛ inches to the foot. When tried it was found impossible to hold the work square with the axis of the mandrel. Because of the steep taper, a slight tilting action was given to the segments, making it impossible to hold the work accurately. The reason for this was that the taper was so steep that a slight difference in the longitudinal position of the segments made a considerable difference in their respective distances

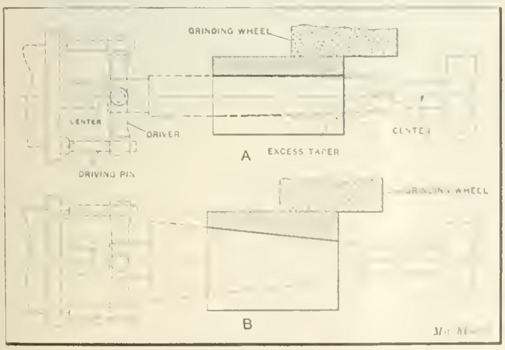


Fig. 6. Holding Straight and Tapered Hole Bushings on Solid Mandrels

Fig. 7. Method of holding Cream Separator Bowl Shell for grinding External Diameter

from the axis. Another mandrel was made, having a taper of 1½ inch to the foot, and this was found to work satisfactorily. This had sufficient taper to take care of the necessary movement required to expand the segments for gripping the work, and also held the work much more rigidly and accurately.

Mandrel for Holding a Transmission Yoke

The external diameter of the transmission yoke *A* in Fig. 12 presents a difficult grinding proposition. By referring to this illustration, it will be noticed that the front end of the yoke is split or slotted and the rear end has a tapered hole. The requirements are that the external diameter be ground true with the tapered hole. In grinding this yoke, the order of operations is handled somewhat differently from that fol-

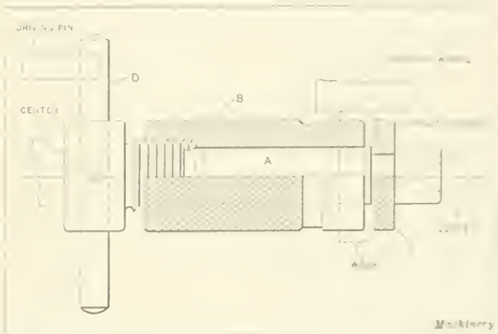


Fig. 8. Special Type of Mandrel for holding Ball Race Cup for grinding External Diameter Concentric with Raceway and Square with Inside Face

lowed in grinding a plain bushing. The bearing surface *a* and tapered hole *b* are previously ground, as will be explained later. This gives two points from which the work can be accurately located for grinding the external diameter. The mandrel used for holding this piece comprises a hardened and ground rod *B*, over which is slipped a flattened bushing *C* ground to fit accurately in the previously ground bearing *a*. The object of this bushing is to prevent the yoke from collapsing. In order to prevent the work from springing outward, a ring *D* is clamped to the end by bolts as shown, fitting in previously tapped holes in the work. This prevents any outward or inward springing of the yoke while it is being ground. The work is held for driving by the tapered portion on the mandrel fitting the tapered hole in the work.

Still another method of holding work for external grinding is shown in Fig. 13. The part *A* being ground is a cone for a fan shaft, and the operation consists in grinding the cone end as shown. The fixture used for this purpose is an old type Landis center grinder, which has been remodeled to fill the requirements. The regular spindle was removed and substituted by a special draw-in spindle *E* operated to hold the work by open-wound spring *B*. The front end of the spindle is slotted and carries a removable split washer. To remove the

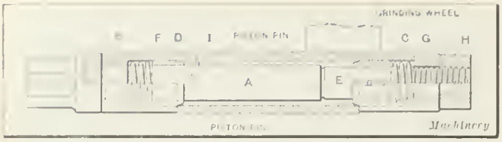


Fig. 9. Spring Bushing Mandrel for holding Piston Pin from End, thus eliminating Clamping Strains

work from the fixture, lever C, fulcrumed in special bracket D, is forced forward, carrying with it spindle E and compressing spring B, thus allowing the washer and work to be removed. Previous to the use of the fixture shown in Fig. 13, this cone was held and ground in a special grinding machine fitted up for the purpose, in which production was greatly limited owing to the construction of the machine. This improvised fixture was then used and production was increased from 800 to 1200 pieces in nine hours.

Work-holding Devices for Internal Grinding

The most common method of holding work to be ground internally, especially if the part to be ground is cylindrical in shape, is to grip it in a four- or three-jaw chuck as shown at A and B in Fig. 14. The jaws of the chuck are sometimes modified to suit the shape of the work and are generally ground to get the required accuracy after the chuck is placed on the machine spindle. The four-jaw chuck is not as frequently used as the three-jaw chuck, because three points of support,

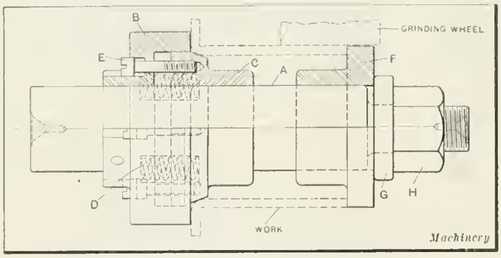


Fig. 10. Another Spring-controlled Bushing Mandrel

especially on work with a rough surface, are better than four. For holding thin-wall bushings, the ordinary chuck is not recommended because of the liability of springing the work out of shape in clamping.

For holding comparatively small work, the draw-in type of collet shown at C in Fig. 14, is used. This is limited to a certain extent to the holding of plain work. With slight modifications, however, it can be adapted for holding segment removable clamping jaws as shown in Fig. 25. D in Fig. 14 shows another method of holding work of the bushing type. This is an air chuck operating on the well-known principle common to this type of holding device. The jaws a of this chuck are operated through levers b, receiving the necessary movement from the plunger c that communicates with the air cylinder. Jaws a can be adjusted independently by screws d to cover a considerable range of diameters. Air chucks can be used with success on work that is of comparatively plain outline and stiff enough to stand the necessary clamping pressure without being sprung out of shape. One advantage of the air chuck over other mechanical gripping devices is that the pressure is constant.

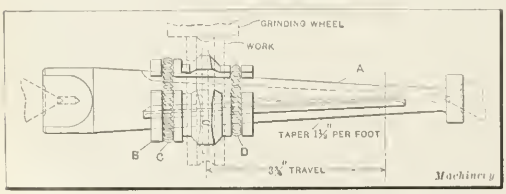


Fig. 11. Special Taper Expanding Mandrel for holding Outer Ball Race when grinding External Diameter

As previously mentioned, it is a difficult matter to hold hardened bushings without springing them out of shape. The reason for this is that the work, when hardened, is distorted to a greater or less extent, and when put on an ordinary mandrel or held in the chuck in the rough condition, there is only point contact, which causes distortion as soon as the hardening scale is removed. The practice sometimes followed is to grind the hole first and then place the bushing on a solid mandrel to grind the external diameter. This practice, as previously mentioned, is not recommended when the bushing

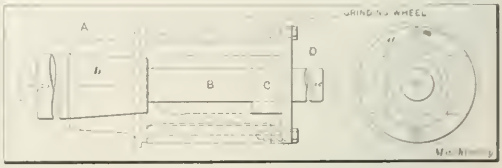


Fig. 12. Method of solving Difficult Holding Proposition

has thin walls. A better way is to grind the external diameter of the work first, using a mandrel of the types shown in Figs. 9 and 10, and then grip the work for grinding the internal diameter in a device of the type shown in Figs. 15 and 16. Referring to Fig. 15, as was previously mentioned, the external diameter of bushing A is ground first, then the bushing is slipped into a close fitting chuck B. The body of chuck B is fastened to the faceplate C, which is screwed onto the nose of the internal grinding machine spindle. The other members of the fixture consist of toe-clamps D, draw-bar E and yoke F. Draw-bar E passes completely through the machine spindle, and being attached to yoke F operates the toe-clamps D that hold the work in place against the resistance of the grinding wheel. It will be noticed that, in this type of fixture, none of the parts extend so as to interfere with its operation or cause accidents. In order to remove or replace the work in the fixture, the draw-bar is released, then the toe-clamps are swung away from the stop-pins G, the finished work re-

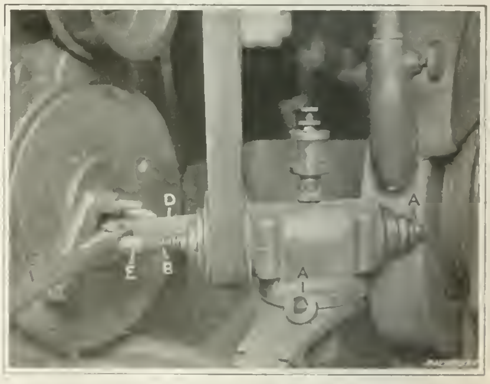


Fig. 13. Improvised Fixture used in holding Cone for grinding, that greatly increased Production over Former Method

moved, and a rough piece inserted, after which the toe-clamps are swung back to the stop-pins and the draw-bar tightened.

Fixture for Holding Drive-shaft Yoke

The drive-shaft yoke shown in Fig. 16 is another example of work that is difficult to hold without distortion. The large external diameter of yoke A has previously been ground in a manner similar to that shown in Fig. 12, and for grinding the internal diameter it is held in a close fitting chuck without putting any pressure on the external diameter. The fixture, as shown in Fig. 16, consists of casting B screwed onto the nose of the machine spindle, and carrying two toe-clamps C tied together by yoke D and operated by draw-in bolt E that passes through the spindle of the machine. In order to protect the workman, brass guard F is fitted over the fixture so

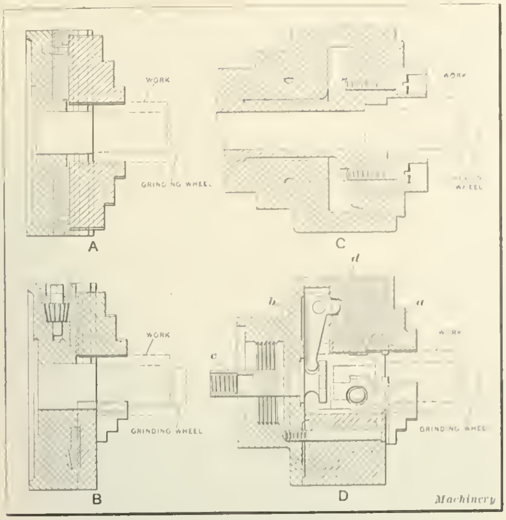


Fig. 14. Diagram showing Various Standard Devices for holding Work for Internal Grinding

that the nuts on the ends of the toe-clamps are not exposed. The forward end of this fixture is ground in perfect alignment with the machine spindle, and is a good fit for the external ground surface of the work. With this type of fixture it is possible to hold the work rigidly without subjecting it to excessive clamping strains.

Holding Work for Internal and External Grinding

Fig. 17 shows a special type of fixture used on a Bryant chucking grinder for holding a transmission countershaft bearing sleeve that is ground internally and externally at the same setting on surfaces *A* and *B*, respectively. This fixture

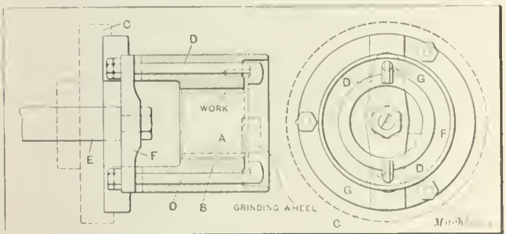


Fig. 15. Recommended Method of holding Thin-wall Bushing for Internal Grinding to prevent springing out of Shape

is of comparatively simple design, and comprises a special cap *C*, screwed onto the nose of the machine spindle and machined on the front end to fit the work. The work, in this case, is provided with a series of grooves which are engaged by projections on cap *C* for driving. The work is then held up against the face of the cap by draw-in bolt *D* that passes through the machine spindle and is operated by handwheel *E*. This bolt is supported in the spindle to keep it from wobbling by means of bushing *F*.

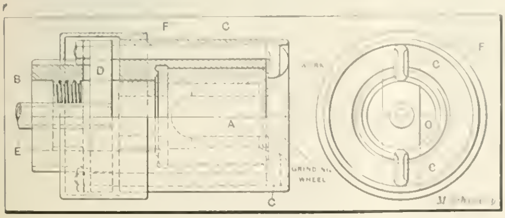


Fig. 16. Satisfactory Device for holding a Main Drive Yoke that is easily sprung out of Shape

Methods of Chucking Gears for Grinding

The problem of holding gears accurately is a difficult one, especially if they have been hardened. The chief trouble of course, is making provision for possible inaccuracies that are caused by warping in hardening. There are several methods in commercial use, as follows:

1. Holding gear by outside diameters or tops of teeth
2. Using rolls between the teeth, sometimes called the "pitch-line control method."

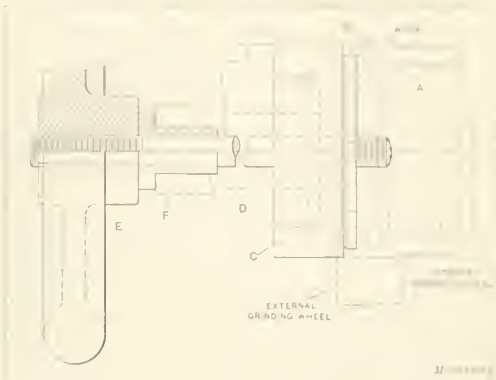


Fig. 17. Method of holding Sleeve for grinding Internal and External Diameters at Same Setting

3. Using jaws of special shape which make contact with the gear at the bottom of the tooth space, known as "root control."

The first method cannot be used with success when the gears are to run at high speeds, because the hole and the pitch diameter of the teeth may not be concentric.

The second method, while requiring the use of a more expensive chuck, is much more satisfactory than the first, if the teeth are fairly evenly spaced. A slight variation in the width of the tooth spaces makes a considerable difference in the relative positions of the rolls, owing to the acute angle made by the tooth surfaces near the pitch line where the rolls contact. This has been considered by some manufacturers as a serious objection to the use of this method, but when it is remembered that gears in which the teeth are unevenly spaced are unsatisfactory for high-speed work, and that prop-

Fig. 18. "Pitch Line Control" Type of Chuck for holding Spur Gears

erly cut gears bear heaviest on the pitch line, it will be seen that the "pitch-line control" method is not devoid of merit.

For the average run of work, the third method is generally recommended. The jaws of the chuck contact directly with the solid metal at the bottom of the tooth spaces so that inaccuracies in the spacing of the teeth do not affect the accurate holding of the gear. Furthermore, it is a very simple matter to maintain the accuracy of the jaws by simply truing the contact points whenever necessary. This does away with continual truing when chucking each gear and effects an enormous saving where large quantities of one size are being

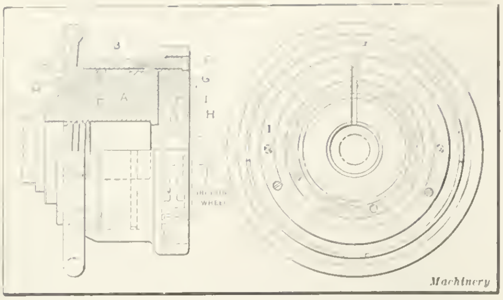


Fig. 19. Details of Spur Gear Chuck shown in Fig. 18, designed by the Heald Machine Co.

turned out. In the following, examples will be shown covering the three methods of holding spur and bevel gears.

Fixture for Holding Spur Gears for Grinding

In the grinding of holes in spur gears, it is essential that the hole be true and concentric with the pitch circle of the gear teeth, and in order to accomplish this satisfactorily, where the teeth are evenly spaced, it is sometimes advisable to locate the gear from the pitch circle. One method of accomplishing this is shown in Figs. 18 and 19. The fixture, which is screwed onto the nose of a Heald internal grinding machine, comprises a cast-iron chuck *A* and a brass clamping sleeve *B*. As shown in Fig. 19, sleeve *B* is keyed to chuck *A* so that it can be drawn back and forth without rotating independently. This sleeve is operated by means of a handwheel *C* having a projection which is threaded into sleeve *B*. The handwheel is held on the fixture by means of a brass retaining ring *D*, and in order to eliminate friction, ball bearing *E* is interposed between the fixture and the handwheel. Sleeve *B* carries the tapered cast-iron filler ring *F* that is held to it by means of fillister-head screws as illustrated. This operates hardened steel split clamping ring *G*, inside of which is located retaining ring *H* that carries nine rolls *I*. Rolls *I* locate

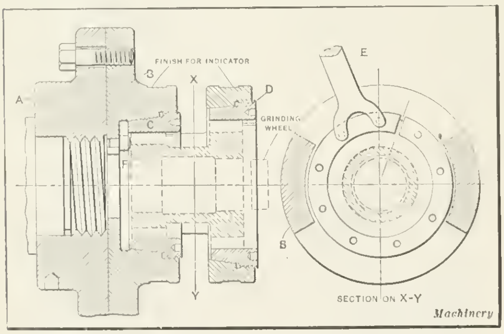


Fig. 20. Special Type of Chuck for holding Double Spur Gear, made by Heald Machine Co.

and grip the gear from the pitch circle of the teeth. As handwheel *C* is operated, it draws in split sleeve *G*, closing the pins down on the teeth and holding the gear rigidly and accurately in position while the hole is being ground. Parts *F*, *G*, *H*, and *I* have to be made special for each size of gear that is handled.

An interesting chuck for holding a double spur gear is shown in Fig. 20. The construction of this chuck differs somewhat from that previously described, chiefly in the method of clamping. It comprises a special faceplate *A* screwed onto the nose of the spindle, to which is clamped the chuck housing *B*. In this chuck, means are provided for holding and locating the gear from both external diameters. It is clamped on both diameters by cone-shaped split bushings *C* and *D* that are tightened on the work by means of the spanner wrench *E*. In order to get at the rear cone *C* with the wrench, the fixture is cut away as illustrated. This method of holding a spur gear cannot be considered as accurate as holding it from the pitch circle, but where the gear has been carefully made fairly accurate results can be secured. Hardened steel pin *F* is provided for the gear to butt up against and give point contact. When being replaced on the machine to turn out an additional lot of work, the chuck is trued up with an indicator, and finished surfaces, as indicated, are provided for this purpose.

Holding Bevel Pinions and Gears for Grinding

There is a diversity of opinion among users of grinding machines regarding the most desirable method of holding bevel gears and pinions for grinding. A device which has proved successful in one shop is not always looked upon with favor in another, and it is sometimes difficult to get men responsible for results to realize the advantage of a certain method if it differs from that which they are accustomed to. The Heald Machine Co. has given the problem of chucking gears for grinding considerable study and has devised several interesting chucks that are shown in the following.

One important point about which a diversity of opinion exists is the shape of the rolls used in chucks of the pitch-line

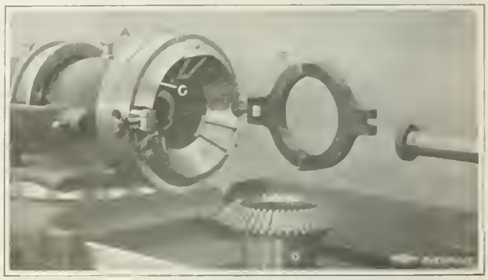


Fig. 21. Satisfactory Type of Chuck for holding Bevel Gears when grinding Hole

control type. Some gear manufacturers claim that cylindrical rolls are just as satisfactory as tapered rolls. After considerable experience in this direction, the Heald Machine Co. has found that the rolls for chucking bevel gears should be tapered because they make contact with curved surfaces, the elements of which converge at a common vanishing point. This company has also found that gear manufacturers using cylindrical rolls have used them exclusively on gears having a face width that is small in proportion to the diameter of the gear, as, for example, ring gears used in automobile transmissions. In such cases the error is not very pronounced, but on miter gears, especially when the face width is from one-quarter to one-fifth the gear diameter, there is a decided tendency for the gear to rock on a cylindrical roll at the central point of the face of the gear tooth.

A satisfactory method of calculating the diameter and taper

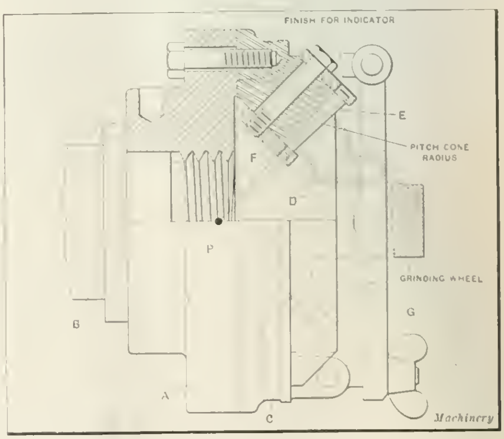


Fig. 22. Detail View showing Construction of Bevel Gear Chuck Illustrated in Fig. 21

on the roll is to make the diameter at the large end sufficient to bring the surface of the roll about 1/16 inch above the outside diameter of the gear teeth. The taper on the roll should be such as would cause it, if extended, to converge at the apex *P* of the pitch cone, as shown in Fig. 22. If the rolls are made to contact properly with the tooth surfaces, the points of contact must lie in a line running from the large end of the tooth to the vanishing point of the pitch cone. Working on this basis it is not difficult to lay out the included angle of the rolls with considerable accuracy. In making the rolls, the taper can be checked up by inserting them between the teeth on opposite sides of the gear, thus forming a temporary gage. The best method of holding the rolls when they have once been properly made is a difficult problem, and this will receive attention in the various designs that follow.

Chucks for Holding Bevel Gears and Pinions for Grinding

The chucking of bevel gear and pinion blanks presents considerable difficulty, as it is necessary to have the teeth run accurately with the hole. A satisfactory way of accomplishing this, of course, is to locate the gear from the pitch line of the teeth. Several methods of doing this are in use, but the most satisfactory way, as previously described, is to use tapered rolls located at various intervals around the circumference, placed between the teeth and locating the gear in the correct position relative to the pitch line. These tapered rolls can be made to fit the entire length of the face of the tooth, and are so held that any slight variations in the gear due to hardening are fully taken care of. The type of chucks to be described will be found an excellent means of locating gears of this kind when it is desired to have them run at high speeds and still remain quiet.

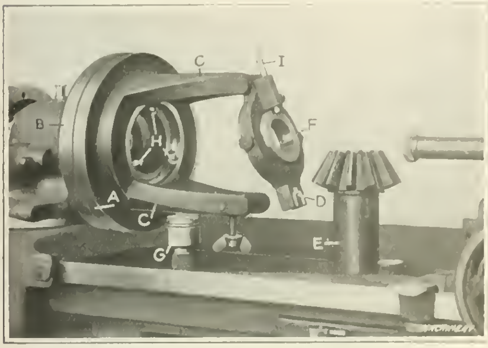


Fig. 23. Chuck for holding Long Shank Bevel Gear for grinding

One type of chuck for holding bevel pinions is shown in Figs. 21 and 22. Fig. 21 shows the chuck in use on a Heald internal grinding machine, whereas Fig. 22 shows a part sectional view, illustrating its construction. Referring to these illustrations, it will be seen that there are three sets of tapered rolls arranged in pairs. This chuck comprises a faceplate *A* screwed onto the grinding machine spindle *B*. Secured to faceplate *A* by screws, as shown, is a second plate *C* recessed to a suitable angle to receive gear *D* and rolls *E*. The rolls are retained in triangular-shaped plates *F* by capscrews that hold the plates and rolls firmly to the plate *C* and also prevent dirt from getting under the rolls. The rolls are held so as to allow for a slight movement in order that they can adjust themselves with relation to the gear teeth. The gear *D* is held in place by a yoke *G* and thumb-screw, as shown. This yoke exerts a pressure in a line parallel with the axis of the gear, and assists in forcing the gear back to a concentric location.

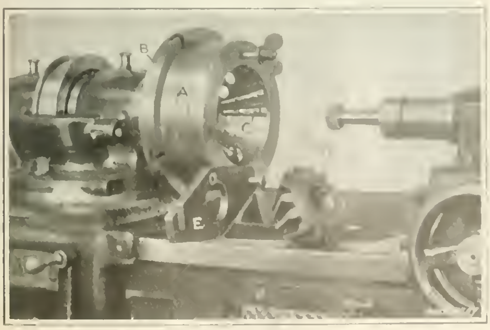


Fig. 24. Another Chuck for holding Bevel Pinions when grinding Hole

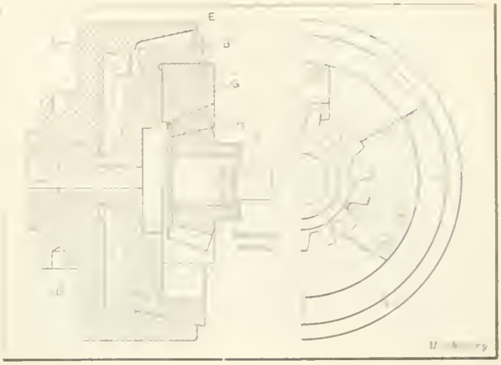


Fig. 25. Draw-in Collet for holding Small Bevel Pinions by Means of Jaws which engage Bottom of Tooth Spaces

Another type of chuck for holding a bevel pinion with a long shank is shown in Fig. 23. In this case the fixture *A* which is fastened to faceplate *B* is provided with extension arms *C* that carry the clamping strap *D*. Gear *E* is $8\frac{11}{64}$ inches long over all, and the hole ground is $6\frac{1}{8}$ inches long by $2\frac{3}{8}$ inches diameter. The clamping strap *D* carries bushing *F*, in which the centering plug *G* fits to locate the shank of the pinion when it is being clamped in position. The gear is centered at the inner end from the pitch line of the teeth

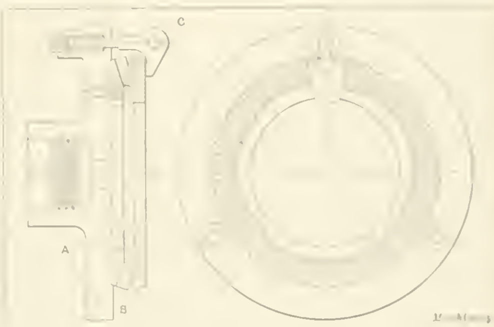


Fig. 26. Fixture for holding Bevel Ring Gears having a Master Gear against which Work is clamped

by three balls *H* held in place by screws, as shown. The inner end of bushing *F* is chamfered to center the shank.

Another point worthy of notice in connection with this fixture is the device for truing the internal grinding wheel. The diamond holder *I*, as will be noticed, is held in a projection on the clamping plate *D* by a knurled-head screw. In truing the wheel, the work-spindle is stopped, the diamond brought down until it contacts with the wheel, and then the wheel-slide traversed back and forth.

The chuck shown in Fig. 24 illustrates another method of locating and holding bevel pinions for grinding. The construction of this chuck bears a marked resemblance to that shown in Figs. 21 and 22 with the exception of the arrangement of the tapered pins for locating the pinion from the pitch circle of the teeth. In this case six tapered pins *C* are held in the chuck *A* by screws, as shown, the latter being fastened

Fig. 27. Special Fixture for holding Gas Engine Pistons for grinding Wrist-pin Holes

to the faceplate in the usual manner. The gear *D* is held in place by clamping strap *E* which carries two hardened pins that come in contact with the rear face of the gear. This method of fastening the rolls can be used in this case because of the coarse pitch of the gear teeth.

Draw-in Chuck for Holding Small Bevel Pinions

When the bevel pinion to be ground is of comparatively small size, the Heald standard type of draw-in collet shown in Fig. 25 can be used. This comprises a cast-iron cap *A*, screwed onto the nose of the machine spindle and machined to receive the tapered ring *B*. The draw-in rod is screwed into a flange-shaped draw-bar *D* that is pinned to ring *B* as shown, the latter being prevented from turning independently of the cap *A* by a Woodruff key *E*. Ring *B*, in turn, is cupped out to receive gear *F* which is held in place by three jaws *G*, fastened to the ring by screws as shown. Jaws *G* are provided with small projections which extend over the outside of the gear, as shown at *H*, and prevent it from sliding out as the jaws are closed. Hence, by simply opening and closing the jaws, the gear is clamped and released, without the aid of straps or yokes. One objection to this device is that if the teeth of the jaws do not have an even bearing on the bottom of the tooth spaces, chances of error will be introduced.

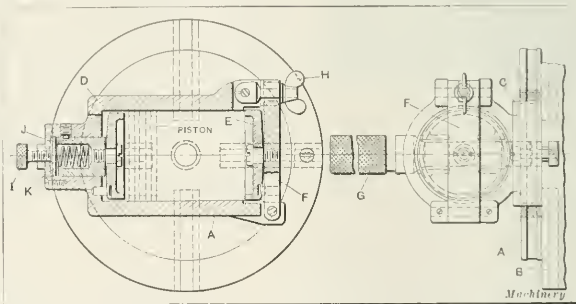


Fig. 28. Detail View of Special Work-holding Fixture shown in Fig. 27

Fixture for Holding Bevel Ring Gears

A fixture for holding bevel ring gears while grinding the hole and the back face, when necessary, is shown in Fig. 26. This comprises a faceplate *A* recessed to receive a ring gear *B* of the same size and shape as the one to be ground. About three-quarters of the inner points of the teeth on this ring gear, which is left soft, are cut away, so as to leave three points containing three or four teeth each. The gear to be ground is then placed up against this "gear chuck" where it is clamped with three toe-clamps as illustrated. This device is self-centering, it only being necessary to place the gear so that the teeth will fit those teeth on the other gear which have not been cut away. The gear teeth that are in mesh also form a positive drive, and the holding mechanism simply keeps the gear in contact with the master or chuck. Repair of the master gear can be taken care of by grinding the high teeth and in this way obtaining the original accuracy.

Grinding Fixture for Gas-engine Pistons

The wrist-pin holes in the pistons of the H. H. Franklin Mfg. Co.'s automobile gas engine are provided with bronze bushings which are ground true after being forced in. The grinding is accomplished in a Heald internal grinding machine provided with a special fixture shown in Fig. 27. A clearer idea of the construction of this fixture can be obtained from Fig. 28. The fixture proper *A* is fastened to the faceplate *B*, located on the machine spindle, by two clamping blocks *C*, only one of which is shown in Fig. 27. These are adjusted so that the wrist-pin hole of the piston can be centered with the axis of the work-spindle. The hole in the fixture is accurately ground and is a good fit for the external diameter of the piston. Located at the bottom of this hole is a spring-operated bottom plate *D* that holds the piston up against the top plate *E* fastened to the swinging clamping plate *F*.

The method of locating the piston in the fixture is as follows: The piston is first put in, then the plug gage *G* is used to locate it from the previously reamed hole in the bushing. Clamping arm *F* is now swung down and thumb-nut *H* on the swinging bolt tightened. If the spring pressure on the bottom plate is not sufficient, screw *I*, Fig. 28, is adjusted; this operates against plate *J* and through spring *K* adjusts the sleeve carrying the bottom plate. When the piston is properly clamped, the plug gage is removed and the grinding proceeds. In a fixture of this type the chief requirement is to grind a hole accurately at right angles to the axis of the piston, and this fixture satisfactorily solves the problem.

Adjustable Work-holding Fixture

Fig. 29 shows an interesting work-holding fixture applied to a Heald No. 70 internal grinding machine. The work being ground is an air pump cylinder, in which four holes 1¼ inch long by ¾ inch diameter must be ground. The fixture proper *B* is held in place on the faceplate *A* by two guide bars *C*. The pump cylinder casting *D* is held to the sliding or adjustable member *B* of the fixture by means of clamps *E* and clamping-screws, as illustrated. To locate each hole in line with the work-spindle, clamps *E* are released and slide *B* moved along until plug *F*, which is previously located in the hole it is intended to grind, locates the casting properly by fitting in the aligning hole in the fixture. The fixture is counterbalanced by means of plate *G*, and in order to keep as perfect a balance as possible, the casting is reversed end for end.

Work-holding Fixture for Rotary Surface Grinder

An interesting fixture for holding a sleeve while grinding the top of the flange in a Heald rotary surface grinder is shown in Fig. 30. This fixture is designed to be clamped to

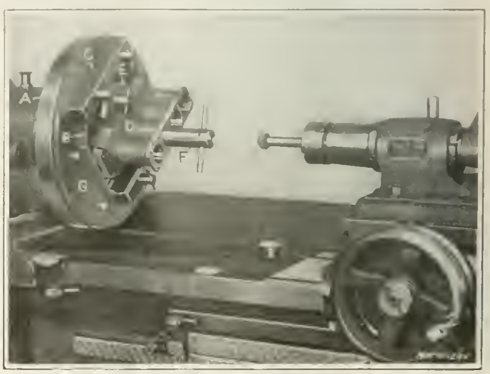


Fig. 29. Fixture for holding a Four-hole Air Pump Cylinder

the table of the machine and carries twenty-eight bushings which are ground at one time. The method of holding the bushings is interesting and is shown diagrammatically in the center of the illustration. The clamping is done by levers A fastened to clamping bolts B that pass through the rim of the fixture and operate on plates C to which the clamping members proper are attached. Two bushings are clamped by each pin D which fit in the counterbored recess in the fixture and are kept out of contact with the work by means of coil springs E, as illustrated. As soon as clamping levers A are pushed down, they operate a cam surface coming in contact with the hardened cams held in plates C.

Fixture for Holding Roller Bearing Rolls on Blanchard Vertical Surface Grinder

Many interesting fixtures have been devised for the Blanchard vertical surface grinder, to act as an auxiliary holding device in connection with the magnetic chuck. One of these devices, used for holding roller bearing rolls, is shown in Fig. 32. This comprises a base A, to which are clamped two rows of segment blocks B. The rolls, both ends of which are to be ground, are, in turn, clamped in vee recesses in the sides of the block, as illustrated—one clamp holding two rolls in place. Two fixtures of this type are provided, so that when the machine is grinding one end of the batch of forty rolls, the other fixture is being loaded, thus keeping the machine in practically continuous operation. Measurements are taken with a Blanchard direct-reading micrometer.

Holding Work by Magnetic Chucks

As an effective device for holding a large number of small parts at one time for grinding, and in fact for a considerably large range of work, the magnetic chuck is without an equal. Magnetic chucks are made in a variety of sizes and shapes, depending upon the type of machine they are used on and the character or shape of the work to be handled. As a fixture for holding work for internal grinding, their use is limited somewhat, their greatest field of usefulness being on surface grinding machines of the reciprocating and rotary types. One of the chief advantages of the magnetic chuck is the short time required to change the work, this being in some cases only a fraction of a minute. Another advantage of the magnetic chuck is the greater degree of accuracy that can usually be obtained.

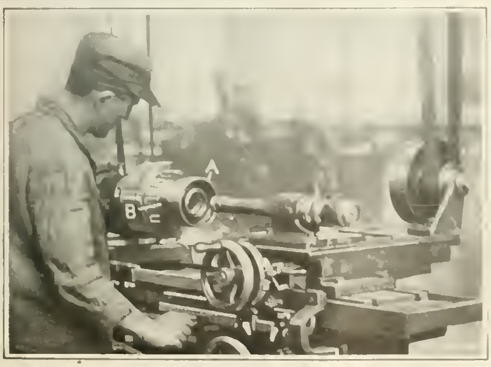


Fig. 31. Method of using Heald Rotary Magnetic Chuck for holding Work for Internal Grinding

Fig. 32. Special Fixture for holding Roller Bearing Rolls on Blanchard Vertical Surface Grinder

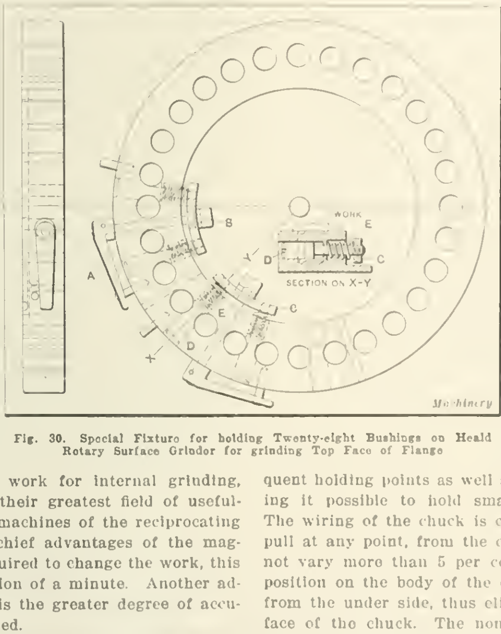


Fig. 30. Special Fixture for holding Twenty-eight Bushings on Heald Rotary Surface Grinder for grinding Top Face of Flange

Holding Work by Magnetic Chucks for Internal Grinding

Fig. 31 shows a Heald rotary magnetic chuck being used for holding a two-step pulley A when grinding the hole. The pulley is held directly to the face of the chuck by the magnetic flux and is prevented from shifting by ring B. The "grip" of the chuck is sufficient to hold the work when taking quite heavy cuts with an internal grinding wheel, and the rapidity with which the work can be removed and replaced makes this method especially advantageous for certain classes of work. Many other applications of magnetic chucks to internal grinding could be shown, but the one illustrated in Fig. 31 is sufficient to show the general application.

Construction of Heald Rotary Magnetic Chuck

For holding work for surface grinding, the Heald rotary magnetic chuck shown in Fig. 33 can be used to advantage, especially on thin work. The body A of the chuck is made from soft steel of high magnetic permeability and the pole pieces are located close together, thus giving more frequent holding points as well as great magnetic pull, and making it possible to hold smaller individual pieces securely. The wiring of the chuck is carefully worked out, so that the pull at any point, from the center to the circumference, does not vary more than 5 per cent. The faceplate B is held in position on the body of the chuck by means of brass screws from the under side, thus eliminating all screw holes on the face of the chuck. The non-magnetic material, it will also be noticed, is comparatively narrow in proportion to the width of the poles, and is held in tapered grooves as illustrated. The body of the chuck has projections C cast integral with it that receive the coils D and carry the magnetism to the pole pieces E in the faceplate of the chuck. The coils slip over the projections and the top face is finished even with the sides or walls of the chuck body. The pole pieces are insulated from the remainder of the faceplate by means of a non-magnetic metal or insulation F. The faceplate B is also insulated by means of a ring of non-magnetic metal G, which prevents the magnetism from leaking into the body of the chuck. On the rotary type of chuck, which is illustrated in Fig. 33, the current is delivered to a set of brushes which contact with two rings H and I of conducting material. These rings are insulated from the body of the chuck by a non-magnetic ring. As to the current consumed, it might be stated that a 12-inch rotary chuck requires only 0.6 ampere of current, and an 8-inch rotary chuck 0.4 ampere. These chucks may be used on a direct-current circuit of either 110 or 220 volts.

Blanchard Magnetic Chuck

Another magnetic chuck used for holding work, and one that differs somewhat in construction from that illustrated in Fig. 33, is shown in Figs. 34 and 35. This type of chuck is used on the Blanchard high-power vertical surface grinder, and as shown in Fig. 34, is of the fine "divided pole" type. The poles are all formed on a single steel forging *A*, which makes the working face of the chuck absolutely water-tight and very rigid. Only four coils are used, but each coil energizes four ring poles which are so closely spaced that a piece of work of the size of a nickel would touch two poles no matter where it were placed on the working face of the chuck. The sixteen ring poles of the chuck are also concentric. Referring to Fig. 34, it will be noticed that the construction amounts to a series of four ironclad magnets *B*, nested one inside of the other, the shell of one magnet serving as the core of the next on the outside. The chuck body has four large concentric grooves machined in one side to receive the

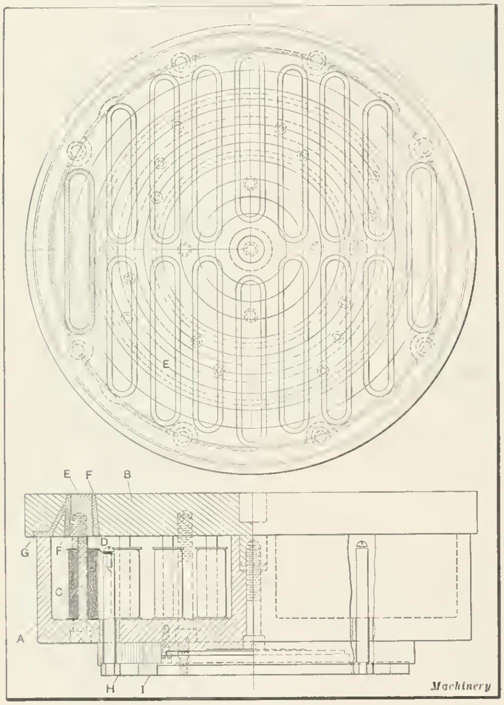


Fig. 33. Heald 12-inch Rotary Magnetic Chuck

coils, while the opposite face of the forging has fifteen grooves machined in it to receive the brass strips which divide the face of the chuck up into sixteen ring poles. These grooves in the face of the chuck are 3/16 inch wide by ¾ inch deep, and are filled with strip brass, driven tightly into place. A safety flange is provided at the circumference of the chuck to prevent water from reaching the joint between the chuck body and the bottom plate. Fig. 35 shows the supposed path that the magnetic flux takes when holding thin work. The piece being held is 1/16 inch thick, and the total distance between the poles is 2 1/16 inches. This distance, however, is divided into four spaces, 3/16 inch wide and filled with brass, and three intermediate poles 7/16 inch in width. Instead of having to traverse a distance of 2 1/16 inches in a strip of steel 1/16 inch thick, the magnetic flux has to travel only ¾ inch—the sum of the intermediate spaces filled with brass—the rest of the way the intermediate poles offer a greatly increased area of path for the flux. This results in lowering the resistance of the path, and thus increasing the magnetic flux and holding power of the chuck. In holding heavy pieces, it is believed that the intermediate poles play a

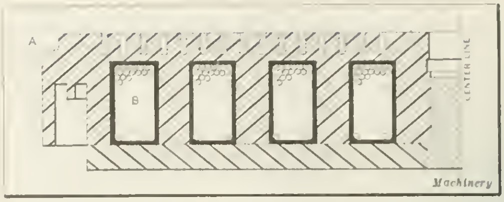


Fig. 34. Cross-sectional View taken on Radial Line from Center, showing Construction of Blanchard Magnetic Chuck

small part, as there is sufficient area in the path to allow the magnetic flux to pass easily from one pole to the next. The terminals of this chuck are connected by a direct-current circuit of either 110 or 220 volts. Steel or iron work held on magnetic chucks becomes magnetized, and a demagnetizer is used to remove the residual magnetism.

* * *

RESTRICTION OF IMPORTATION OF MACHINE TOOLS INTO GREAT BRITAIN

A. H. Baldwin, London commercial attaché of the consular service, reported in the January 3 number of *Commerce Reports* that the restriction of the importation of machine tools into Great Britain is a part of the general war control of manufactures, imports and exports by the government, and that the primary impulse comes from the war munitions board, which controls many factories and, in general, has the power to make such restrictions as may seem necessary for the conduct of the war. Machine tools are so important that the board of trade has been requested to take charge of the issuance of licenses for the importation of these products, instead of the war trade department which furnishes the licenses for export. In order to import machine tools, British importing houses or manufacturers, as purchasers, must first obtain permission from the board of trade and must make certain agreements with respect to their disposal. Importers who desire to resell machine tools are restricted as to profits, and definite permission must be obtained before any machine tools can be exported. It apparently is not the intention to prevent such importation, but merely to control the imports so that the interests of the government will be served.

In this connection, it is interesting to note also that the minister of munitions has prohibited all dealings without license in certain optical instruments, including prismatic binoculars, monoculars, telescopes, periscopes and compasses for reading an azimuth angle simultaneously with sighting an object.

* * *

The scarcity of nickel and copper in Germany is indicated by an item in a publication by the American Association of Commerce and Trade in Berlin, in which it is mentioned that the German government has issued 60,000,000 steel coins. These coins will be withdrawn from circulation within two years after the war. Although not so stated, the natural inference is that the present nickel and copper coins are melted down and used for ammunition purposes.

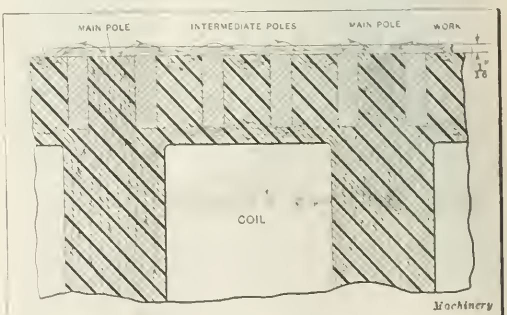


Fig. 35. Diagram showing Path of Magnetic Flux in Blanchard Magnetic Chuck when holding Thin Work

HOW TO GO AFTER SOUTH AMERICAN TRADE*

AMERICAN MACHINE TOOLS HAVE EXCELLENT REPUTATION—MANUFACTURERS NEED PERSONAL REPRESENTATION

BY R. W GIFFORD†

EVERY manufacturer of machine tools is more or less interested in export trade, and since the outbreak of the present European war his attentions have been more than ever directed toward our South American neighbors. To those who are already familiar with these markets, very little need be said. Unfortunately, only a few of our manufacturers have had any personal experience in these countries. Their knowledge of the size and importance of the various countries and their markets is so slight, and the distance seems so great, that no matter how desirous they may be of extending their trade in this direction, they hesitate to take the necessary steps.

It is self-evident that with Europe engaged in the present war, the opportunity for American manufacturers to expand their foreign trade is better than ever before. We, as Americans, have always prided ourselves on our ability to get almost anything we go after, but now is the time to prove our claim. That this statement is founded on facts and realized by others is clearly shown by a statement the writer heard made by a prominent English manufacturer, while slowly steaming down the east coast of South America. A group of us on deck had been discussing everything in general until the talk had turned to the ever important race between England and Germany for commercial supremacy. Finally the Englishman referred to above, turned to me and made this statement: "We, of course, expect to keep the lead but some day you Americans and your government will wake up to the fact that you have long been asleep and are getting only a small share of the trade to which you are entitled. Then you will be more serious competitors than the Germans ever can be." Who will dispute the fact that now is the time to awake and go after what we feel should rightfully be ours?

At the outset it is well to bear in mind that American machine tools lead the world. This is recognized everywhere, but in spite of this, in many countries we have failed to get our share of business. In calling on the machinery trade from Cuba to the Straits of Magellan, the writer has yet to encounter a single dealer who does not speak in the very best terms of American tools: He may spend an hour condemning the methods of some of our exporting houses but never in condemning the machines themselves. In this we are extremely fortunate, for with most of our manufactured articles we have a hard but by no means a hopeless fight ahead of us. In Europe where the demands are greater and where most Americans feel very much at home, the majority of our larger machine tool houses maintain their own branches. As a result, we export millions of dollars worth of machinery every year to these countries. At the same time, how many of these firms have ever given serious consideration to the possible demands in many sections of South America?

The principal reason why a great many of our firms have not been more interested in South American trade has been because of the demand at home. This is quite largely due to the enormous development in the automobile and allied lines which have taken machine tools in quantities that were previously almost unknown. The resulting increased production of machine tools has now taken care of this demand and even before the business depression due to the war, many of our manufacturers were spending considerable energy in developing more distant fields.

Few realize the importance of South American markets unless they have actually visited at least some of the important cities. The time is not so far distant when, if South America was mentioned, we immediately had in our mind a confused picture of tropical jungles, boa constrictors, yellow fever and revolutions; but the time for all of this is passed. All now know more or less about Rio-de-Janeiro and Buenos Aires, although how many who have not actually traveled south can give the names of two other cities in either Brazil or the Argentine, not to say anything about the other countries concerning which we know almost nothing? In fact, it is a safe wager that in the majority of offices there is not one who can, without previous thought, make a complete list of the South American countries; or with the list furnished them, can write down the capital cities only. I have tried this several times and the results are amusing, even among a well posted staff. In one case I asked a mechanical engineer, who is a graduate of one of our largest Eastern Universities, what he estimated the population of Buenos Aires to be. After making some excuse for his lack of knowledge, he made what he called a rough guess, placing it at 20,000. When one remembers that it is well above 1,250,000, the extent of his knowledge can be appreciated.

The countries with which we are best acquainted are Brazil and the Argentine, due to their greater wealth and prominence; but every country in South America has a permanent and rapidly increasing market for machine tools. It is true that the demand in either of these countries will probably never equal that in the United States or even Canada, but at the same time the extent of this demand and the rapidity of its growth will surprise you. Take, for example, the Argentine Republic—a country about equal in area to our own country east of the Mississippi River. It already ranks as one of the greatest grain exporting countries of the world, and its cattle industries are also taking an important place in the meat supplies of the world. The population is about equal that of Canada and in many ways the two countries are somewhat similar. No one would for a minute dispute the importance of our Canadian markets. Now imagine all the goods imported into Canada going through the port of Montreal or Toronto and you have a condition similar to that in the Argentine. In other words, while there are other important cities besides Buenos Aires, almost all goods are bought and sold through this one city.

In a country so rich agriculturally, it follows that there must be a rapidly increasing demand for machine tools. The railroads are pushing out in every direction and opening up new territory, and the cities are fast assuming the appearance of our own. While manufacturing in the Argentine Republic is practically in its infancy, nevertheless it has already assumed very considerable proportions. Certain branches of trade and manufacturing are, of course, developing more rapidly than others due to the nature of the country and its products; and some of our American industries have not been slow to realize this. For example, the representatives of the American Shoe Machinery Co. have been on the ground for years, installing, organizing and operating factories, not only on the east coast but on the west coast as well. To attempt to enumerate the various uses to which machine tools are put would be as difficult as to do the same in St. Louis, Kansas City or Indianapolis. They are used everywhere, but as stated previously, in smaller quantities.

The demand in Brazil is even more varied than in the Argentine. It is a country with an area greater than that of the United States (without Alaska) and natural resources that are not excelled by any country on the globe. Gold, diamonds, rubber, coffee and other products too numerous to mention abound in quantities which are almost unlimited. Foreign capitalists have poured in hundreds of millions of

* For additional information on the development of South American machine tool trade and allied subjects published in MACHINERY, see also "Establishment of American Banking Facilities in South America" by H. R. Eldridge, November, 1914; "Important Details in South American Trade," October, 1914; "Export and Import Trade" by George Seberr, June, 1914, and other articles there referred to.

† Treasurer and superintendent, Deyo Macey Engine Co., Binghamton, N. Y.

dollars and today we find Brazilian industrial stocks listed in almost all our important cities. This is especially true in Canadian cities, as our near neighbors, led by the famous railroad builders McKenzie & Mann, have been among the leaders in developing Brazilian fields. Railroads have branched out in every direction, while their system of natural water ways is the greatest in the world. To describe even a few of the cities in Brazil with their industries would require a book; to visit and become acquainted with them takes months. However, no matter where you travel, whether it be a thousand miles up the Amazon or in any of its many large coast cities, the market for machine tools will be found. This market, unlike the River of Doubt, has long been discovered by our English and German competitors, but still remains a market of doubt to many in America.

We can only mention Uruguay with its beautiful capital city, Montevideo. The writer remembers well an extended visit around the city with an elderly English gentleman who had long been the head of the machinery department of one of the largest firms. He had spent forty-five years there and was well justified in his pride in both the city and its progress. Small industries were thriving everywhere, although here, as in the Argentine, their largest business resulted from the cattle industry. The west coast of South America is very different from the east, for previous to the completion of the Panama Canal there were no countries on the globe—unless it be East Africa—which were more isolated or harder to reach. When once familiar with these countries, however, this feeling of isolation entirely vanishes. Peru and Chile are as yet the only two west coast countries which have any established machine tool markets, but Colombia is developing slowly; Ecuador is still very much handicapped due to lack of sanitation. For years American capital has been interested in Peru more than in any other South American country. Unlike those of Chile, the merchants have a natural friendly feeling toward America and Americans, due probably to our interest in them. Mining is their most important industry and the field is almost unlimited.

In Chile we have a people called by some, "the British of South America"; and while this may be resented by the British, nevertheless there is some truth in this comparison. Geographically Chile is the strangest country on the globe, extending for more than 2000 miles along the Pacific coast. While we are inclined to consider Chile as all mountains, a fair comparison of the size of the country is often made by stating that if the southern boundary of Chile were placed at the southern extremity of California, the width would be approximately the same as that of California, while Chile would extend along our entire Pacific coast and part of the way into Alaska. All kinds of scenery and climate may be found, varying from the tropical desert of the north to the barren mountain section of Tierra-del-Fuego. Contrary to the general impression, Chile has in addition to her nitrate fields, fine farming lands. While the country is wedged in between the Andes and the sea, there lies between the coast range of hills and the Andes a flat, fertile plain which is approximately fifty miles wide and extends for hundreds of miles north and south. It is this level plain which is responsible for the agricultural wealth of the country. The people are a mixed race, descendents of the Spanish, but with a liberal sprinkling of Irish blood. They are hardy and aggressive, and already dominate affairs on the west coast. Valparaiso, Santiago, Concepcion, Valdivia and many others are flourishing cities, but Valparaiso leads in manufacturing.

The question of how to obtain a portion of this trade is uppermost in the minds of all; and the simplest and truest answer is easily expressed. Go after it! In other words, treat this market exactly as you would any section of your own country. What chance would the average machine tool manufacturer have of obtaining the trade in San Francisco if he had no representative on the ground? When the writer first visited South America and the West Indies, it was rather unusual to encounter a direct representative of any American machinery house, although such American firms as the International Harvester, Singer Sewing Machine Co., United Shoe Machinery Co. and Standard Oil Co. have representatives everywhere. A great many American machine tools were sold, but nearly all were purchased through some export agents in New York. The orders were, in a large measure, obtained unsolicited and no follow-up work was ever done to make sure that the machine was properly installed and giving satisfaction. Would we expect good results from sales of this kind even in our own country where manufacturers are familiar with modern machinery? If not, how can we look for something in South America which cannot be obtained here?

For the benefit of the manufacturer who has had little or no experience in South American markets, we would suggest that he first investigate Brazil and the Argentine Republic on the east coast, and Chile and Peru on the west. Their leading cities have machinery houses equal to those in our own cities. In fact, Buenos Aires has more than a dozen large firms, any of whom are capable of handling in their machinery department any line of good machine tools. So far, however, there is scarcely an American machine tool manufacturer having his own office in any of these cities. In planning to enter these markets, don't spend money in advertising unless you are prepared to follow it up. Personal work backed up by proper advertising is good, but don't expect paying results without personal work. The best representative is, if possible, some one from your own company. If this is not possible, then be sure that the man you select is some one thoroughly competent to handle your line and broad enough to study conditions intelligently.

If your tools are such as to warrant it, keep a man on the ground. If not, try to get your agents to send one of their own machinery salesmen to your factory. Remember that you are in competition with firms who have already done just these things, and the natural inclination of every salesman is to sell that with which he is best acquainted. You must also remember that almost all of the large machinery firms in South America are either English or German, or if Spanish, they have English or German managers of their machinery departments. They will always give preference to the tools of English or German make, unless the American tool is proved superior.

The question of credits should also be given consideration. This can always be arranged by any firm really willing to do business, and in the writer's opinion, the chances of loss are not as great as in our own trade. The South American machinery houses often have their own New York office but whether they have or not, you should remember that good houses there guard their credit standing even more than our own firms. Furthermore, either R. G. Dun & Co. or Bradstreets can furnish you reliable reports on firms in South America as readily as in our own country. These are all on file in New York and can be obtained at a very nominal figure. A traveler should also have a letter of introduction to the foreign offices of these companies so that an accurate rating of any prospect can be obtained while on the ground. In closing, it seems advisable to give a word of warning against the many fake exporting schemes which are now being advanced. Knowing that all manufacturers are interested in foreign trade as never before, the mails are full of letters and circulars telling of the wonderful chances to make money in export trade. Money can be made, but only by intelligent and consistent work.

* * *

MONTHLY MEETING OF THE A. S. M. E.

The monthly meeting of the American Society of Mechanical Engineers was held Tuesday evening, January 11, at the Engineering Societies building. It was addressed by Walter N. Polakov, the topic being the standardization of power plant operating costs. Mr. Polakov outlined a method by which the owner of a power plant can judge, without having to study the technical details of operating, how close the actual performance of the plant is to the possible minimum cost. All variable factors beyond operating control are automatically adjusted.

APPLICATION OF THE THREE-POINT PRINCIPLE IN FIXTURES

TOOLS FOR VARIOUS CLASSES OF HORIZONTAL AND VERTICAL TURRET LATHE WORK

BY ALBERT A. DOWD*

A stool with three legs can be placed on any uneven surface and yet be firmly supported, but a four-legged one is rigid only when the surface on which it rests is of such a nature that all the legs obtain a bearing. The farmer then, when he makes a milking stool, bears this point in mind and makes his stool three-legged, not because this construction is mechanically superior but because he knows that a four-legged stool will not give a firm support on the surface of the barn or stable floor. In the mechanical field the principle of three-point support is applicable to many classes of work and its importance is understood and made use of in every kind of machine and fixture work. In the automobile industry, alignment of the working parts is preserved by making the power plant a self-contained unit and having it supported on three points in order to equalize or neutralize the twisting action caused by the passage of the car over the more or less uneven surface of the road. If some provision of this kind were not made, distortion of the parts would result and they would consequently fail to perform their functions. Several years ago one or two manufacturers made a strong advertising point of this feature in their cars, and even at the present time one company uses a diagrammatic representation of the three-point support as a sort of trademark. All manufacturers now provide some form of three-point support for their power plant, although the working out of the principle varies somewhat according to the construction of the car.

In machine design the three-point principle is utilized in numerous ways, one of the most important of which is in the setting up and leveling of the machine itself. Machines of the lathe type, having four legs, are carefully leveled by shimming up under the feet, care being taken that strains are not produced in the machine bed or ways. Sometimes the bed itself is supported on two points at one end of the machine while the other has a single swivel bearing or its equivalent; and machines provided with this feature are easily set up without danger of distortion or changes in the alignment. The principle is applied to machine design in other ways to secure a solid support, to equalize strains, etc. Castings for various purposes are often made with three projecting lugs or bosses in order to gain a good bearing surface under all conditions. In the design of fixtures of all kinds the principle of three-point support is used in many ways, on both rough and finished work and on all varieties of machines. In this article, however, we shall consider its application to fixtures for horizontal and vertical turret lathe work, and in order to make the matter as clear as possible the examples selected are as simple as could be found to illustrate the subject and avoid complications. A few points worthy of note in connection with the design of fixtures employing the three-point principle are given herewith, and although some of these may appear so simple as to be obvious it is believed that it is better to err on the safe side than to leave out some point of interest because it is well known.

* Address: 7900 Ridge Blvd., Brooklyn, N. Y.

Important Points in Design

1. The application of the three-point principle for the location and support of rough castings or forgings must be carefully thought out in order to make sure that none of the points will strike against a fin or parting seam, or come against the portion of the work on which the piece number may be imprinted. If the work is to be located from two rough surfaces at right angles to each other, it must be remembered that if three fixed points are used as locaters on one side, the other points must be arranged so that only one is fixed, and two are adjustable to compensate for variations in the surfaces. When the work is shallow and is held in chuck jaws this point may be neglected, as the work can rest on three points and be gripped by the jaws

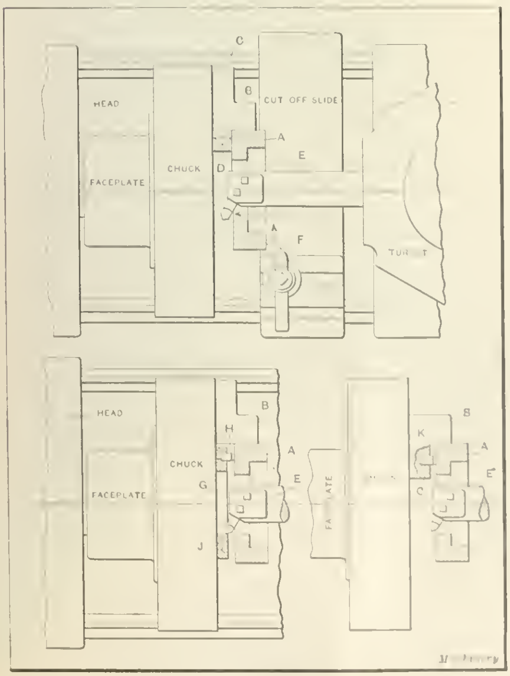


Fig. 1. Three Methods of holding Forged Steel Clutch Ring to be machined on Horizontal Turret Lathe

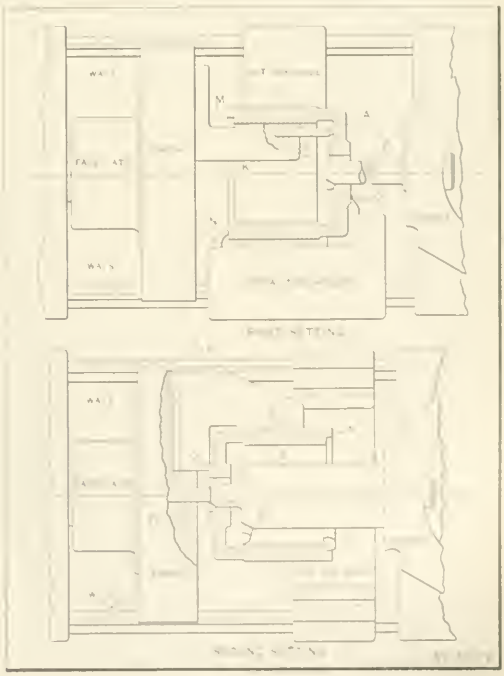


Fig. 2. First and Second Settings for Boring and facing Steel Casting A

2. When a finished surface is used for centering the piece in the fixture, and it also rests on a finished surface, the three supporting points may be fixed. If the work is to be clamped as on a faceplate fixture, the clamps should be arranged so that they will draw the piece directly down or back onto the supports in order to avoid any chance of "cocking" or distortion. When a finished surface is used for centering the work and a rough one for end location, the points must be arranged the same as for handling rough castings, *i. e.*, with two of them adjustable. It is often desirable on large work to locate the piece on three strips instead of on a continuous surface in order to facilitate assembling. When this is necessary, it is advisable to make the strips in such a way that they can be readily replaced when worn.

3. The supporting points should be so located that they can be easily reached for cleaning, in order that locations will not be affected by an accumulation of chips or dirt at important points. Adjustable points should be so arranged that dirt and chips will not clog the screws and thus make them difficult to operate. This point in design should receive careful attention when fixtures are designed for use on the vertical turret lathe or vertical boring mill. On machines of the horizontal type, less trouble is likely to be experienced in this respect, because the chips do not tend to fall onto the screws. In either case, however, it is well to provide against trouble from this source.

4. It is frequently desirable to insert hardened steel buttons of uniform height in the jaw screw-holes in order to raise a portion of the work above the tops of the standard jaws, so that the work can be faced or under-cut. These buttons form an excellent three-point support for the work in addition to performing the function already mentioned. Short parallels cut from cold-rolled steel may be used on a vertical turret lathe and are somewhat cheaper than the buttons, but they are open to the objection of becoming easily displaced and lost.

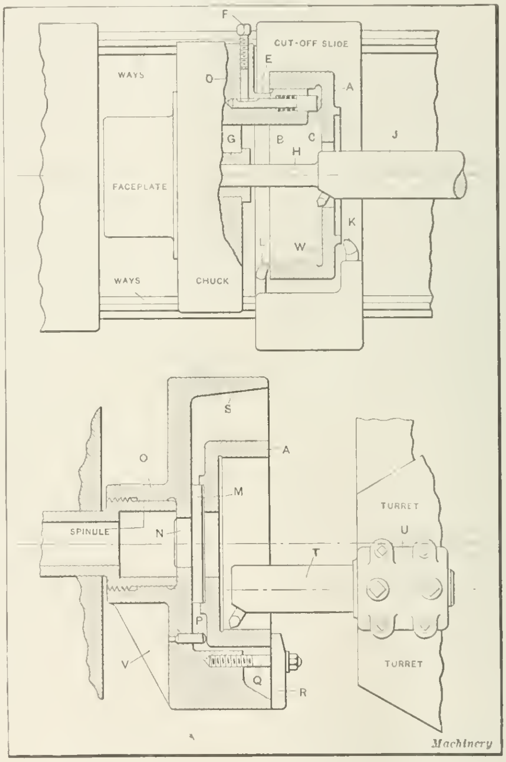


Fig. 3. Application of Three-point Principle in holding a Flywheel while performing Boring and Facing Operations

5. When it is necessary to arrange points to act as a vee on long cylindrical surfaces it is good practice to make them so that they can be adjusted to take up wear. This can easily be done by means of headless set-screws with check-nuts to lock them securely in any position; and it is a better construction to place one check-nut on the outside and another one inside, than to have both nuts on one side of the fixture wall. The construction of the fixture will not always permit of using this method, but when it will, very satisfactory results are obtained.

6. Three-point support for the fixture itself may sometimes prove an advantage, especially on fixtures for large work, as a considerable amount of machining time is saved thereby. When three-point support is used in a case of this kind, the clamp screws which hold the fixture in place on the table should be arranged at the points where the supports are placed, and any clamps for the work itself should be as near the same place as possible.

Some of the other points in connection with the design of fixtures employing the three-point principle are equally applicable to all classes of fixtures for horizontal and vertical turret lathe work. For example, rigidity must always be considered; the cost of the fixture should be, to a certain extent, proportional to the number of pieces to be machined; parts subject to excessive wear should be designed so that they are readily replaceable; and methods of clamping, convenience of operation, and accessibility of all parts should be given careful attention. Other points in design and construction will be noted in specific cases during the progress of this article, and attention will be directed to faults or praiseworthy features.

Three-point Principle Applied to Plain Chucking

The three-point principle may be applied in a number of different ways in handling plain chucking work on a horizontal turret lathe. The work *A* shown in the upper portion of Fig. 1 is a forged steel clutch ring. It is set up on three steel blocks *D* placed against the face of the chuck while the work is gripped by the outside in the jaws *B*. It is a difficult matter to set a piece up in this way unless the blocks *D* are fastened in some way to the chuck. If they are not fastened they will continually move about and become misplaced so that their usefulness will be destroyed. In the instance shown it would have been easy to gain a backing for the work by reversing the jaws and using the tail *C* as a support. As it was necessary to bore the work, however, the projection of the jaw would cause an interference with the boring tool as it passed through, so that this method was not advisable. The bar *E* was used to bore the work while the facing tool *F* on the cross-slide faced the rim. Another method of holding the same piece is shown at the left in the lower part of the illustration, a steel ring *G* being screwed to the face of the chuck by three screws *J*. The three pins *H* are set into the ring at points equidistant from each other and serve as a support. This method is fairly good, but involves the making of the ring and drilling into the face of the chuck for the screw-holes. A still better method is shown in the lower right-hand illustration, in which a special set of jaws *B* is used, each of these having a pin *K* against which the work locates. Clearance is provided by the amount of offset in the pin. The conditions shown in this illustration are as simple as can be conceived of, and as a matter of fact, work as shallow as this is seldom provided with three-point support other than that afforded by the tails of the jaws, unless conditions are similar to those shown.

Three-point Support for a Piece of Electrical Work

The work *A* shown in the upper part of Fig. 2 is a steel casting which is held on an internal cored surface by the special jaws *K* of a three-jawed chuck. One of these jaws is provided with a pin *L* which strikes against the cored surface of the casting, thus giving correct longitudinal location. A

portion of the jaw is cut away at M in order to provide for the facing of this end of the casting by the tool N on the cut-off slide. Another tool O is used for facing the end of the boss, and both of these tools are held in a special tool-holder. A boring-bar P in the turret is used to bore the hole simultaneously with the facing operation. In a case of this kind it will be noted that the jaws have a wide surface contact and that the use of three pin supports would not be practicable, unless two of the pins were adjustable. The adjustable feature was deemed unnecessary in this case. The lower portion of the illustration shows the second setting of the work, which is extremely simple. A three-jawed chuck is provided with a set of special jaws D, bored at B to the diameter of the finished surface of the work and faced at C to engage the finished end of the boss. The surfaces used as locating points are finished, thus permitting of this method of procedure; the supporting points do not require any means of adjustment. A bushing F is set in the chuck to act as a guide for the pilot of the boring-bar E, thus insuring greater rigidity. The tools G and H are used for boring, and the tool J cuts the recess in the end of the work. A method of this kind is applicable to many kinds of work when two finished surfaces at right angles to each other can be used for holding and locating the work, respectively.

Three-point Support used in Chucking a Motor Flywheel

The motor flywheel shown at A in the upper part of Fig. 3 is another instance where three-point support is used in connection with chuck jaws. In this case the flywheel is of such a diameter that a single supporting point in one of the jaws would not be sufficient to resist the pressure of the cutting action of the various tools used in machining, so that the use of three supporting points was found necessary. The work is held by the inside in the special jaws B which are relieved at E to permit the back facing of the rim. The tools L and K which are held in a special tool-block on the cut-off slide, are used for back facing and finishing the pad; and other tools (not shown) in the turret face the portion W of the flywheel. The boring-bar J has a pilot H which enters the guide bushing G in the chuck to give greater accuracy and rigidity. Two of the jaws are provided with spring pins C which are released and locked by the action of the screws F on the shoes D. Attention is called to the manner in which the supporting pins are beveled at their points to prevent any change of position after they have once been locked. The stop-pin in the other jaw (not shown) is fixed in order to give positive longitudinal location of the work. Work of this kind is very frequently located on the three fixed ends of the jaws and gripped by the inside as shown, but when this is done there is always a chance of incorrect holding and possible slippage due to spring of the casting. Sometimes this results in the production of grooves or a wavy surface on the outside of the work.

In the second setting of the work a fixture is used and the point of location is the recess which has been machined in the first setting. This locates the piece on a plug M which is shouldered at N and fits a hole provided for it in the center of the fixture. The previously machined surface W rests on three pins P which are of uniform height and so arranged that they leave a slight clearance between the face of the plug M and the face of the shoulder on the work. The fixture body O is screwed to the spindle and its exterior forms a continuous ring S so as to make this surface clean and avoid danger to the operator through projecting lugs, etc. The work is drawn back against the pins P by means of the clamps R through the medium of the screws Q. Work of this kind is frequently held and drawn down onto a continuous finished surface instead of a series of pins. The disadvantage of a continuous surface is that dirt collects upon it and renders locations uncertain unless great care is taken to keep the fixture clean. With an arrangement of pins such as that shown, no dirt can possibly collect and locations are therefore positive. During this setting the turret is set over and the bar T used to bore the clutch seat.

Fixture for Irregular Work using the Three-point Principle

The work shown at A in Fig. 4 is of such a nature that it cannot be held or located in chuck jaws, so that the provision of a fixture was found necessary. The fixture body W is screwed to the spindle and has three fixed locating points B set in its face. The casting is located on these points and an adjustable screw C is used to give support at a fourth point. Two set-screws H are set in lugs K on the face of the fixture, thus forming a vee which centers the work. There are four lugs O around the exterior of the casting, these lugs being provided for clamping purposes. In setting up the work, the clamp Q draws the casting down on the pin B when the stud R is tightened. The lug S and the end of the clamp are beveled so that in addition to clamping the work, they force it over into the vee formed by the set screws H. Two check nuts J, one on each side of the lugs K are provided to secure the screws H in any desired position. A driving pin D takes the thrust of the cut so that the clamps are not depended upon for driving; and three other clamps L are drawn down on the lugs by means of the screws P, the ends of these clamps being supported by pins M.

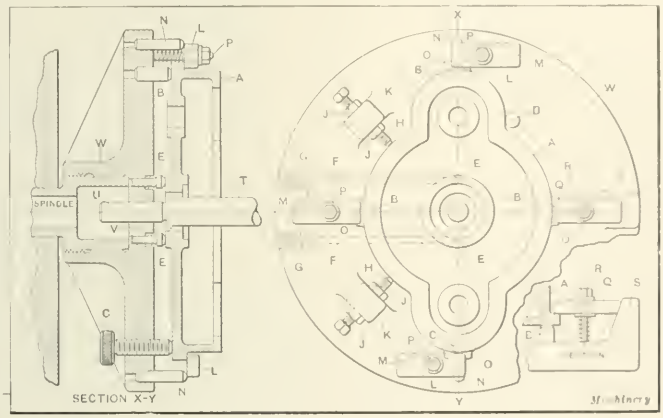


Fig. 4. Fixture employing Three Fixed Locating Points B and One Adjustable Point C

In order to keep the diameter of the fixture down, the two clamps L are set so as to economize space, and the pins N help to distribute the pressure properly when the clamps are tightened. As the casting is somewhat thin, it is necessary to provide two spring pins at E in order to support the center of the work; these are located in position by the plungers F which are operated by the hollow set-screws G. The section X-Y makes this construction clear. A bushing V is set in the center of the fixture and acts as a guide for some of the tools used in machining, one of these tools T being shown in position in the work. Although the fixture gave excellent results some care was necessary to see that it was not sprung out of shape by the action of the clamp Q, which was tightened first to force the work over into the vee and had an inclination to tip the work slightly away from the opposite stud. This was obviated by tightening the opposite clamp slightly before completing the clamping with Q.

Chuck Jaws and Adjustable Points on the Vertical Turret Lathe

It is frequently possible on the vertical turret lathe to make use of adjustable points in connection with chuck jaws for setting up work. An instance of this kind is shown in the upper part of Fig. 5, where the work A is centered by the action of the jaws B. Raising blocks D are tongued at E to fit the regular sub-jaws of the table, and the upper jaws are

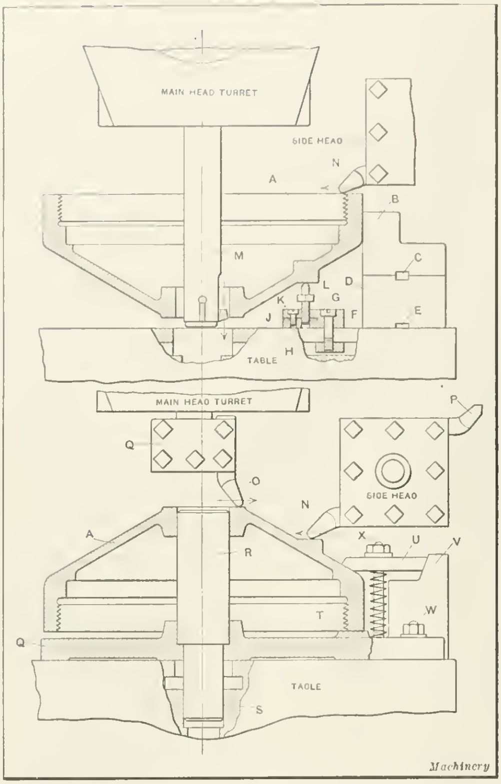


Fig. 5. Use of Adjustable Locating Points in connection with Chuck Jaws for holding Work on Vertical Turret Lathe

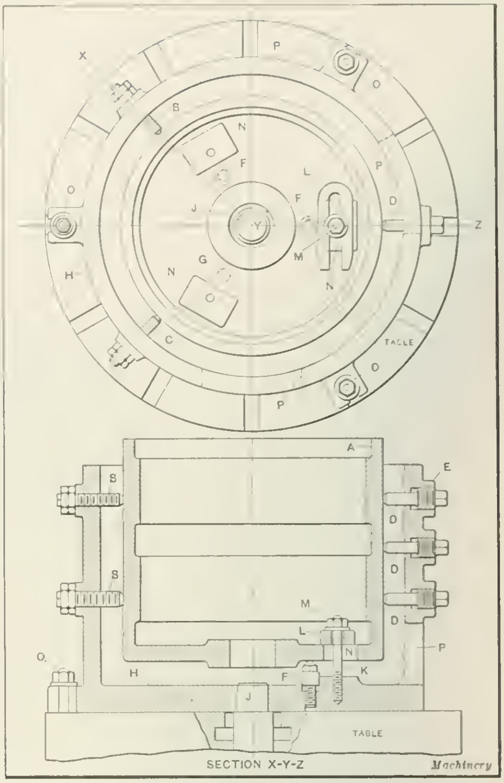


Fig. 6. Fixture for holding Work where both Supporting and Driving Facilities must be of Ample Capacity

keyed to them at C. Three special blocks F are secured in the desired positions by the screws G and shoes H in the table slots. The screws L are squared up so that a wrench may be used to adjust them, and their upper ends are rounded to form a seat for the casting. The blocks F are split at J and the screws K draw the two sides together and thereby hold the locating points in position. The boring-bar M in the main-head and the tool N in the side-head are used for boring and facing the casting. In the second setting of the work, a fixture is used having a central stud R on which the piece locates, while the lower portion of the stud S centers the fixture Q on the table. Three pads T form a resting place for the previously machined rim of the casting A and the clamps U are used to draw it down firmly. On account of the beveled exterior of the work, the clamps are also beveled —both where they bear on the casting and also at their rear ends—in order to keep them from pushing back when the pressure is applied. The lugs V are beveled to correspond. The fixture is held down on the table by means of the screws at W which enter the T-slots in the table. This simple and inexpensive fixture gave excellent results.

Three-point Fixture for a Pot Casting

The fixture shown at H in Fig. 6 was arranged to hold the casting A which is of large size, instead of using jaws, for the reason that both the supporting and driving facilities were required to be of greater capacity than could be applied by means of jaws. Attention is called to the fact that large castings held in a fixture require considerable clearance between the work and the fixture, because of the variation in size and also on account of the finish allowance that is necessary. Care must therefore be taken to see that the amount of clearance is ample to take care of any condition which might be found. An inch of clearance all around is none too much on a big casting. The pot fixture H is centrally located on the table by the plug J and is fastened down by the T-bolts O in the table slots.

The V-principle is used in locating the work, the set-screws at B and C serving as locating points. There are two screws at B and one at C, the latter being located midway vertically between the other two and 90 degrees from them. This is somewhat contrary to the usual custom and in some cases might not be found desirable—for example, when considerable dependence has to be placed on the locating screws to assist in driving the work. In this case, however, ample provision for driving is obtained in the holes N. The work is forced over into the vee by the center set-screw D of the three shown opposite the vee; and when the casting has been brought up snugly into place, the upper and lower screws D are also tightened. Attention is called to the manner in which protection against chips is provided for in the construction of these set-screws, in which no portion of the thread E is exposed. The work rests on a fixed point G (shown in the upper view) which acts as a positive stop. Two additional points F are adjustable by means of a wrench, and their threads are protected from dirt by a cylindrical portion above. The openings P in the wall of the fixture allow access for the screws; and the piece is held and driven through the U-clamps L which draw it down onto the points by means of the nuts and washers M on the studs K. The clamps L being of U-section are readily removable without requiring the nuts and washers to be taken off. The plan view shows only one clamp in position in order to show this clearly.

Two Methods of Obtaining a Three-point Support on a Hub Casting

The work A shown in the upper portion of Fig. 7 is a hub casting of large size, and the method to be described was first suggested in connection with the handling of this work.

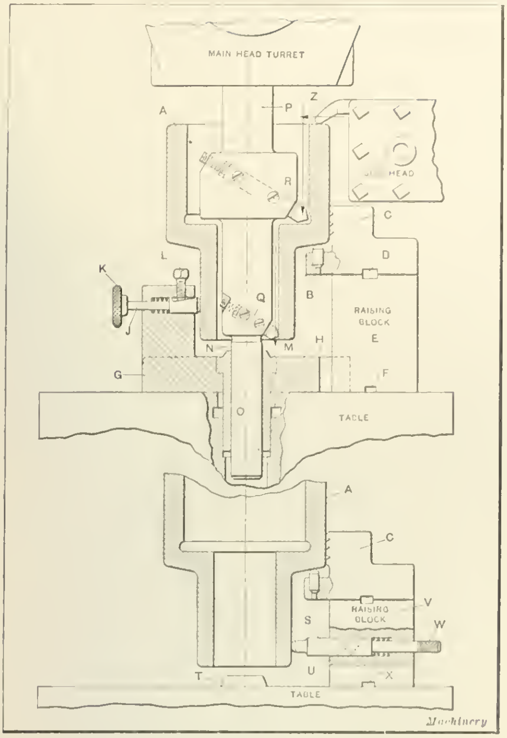


Fig. 7. Original and Improved Methods of holding Large Hub Casting by Three-point Support

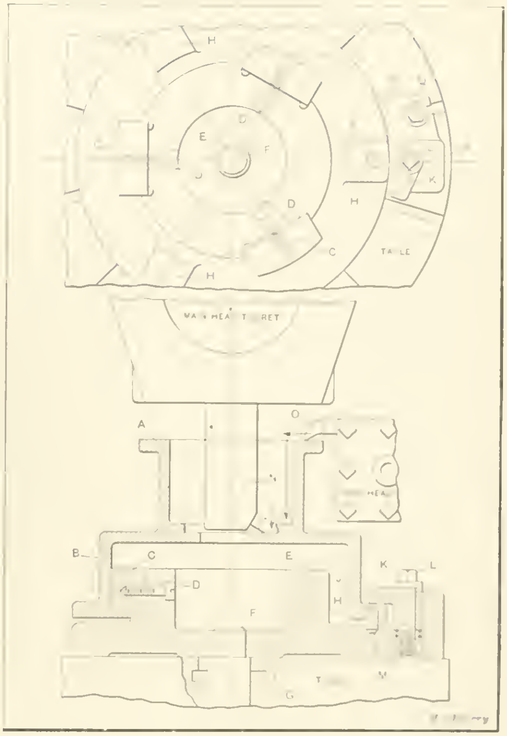


Fig. 8. Fixture for locating Work from Surfaces bored and faced in Previous Operation

The idea was abandoned, however, in favor of the method shown below. In the upper illustration, the jaws C are mounted on the raising blocks E and tongued to them at D, while the raising blocks are tongued and fastened to the sub-jaws of the table at F. Three hardened points B are set in projections of the upper jaws and the work rests on these points. A supplementary casting G is centered on the table by means of the hollow plug M which also acts as a guide for the boring-bar pilot O; and the upper part of this bushing is beveled as shown, but the edge of the hole is left sharp so that chips will not be drawn down with the bar and tend to destroy it together with the bushing. The base of the fixture is slotted at three points H to allow the necessary movement of the jaws; and there are three lugs midway between the jaws on the base, in which the spring pins J are carried. After the work has been centered by the jaws, these pins are released and allowed to come into contact with the work; they are then locked by the set-screws L. The boring-bar P is of the multiple type, having two tools Q and R for the two inside diameters. Attention is called to the fact that the tool Z is carried in the upper part of the side-head instead of the lower; this is done in order to economize on the length of the boring-bar.

As the purpose of three supporting points J was simply to steady the work, it was thought that a simpler design would answer all purposes, and the previous scheme was therefore abandoned in favor of the one shown in the lower part of Fig. 7. In this case the bushing T is used directly in the center hole of the table and the boring-bar is made correspondingly shorter. The raising blocks V are also lower than in the previous case, and are keyed to the sub-jaws at X in the same manner. The construction of the jaws C is identical in both cases. Three spring plungers S with knurled ends W are inserted in the jaws and tightened in any desired position by the set-screws U. This method is much simpler than the other and possesses the added advantages of being both cheaper and more efficient.

Three-point Location for a Large Casting

The work illustrated at A in Fig. 8 has been partially bored and faced in a previous setting; and in the setting shown, it is necessary to work from the previously finished surfaces. The base casting E is slotted to receive the three steel locating jaws C on which the finished surface B locates. These jaws are held in place by the screws D and are carefully finished after being drawn into position. The base is centered by the plug F in the table hole G, and is held down by the screws Q in the lugs P, one of which is shown in the plan view. Three pads H are finished to support the flange and a driver J is inserted in one of these pads. The work is clamped by means of the hook-bolts K in order to keep the diameter of the fixture as small as possible; and a cap-screw L passes through the hook-bolt and enters the bushings M into which it is threaded. Attention is called to the manner in which the hook-bolt is backed up by the lug R so that it will not become distorted when under strain. The boring-bar N in the main-head turret, and the tool O in the side-head, are indicated in order to show the method of machining. On large diameter work, such as the piece shown, relieved points of location are much better because there is less friction in assembling or placing the piece in position. A series of pads in place of a continuous surface is also a better construction, because a fixture so designed is much easier to keep clean.

The Three-point Principle Applied to a Four-jawed Table

The forging A shown in the upper portion of Fig. 9 is a large bevel gear blank, and it was desired to machine this piece on a vertical turret lathe having a four-jawed table for the reason that the machines having three-jawed tables were overcrowded with work. A cast-iron locator B, having three raised strips F inclined at 30 degrees to the center line of the table, was pinned at D to the stem E held in the main-head turret. This was brought down into the hole C, thereby approximately centering the work. Three of the jaws H

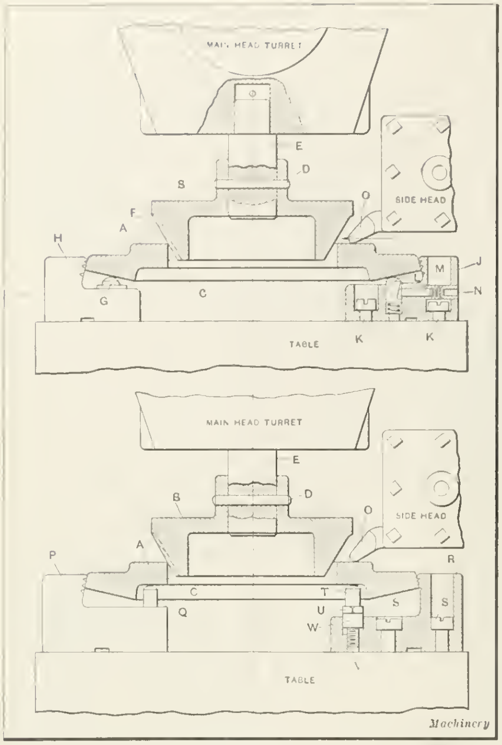


Fig. 9. Two Methods of holding Bevel Gear Blank; the Method shown above gave Trouble through Slippage of Supporting Pins on Beveled Surface

were then brought up on the work rather lightly, the pins *G* in the jaw screw-holes serving as supports to engage the beveled portion of the gear blank. The fourth jaw *J* was then brought up and the spring pin *L* allowed to come into contact with the beveled surface of the work, after which it was locked by the shoe *M* and the hollow set-screw *N*. The two screws *K* were used to hold the jaw in position on the sub-jaw of the table. The side-head tool *O* is shown in position for facing the back of the gear. This arrangement was entirely unsatisfactory due to the "cocking" of the gear resulting from movement of the pins *G* along the beveled surface when tightening the jaws. In addition to this there was more or less slippage of the pin *L* on account of the pressure of the cut. The improved design of a fixture for handling this work is shown in the lower portion of Fig. 9, in which the same method of centering is used, but the jaws are arranged differently. The three jaws *P* have locating pins *Q* of equal height, on which rests the relieved portion of the gear blank which is not beveled. The fourth jaw *R* is held down on the sub-jaw by the two screws *S* and has an adjustable point *T* which is threaded at the lower end and squared up at *U* so that a wrench may be used upon it. Attention is called to the fact that the portion *W* of the adjustable point is larger than the screw and therefore protects it from being clogged with chips or dirt. This method was much more satisfactory than the one previously described.

Double Three-point Locating Device

A somewhat peculiar arrangement is that shown in Fig. 10 for holding a piece of work *A* by the interior cored surface. The base *B* is made of cast iron and is centered on the table by means of the hollow plug *C*. It is held down in the usual manner by screws *D* which enter shoes in the table T-slots. The upper portion of the fixture *E* fits a circular tongue *F* on the base, to which it is screwed by the screws *G*. The upper portion *E* is slotted to receive the jaws *N* and *O*, and there are three of each of these jaws set 120 degrees apart. The upper portion of the fixture *E* is made separate in order to facilitate the machining of these slots. Two cylindrical cams *H* and *J* control the radial movements of the jaws by means of the screw *K* which is threaded with a coarse pitch left-hand thread in the lower cam and a right-hand thread in the upper cam. The upper end of the rod is squared at *L* and is operated by a socket wrench *M*. In order to prevent the entry of chips and dirt into the mechanism a felt washer *S* is fastened to the upper cam; and steel cover plate *R* is placed on top of the fixture and held in place by screws. The hardened steel pin *T* strikes against the inner cored surface and locates the piece vertically. Slots are cut in the upper portion of the fixture *E* to allow the insertion of the flat springs *Q* which throw the jaws back into position upon withdrawing them from the work; and a sheet steel cover plate *P* keeps the dirt out of these slots. The cams and screw are supported by the coil spring shown below the lower cam, and the action of the cams is limited by the screws *U* which enter slots in the cams. These screws also serve to prevent the revolution of the cams. A combination boring and reaming bar *W* is used for boring and reaming the hole while the outside surfaces are machined by various tools in the side-head, one of these being shown at *V*.

In the construction of this device it will be noted that although six points or jaws are used for locating, the arrangement is such that they all bear against the inside of the casting with an equal amount of pressure, at the same time centering the work from the cored interior. As the right and left screw on the rod *K* is rotated, the two cams float vertically so that the pressure on the jaws is equalized. A device of this kind is useful in many instances when work is to be held from an internal cored surface. From the instances given during the progress of this article, the importance of three-point support can be readily seen, and the examples shown, although purposely selected for their simplicity, cover the majority of cases met with in general practice.

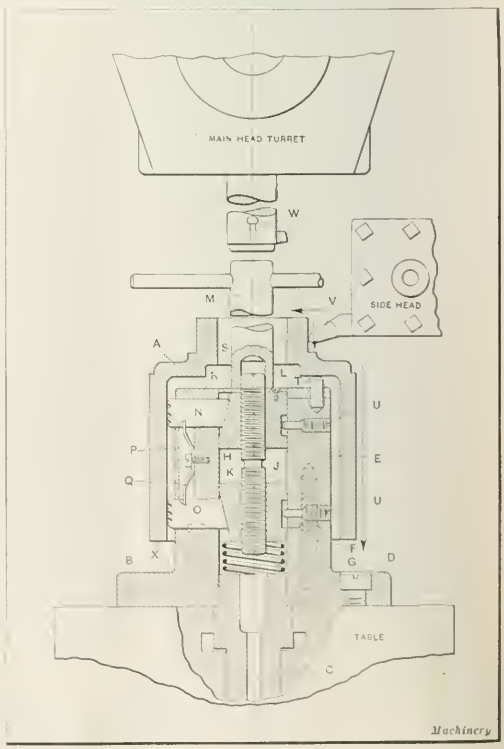


Fig. 10. Method of holding a Piece of Work by an Interior Cored Surface

MANUAL TRAINING VS. TRADE TRAINING

BY E. H. FISH*

How may we distinguish between manual training and trade training? It is not enough to say that the leading purpose of manual training is cultural while that of trade training is vocational. There must be some way in which we can tell whether we are in a manual training high school or in a trade school without depending on the sign over the door.

It does not depend on cost of equipment, for some manual training schools have very fine and elaborate equipment, and a trade can often be taught with a very meager one. It does not depend on the quality of the equipment, for while good quality is desirable in one school it is no less desirable in the other. It does not depend on the amount of money spent for instruction. It does not depend on hours of shop practice, for the hours given to manual training are enough for its purpose, but more hours of the same kind of practice would not make a journeyman. It does not depend on housing, nor on materials, nor on exercises, nor on related or non-related study. On what then does it depend? No brief direct answer to this question is possible. The most concise answer would be to say that it depends on the spirit in which the work is undertaken—that manual training is amateurish and trade training professional; but that answer is not complete without further definition.

The spirit of amateurishness shows itself in manual training in the limited amount of work done in a given time, which is very properly justified because the greatest educational value of the various projects must be gotten from them. It shows itself also in the variation of its methods from those of the professional tradesman. For example, a favorite project is a roller towel-holder which, in itself, is an abomination because it suggests a towel which will be used until it is uniformly black all over. In manual training the roller is planed square, octagon, and many-gon until it can be sandpapered into a pretty good cylinder. In a shop a small boy turns these out by the bushel with a back-knife lathe while the manual training boy makes one. The lathe-made rollers are nearer round and straight, not because they need be, but because it is quicker to do it that way. There is not as much educational value to be had per dollar's worth of lumber the manufacturer's way as the manual training way, but the boy who has made a roller towel fixture with a plane is not worth as much in industry as the boy who has made a thousand or even one by means of a lathe.

Amateurishness shows itself in the failure to continue training until work is done habitually well. One piece well made is accepted as evidence that the pupil could continue to go on and make others equally well, which is by no means true. A workman could not possibly go on day after day putting the close mental attention upon his work that was necessary for the first job. He goes through three stages: the first is when he begins a new operation and is careful to follow directions because he is afraid he will spoil work. During this he is slow. The second is one of self-confidence when he speeds up and spoils work; and the third, is one of sub-consciousness when his work is done rapidly and well without any considerable conscious thought. If there were not this last stage most of us would land in the insane asylum.

Professionalism then requires an abundance of work of such a character as to give plenty of repetition with only a gradual demand for a growing intellectual attainment. It requires the use of the methods to be followed in the trade to a great extent and it requires the attainment, as a matter of habit, of skill of a commercial standard or better.

I realize that it shocks many good souls to walk into a school shop and see boys running a lathe with a hundred or more bolts or toolposts or screws or collars or what-not stacked up beside them. There is a feeling that when a boy has done a good job once he should be promoted to the next. It will not do, for boys are boys and they are boys because they have not matured. When they mature they will be men regardless of age. When a mature man is given a single shaft to make, it may be that he will have learned all that is to be learned about it if he makes one and does a good job, but a boy very seldom does the fifth or sixth piece as well as he does the second or third.

Again, trade training must of necessity train in the ways things are done for profit and that means in many ways. For example, in a shop where a few short studs are needed they are centered, turned and threaded on a lathe; where larger quantities are needed they are made in a hand screw machine, and where large quantities are used they are made on an automatic. The first is the machine shop method, the second is a manufacturing method, and the last a factory method. The first two should be taught to a machinist, the last only in such communities as have industries where the method is used.

Often it is desirable that boys should be taught an obsolete way of doing certain things because it is fundamental and because they will understand the modern way much more thoroughly if they know the old way. It should be borne in mind that a school shop must train boys so that they will be quick to see ways in which work may be done, for no shop, in school or out, can train a boy or man in all the things which he may be called upon to do. Every new job in a shop is like an original problem in geometry; it requires a new combination of simple fundamental processes for its completion. If the workman can apply these fundamentals he has a trade, if he cannot he must be content to remain an operative.

* Address: 18 Vassar St., Worcester, Mass.

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PROFIT SHARING SYSTEM, CLEVELAND TWIST DRILL CO.

The Cleveland Twist Drill Co., Cleveland, Ohio, has put into effect a system of profit sharing with its employes which provides as follows:

1. Before any profits are divided with employes, the stockholders shall receive eight per cent per annum.

2. When the above eight per cent has been paid to the stockholders in any calendar year, all cash dividends subsequently declared in that year will be divided between the stockholders on the amount of their stock interest and the employes on the amount of the salary or wages received by them during the twelve months ending June 30 of that year as follows: (A) Employes who have been continuously in the service of the company for at least two years prior to July 1 will receive dividends at the same rate as the stockholders. (B) Employes who have been continuously in the service of the company for more than one year and less than two years prior to July 1 will get three-quarters of that rate. (C) Employes who have served continuously for less than one year will get one-half the rate of the stockholders. (D) Dividends that have accrued will be distributed to employes once a year in December except that dividends for the year 1915 will be distributed January, 1916.

3. No person will be entitled to a share of these dividends unless a bona fide employe of the company at the time of their distribution, except that employes laid off owing to lack of work or sickness will be entitled to the dividends accruing in any year on the wages earned by them during the twelve months prior to June 30 of that year.

4. Employes voluntarily leaving the service of the company or dismissed or discharged will forfeit their right to any accrued dividends.

5. Any employe who may receive a commission from the company or any share in profits other than the profits shared in this plan, except through dividends of stock, if a stockholder, shall thereby be rendered ineligible to receive dividends under this plan.

6. All employes except those entered in the three preceding sections shall be eligible to share in the profits under this plan.

7. The above plan for division of profit is absolutely voluntary on the part of the company and is in no sense a contract. The right is therefore reserved by the directors to make at any time such changes in the plan as they may consider desirable for the best interests of the organization. The fact that any employe is receiving the dividends in this profit sharing plan shall not deprive the company of the right at any time to discharge the employe and thereby terminate his participation under the plan, nor shall any employe acquire any right thereunder to any accounting by the company concerning its business or profits.

* * *

The man who says "It can't be done," is always being interrupted by somebody doing it.

TURNING "DIFFERENTIAL SPIDERS"

BY CHESTER L. LUCAS*

In the manufacture of differential gears for automobiles, one of the principal parts of the work is the "spider," so called because of the four radiating arms upon which the bevel pinions are mounted. These "spiders" are drop-forgings, and one of the machining operations is the turning of the four arms. At the New Process Gear Corporation's plant in Syracuse, N. Y., this turning operation has been reduced to its lowest terms by the automatic turning lathe that has been built for the company by the Porter-Cable Machine Co. of Syracuse, N. Y. This machine has many points in common with the standard Porter-Cable manufacturing lathe, but the general appearance of the new machine is different, because of its two tailstocks and vertical position.

This machine is shown as a whole in Fig. 1; a view of the turning operation may be seen in Fig. 2; and in Fig. 3 the clutch operating mechanism for stopping the machine after each operation is illustrated. Before coming to this machine to be turned, the forgings are centered at the ends of the arms. In Fig. 2 the rough spider may be seen at A ready to be turned. On the bed and at the right of this illustration some of the spiders may be seen. The lathe centers upon which

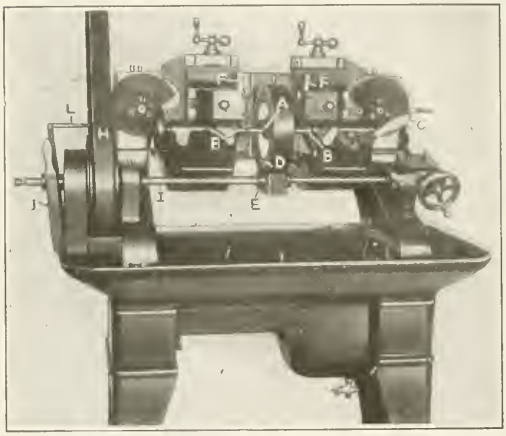

Fig. 1. Semi-automatic Lathe for turning "Spiders"

the work is held are shown at B and a quick-acting lever C is for operating the right-hand center quickly. The drive for the work is furnished by ring D that is driven through teeth on its outer surface that mesh with those of pinion E on the driving shaft. A pin inside of this ring acts as a driver against one of the arms of the spider. The cutting is done with two tools F that are mounted in the two carriages. For adjusting the position of the tools, the carriages are provided with cross-slides; thus any depth of cut is quickly obtained.

The carriages are cam-actuated, as may be best seen in Fig. 1 which was photographed with the cam guards removed. The rises of the cams govern the rate of advance. The carriages travel in opposite directions, each starting its cut from the end of the arm upon which it is to work. After the cuts have been taken, the carriages are returned to their starting positions by means of the spiral springs G, shown in Fig. 2. The drive of the machine is through the main pulley H, and this is connected by a clutch to the main driving shaft I. An angular shaft at the extreme right-hand end of the machine is rotated by driving shaft I, and transmits motion to a longitudinal shaft back of the machine that runs parallel with the main shaft. The longitudinal shaft is not shown in the illustrations, but it carries worms that mesh with worm-wheels on the two cam-shafts and thus transmits motion to the two cams.

The starting of the machine is accomplished through the

* Associate Editor of MACHINERY.

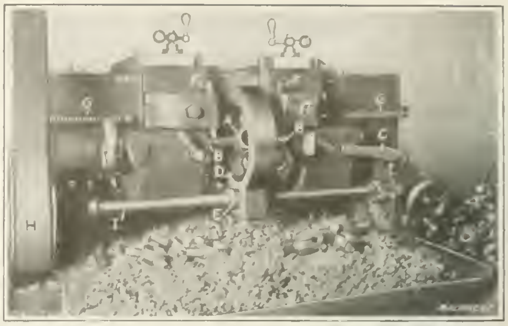

Fig. 2. Lathe in Operation

hand clutch lever J at the left-hand end of the machine. After the spider has been put on the centers, this clutch is thrown by hand and the machine commences its work. The two cuts progress until they reach the hub of the spider. By this time the cams have reached the limit of their rises, and as soon as the drops in the cams are reached, the carriages are drawn back by springs G. There is no shock to the carriage return movements, as the cam-drops are not quite radial. The receding action of the left-hand carriage results in throwing the clutch-operating lever and stopping the machine. The manner in which this is accomplished is shown by the two views in Fig. 3.

Referring to the view at the left, the extreme left end of one of the carriages is shown at the time of returning. On the under side of the carriage a block K is bolted, and as the carriage moves back, the edge of this block hits the end of clutch lever rod L. The clutch lever rod is guided in a bracket M, and a leaf spring forces the rod against the under face of the bracket. There is a pin N against which the upper face of the clutch rod contacts, and as the rod is pushed backward by block K on the carriage, an angular step on its upper face causes the rod to be depressed slightly as it passes the pin. This action permits block K to finally clear its contact with rod L and the action is thus stopped. It is the movement of rod L and its action on the clutch operating lever that throws out the clutch and causes the main driving shaft of the machine to cease rotating until the operator has thrown the clutch in again by hand.

Two settings of each spider are necessary to complete the turnings on the four arms. The production of the machine is very high, it being an average nine-hour day's work for an operator to produce 375 spiders, or a total of 1500 turned arms. An idea of the way the chips accumulate may be gathered from Fig. 2, and it was to permit gravity to remove the chips that the lathe was mounted in a vertical position rather than in the conventional way. Had the lathe been operated in the usual way, the space between the work and the two approaching carriages would frequently have become choked with chips and the operation impeded.

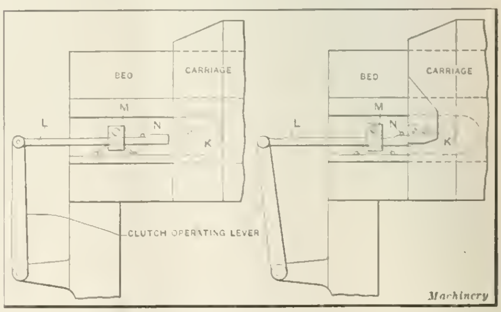

Fig. 3. Mechanism that throws out Clutch

THE HEAT-TREATMENT OF DROP-FORGING DIES

BY FRANK E. MERRIAM*

The heat-treatment of drop-forging dies depends largely upon the material of which the die is composed and this, in turn, is determined by the nature of the forging which is to be made and the severity of the requirements. As an illustration, consider the die for a forging requiring to be finished all over or having portions which need not bear a definite relation to other portions even though not machined. In this case it is evident that a variation of 1/16 inch, or even more, is not likely to be regarded as excessive and therefore a similar error may exist in the die, either from wear, distortion in heat-treatment or in machining.

On the other hand, consider a forging of which certain portions are not to be machined and yet must maintain definite relations to adjacent portions. In the case of forgings of this kind the variation allowed is sometimes not over plus or minus 0.005 to 0.010 inch. Of these two cases it is evident that in the first a high grade of steel is not necessary and the heat-treatment will necessarily be simple. In the second case the very best material must be used in order to secure the required degree of hardness, together with suitable toughness. In this case very great care must be used in the heat-treatment in order to bring out the best there is in the steel and combine its good qualities in the proper manner. This article will describe a method of heat-treating dies of the second class.

A suitable grade of steel is high-quality crucible steel of approximately the following analysis: carbon, 0.75 per cent; manganese, 0.25 per cent; silicon, 0.15 per cent; sulphur, 0.015 per cent; and phosphorus, 0.015 per cent. The decalescent point of this steel is between 1350 and 1360 degrees F., and in eight-inch cubes, it will harden properly at 1450 degrees F. This size die-block is common, and the heat-treatment described below has particular reference to it. A die for this purpose must evidently be machined carefully, heat-treated to wear well, and distorted as little as possible, besides being tough enough not to break. The necessary operations for heat-treating the dies are as follows: annealing; preheating; heating for hardening; quenching; preliminary hardness test; drawing; and final hardness test. These operations and the apparatus used will be taken up in detail.

The annealing is similar to that of ordinary tool steel. The blocks are placed in a furnace, slowly heated to 1400 degrees F. and then allowed to cool slowly. The cooling takes place in the furnace, which has all openings closed with fire-clay, after the proper temperature is attained. During annealing care must be taken not to allow the steel to soak long at the maximum temperature. No special care need be taken to prevent scaling, because machining takes place afterward, removing all the decarbonized surface.

Preliminary to heating for hardening, the dies are preheated in front of the open door of the hardening furnace until they reach a temperature of 800 to 900 degrees F., which should be in two to four hours if the furnace is at approximately 1000 degrees F. A good practice is to start this operation in the evening and allow the dies to warm all night. In case the furnace must be used for other work during the preheating, the dies may be placed on the shelf in front of the door, but when the die is finally placed inside, the furnace must be brought to a very low heat. The purpose of preheating is to avoid raising the temperature of the die rapidly from the lower temperature, since such procedure is almost certain to result in cracking. The above methods are recommended because they are more certain to be slow than placing the die in a newly fired furnace.

After preheating, the dies are placed in the furnace and heated for seven to seven and a half hours, the temperature being gradually increased to 1450 degrees F. When this temperature has been reached the heat is maintained for thirty to forty-five minutes. After this, the die is removed from the furnace and immediately quenched. During the heating an accurate check should be kept not only on the actual temperature but on the rate of increase as well. This can be done by means of recording and indicating pyrometers connected to the same couple and placed close to the die. The pyrometer may be of the base-metal, low-resistance, or rare-metal, high-resistance type. Suitable openings should be provided in the furnace so that the temperature may be taken at various points if desired. To insure uniform heating the die should be frequently turned, thus averaging any slight temperature differences.

Since the die is now completely finished as far as machining is concerned, it is necessary to prevent scaling as far as possible. This is entirely a matter of regulating the air entering the furnace for combustion; the small quantity that enters around the door, burners, etc., is negligible. Proper air regulation can be obtained only by close attention to the burners and the interior of the furnace. There is certain to be some free oxygen in the furnace even with the most careful attention, and to take care of this several lumps of coke should be used which will combine with the oxygen and prevent scaling of the die. By observing these two precautions, the dies may be heat-treated without causing more than a discoloration, which is easily removed with abrasive cloth.

The quenching consists of sinking the die about three inches, face downward, in water and playing a spray on the forms. This method leaves the back of the die tough and the greatest hardness at the form and on the face, where it is most necessary. Cooling in this manner, however, creates a tendency to warp the die face, and to prevent this, a small quantity of water should be poured on the center of the back to induce more even cooling. This will prevent a distortion of more than 0.005 to 0.010 inch in the alignment of the face. Any distortion of the back can be easily corrected by grinding. The cooling tank should be sufficiently large to make certain that the water does not become too warm for rapid cooling and should have two bars suspended at the proper distance below the water surface to carry the die while it is cooling. The spray consists of a perforated pipe suspended just beneath the bars and connected to a water supply at considerable pressure. After the die has become sufficiently cool to handle, a scleroscopic test is made at several points close to the forms. The die must show not less than 98, since this represents the condition of full hardness. A file should also be used, as both tests are needed to determine whether the steel has been over- or under-heated. Such matters as over- or under-heating and decarbonization of the surface are easily detected by these tests.

After proper hardening it is necessary to draw or temper in order to give sufficient strength, though it will be at the sacrifice of hardness. The drawing should be done without delay after the die has been quenched. This operation can be readily performed by placing the die with the back to an open furnace door, or in melted lead, and allowing the heat to penetrate gradually until the face is of the proper hardness and toughness. For first-class work this operation requires four to five hours. The extent to which the die must be drawn is originally determined by experiment, and gaged by the scleroscope so that the operation may be repeated at any time. The temper colors or oxides can be used instead of the scleroscope, but this method requires a great deal of skill and experience. The temper colors, however, are useful for indicating the progress of the drawing and to indicate when to make scleroscopic tests. The proper hardness will be about 80 to 82. To make certain that the die will not be harder or softer than this when it is cold, it is necessary to make an allowance for the heated condition. This allowance must be determined by experiment, which has shown in this case that, with the steel fully hardened, to secure a final hardness of 80 to 85 the die must be 76 to 78 hard when still warm. When the die has attained this hardness it is quenched to prevent further drawing.

One of the most difficult determinations is the time required to heat a given size die-block properly. This can be determined only by experience, since no two furnaces heat alike and different grades and types of steel vary as to the rapidity with which they can be heated. About the only guide is the appearance of the steel, which gradually comes to assume a

* Address: 915 Summers St., Dayton, Ohio.

uniform color throughout, thus indicating that it is thoroughly heated. When a satisfactory condition has once been found it can easily be repeated by heating for the same length of time and in the manner indicated by the recording pyrometer record. Care should be exercised to avoid keeping the die at the hardening heat unnecessarily long. The pyrometers should be frequently checked in order to detect any errors and thus prevent spoiling the work. A pyrometer used continuously at 1450 to 1500 degrees F. should be checked at least twice a week and the couples should be examined even oftener, since they are particularly prone to deterioration. The instruments should be closely watched in order to detect any sticking of the movement. The best way to calibrate is by a master pyrometer which can be occasionally checked at a standardizing laboratory. Another and quicker way is to check the decalescent point of a piece of steel which has been standardized for this purpose. To make this test it is necessary to place the couple of the pyrometer to be tested in intimate contact with the test piece, apply an increasing heat, and observe where the halt occurs. If the heating is not too rapid and ordinary tool steel is used, this point can be readily observed. This, of course, calibrates but one point, but if this point is chosen near the temperature at which the pyrometer is to be used, it will be sufficient to detect any ordinary error. The scleroscope, too, must be calibrated occasionally with the standard test piece, since dust in the tube or rusting of the hammer will cause it to read low and thus upset all the tests.

The method and data of heat-treating drop-forging dies as outlined above was developed by the writer and several others, and has been successfully used for treating a great many dies for difficult forging work.

* * *

DUTY ON DENTAL TWEEZERS

BY JULES CHOPAK, JR.*

The Secretary of the Treasury at Washington, D. C., in a letter of December 23 to the Collector of Customs, has directed that, in future, duty to be taken on certain dental tweezers will be 20 per cent instead of 30 per cent. The tweezers in question are riveted together at one end and do not have two lever handles working on a pivot.

The Philadelphia customs collector was of the opinion that the proper duty to be collected was 30 per cent under Paragraph 166 of the present tariff as "nippers and pliers of all kinds," as his interpretation of certain decisions of the board of general appraisers. The New York collector was not of that opinion, necessitating the rendering of the above decision by the Secretary of the Treasury.

It seems that in the board decisions, nippers and pliers were defined as "two lever handles working on a pivot." The Treasury Department had previously decided that "nippers and pliers covered articles having two lever handles working on a pivot which operate two cutting, gripping or pinching jaws or blades." In another case, the board decided that forceps, clamps, tweezers, needle holders, etc., were dutiable at the higher rate as pliers. Whether or not the tweezers in that case were like these is not apparent.

The sole question is if such tweezers as are subject to this decision are "nippers" and "pliers" within the common or trade understanding of these terms. If they are and satisfactory evidence is produced to the secretary, he will probably change his decision again, and direct that the higher duty be taken.

The common understanding of what constitutes nippers and pliers is the definition that appears in dictionaries and textbooks. The trade understanding is what wholesale dealers in the United States called this merchandise in their wholesale transactions before October, 1913, *i. e.*, if there was a class of goods known as "nippers" or "pliers," and if these tweezers came within that class. In the event that these articles are not nippers or pliers, then the 20 per cent duty should stand under the only other classification in the tariff for "articles or wares, composed wholly or in chief value of metal, not plated with gold or silver, whether partly or wholly manufactured."

* Customs Lawyer, 20 Broadway, New York City.

THE RELATION OF DUCTILITY TO ELONGATION

BY HUGO FRIEDMANN*

The percentage of elongation determined in making a tensile test is generally supposed to give a fair idea of the ductility of the material, and in many cases this relation of elongation to ductility is very marked. For instance, soft annealed copper, which is noted for its high ductility, has an elongation of 40 to 45 per cent in 8 inches. Cast iron, on the other hand, is the best example of the opposite condition; this metal is entirely lacking in ductility and breaks in the tensile test without even being stretched. Another proof of the supposed relation between elongation and ductility may be seen in the change of properties produced by cold working. Even such metals as copper and aluminum lose a great deal of their ductility by such treatment, and at the same time the amount of elongation is correspondingly reduced. Thus the elongation of thin hard-rolled copper may become as low as 4 per cent. The ductility of brass is so rapidly decreased by mechanical treatment that it has to be annealed after almost every process. This change of properties is likewise accompanied by a corresponding lowering of the elongation, as for example, from 35 to 15 per cent in one commonly used brass mixture.

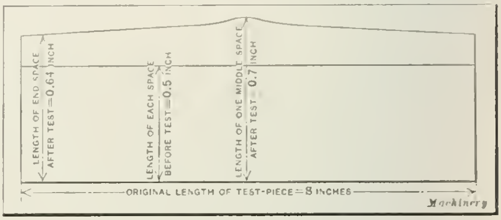

Fig. 1. Result of Test conducted to determine Local Distribution of Elongation in a Test Piece of Hot-rolled Brass

The same figures, however, furnish evidence that there is at least no strict proportional relationship between ductility and elongation, for the drawing of copper may be repeated without any limit, even after the lowest value of elongation has been reached; whereas it becomes practically impossible to handle the brass previously referred to when the elongation is several times higher than that of the hard copper. This is only one example, taken from common practice, that should caution one against the use of elongation figures in judging the ductility of any metal. By testing various materials which generally receive less attention, plenty of additional evidence may be discovered to verify the truth of this objection. Thus a special kind of brass has been investigated, which shows extremely striking properties. The sample was sheet brass about 1/8 inch in thickness, hot-rolled from a mixture containing 57 per cent of copper. It was made of a rather poor raw material containing a large amount of scrap. The ultimate strength was 66,000 pounds per square inch and the elongation 24 per cent, which, although not very high, certainly could not be called low. It

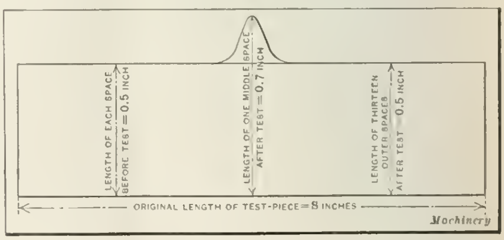

Fig. 2. Result of Test to determine Local Distribution of Elongation in a Test Piece of Cold-rolled Copper

* Address: 5481 Kenwood Ave., Chicago, Ill.

seems to indicate, therefore, a moderately tough material. As a matter of fact, however, the sheet was as brittle as glass, and if the slightest marks were traced with a chisel, a light blow would cause the fracture to follow these lines. For the same reason the test-bars had to be handled with the utmost care. The gage length had to be marked with pencil only, for if scratched with a steel pin the bar broke at these very scratches under a low load. This peculiar material proves most forcibly that a fair value of elongation may co-exist with the lowest degree of ductility and malleability.

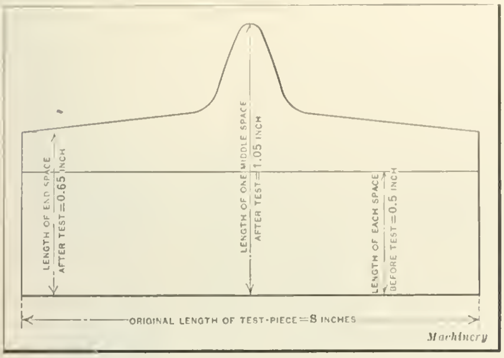

Fig. 3. Same Test conducted on Sample shown in Fig. 2, after annealing Metal

Test pieces of the same material, however, show another peculiarity that appears to be in closer relation to the true properties of the metal than the commonly used value of elongation which is determined as the average for the whole length of the test piece. This peculiarity is found in the local distribution of the lengthening. In order to investigate this condition, the length of an 8-inch test piece was divided into sixteen equal spaces of ½ inch before applying the load; and after the test had been completed, the new distances between the marks were measured, the results being shown in Fig. 1. In order to appreciate the peculiar character of this curve it must be compared with those developed from the tests of other metals. Fig. 2 shows the lengthening of a test piece taken from a cold-rolled copper sheet with only 3.8 per cent elongation; and Fig. 3 shows the results of a test of the same material after annealing. The difference between the latter curves and the curve shown in Fig. 1 is very striking. The brass sheet shows a nearly uniform elongation for the entire length, whereas both copper samples are characterized by a very distinct maximum at the breaking point. Corresponding to these diagrams, the broken copper

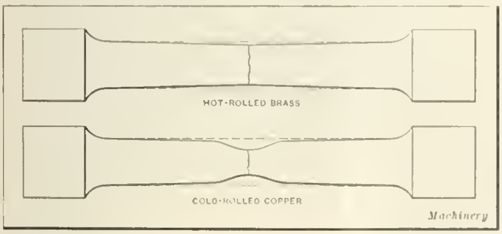

Fig. 4. Outline of Broken Brass and Copper Test-bars, showing Reduction of Cross-sectional Area at Breaking Point

bars showed the usual outlines, as shown in Fig. 4; the brass bars, on the other hand, had nearly parallel edges as before the test. In other words, their distance was reduced uniformly throughout the whole length.

As the high value of local elongation obviously corresponds to the reduction of area at the point of fracture, it might be assumed that the percentage of reduction is the natural measure of ductility; and in many cases, a close relation has been proved to exist between these properties. In one instance, four different mixtures of brass were studied. Their tensile strength was raised to 73,000 pounds per square inch by different degrees of cold treatment, and the reduction in area of these samples was found to be 32, 40, 56, and 62 per cent, respectively. These values are in direct proportion to the percentage of copper and the actual ductility of the mixtures. In other cases, however, no similar relation exists, and the reduction of area may be just as misleading an indication of ductility as the elongation. The brittle brass referred to in connection with Fig. 1 and the cold-rolled copper in Fig. 3 have the same local reduction of area, i. e., 25 per cent, despite the great difference in their properties. In addition to the occasional difference, the use of the reduction figures does not prove practical for commercial tests, as it is often hard to obtain reliable measurements of the broken section; moreover, the reduction depends upon the shape of the section, the cross-strain being less uniform in a flat bar than in a round one.

For these reasons the reduction figures are not fit to use as a general index of the ductility of the metal. Therefore it seems advisable to resort to the diagram of local lengthening. This is certainly less handy than one figure, but it furnishes a true and reliable proof for our purpose, i. e., the more marked its elevation near the point of fracture, the more ductile is the metal. On the other hand, the straighter and more uniform the line, the more brittle is the material. The average elongation, measured by the mean ordinate of the diagram, is only of secondary importance to the general character of the curve. The ductility may also be judged approximately from the outline of the broken test-bar. It must be remembered, however, that this outline is of a less distinct character than the elongation diagram, for the former is proportional to the square root while the latter is proportional to the full value of the area.

* * *

During the past few years, at large exhibitions of machinery, motor cars and other manufactured products the rule has been to enforce uniformity of decoration, signs and other features of the booths of exhibitors. It was made in the interest of harmony and has worked well. No longer do we see booths gaudily decorated in glaring color schemes and exhibiting signs of great size or hideous designs. Everything is uniform and harmonious, and no one exhibitor can secure an advantage over another except in position and space that he pays for.

The rule of uniformity might be extended to include all literature distributed at such shows. The same argument that applies so forcibly to the arrangement and decoration of booths can be applied with equal force to the advertising literature. Advertising literature, uniform in size and style, distributed at a show would be more effective as a whole than the varied and motley mass of stuff now given away. One who visits a motor car show and collects the catalogues, circulars, leaflets, booklets, etc., distributed for the purpose of examining them at leisure has an unwieldy mass on his hands that cannot be conveniently arranged or filed. If every piece of advertising literature distributed was, say, 6 by 9 inches or 9 by 12 inches, the collecting and filing of all the advertising literature would be made much easier and more effective than it now is. Managers of advertising shows might specify the size, shape, color and quality of paper to be used for describing the products shown. To insure uniformity, they might go still further and insist that each exhibitor furnish cuts and copy for the literature it wishes to be distributed at the show, and have all printed in uniform style under the direction of the show management.

* * *

The electrolytic process of cleaning metals is comparatively new, but has recently been introduced by many large manufacturing concerns. The process is cheap and good results are obtained. Baths composed of alkaline substances such as sodium carbonate or potassium carbonate with small portions of potassium cyanide are used. With a current of from four to eight volts, these develop sufficient hydrogen to remove organic substances from the metals, leaving them chemically clean.

ROLLED THREADS FOR SCREW SHELLS

The American Society of Mechanical Engineers appointed May 1, 1914, a committee to take up the subject of standardization of special threads. During June, 1912, some of the manufacturers of electric wiring supplies and lamps held a meeting in the attempt to standardize these threads, and arrived at a practical compromise on those then in use. Later, however, it was thought advisable to modify certain features of the standard agreed upon in 1912, and another meeting of manufacturers was held March 18, 1914. At this meeting the American Society of Mechanical Engineers was asked to take up the subject, and make recommendations. This resulted in the appointment of the committee mentioned. The committee has held two meetings for the consideration of this subject, and has conducted numerous conferences with manufacturers and corresponded in detail with a number of the largest manufacturers. Only minor changes on the generally recognized standard have been made. Twenty-seven manufacturers have approved the recommendation.

The standards recommended are given in the accompanying illustrations and tables. There are four sizes for both male and female shells. The male shells are used on lamp bases, fuse plugs, attachment plugs, etc., and the female shells for electric sockets, receptacles and similar devices. The male shells are usually known as lamp-base screw shells, and the female as socket screw shells.

It is recommended that for each size of lamp-base screw shells there should be two threaded ring gages to govern the diameter of the bottom of the threads, and the form of the thread; also two plain ring gages to govern the diameter of the top of the thread on the outside. For each size of socket screw shells, there should be two threaded plug gages to govern the diameter of the top of the thread inside, and the form of the thread; also there should be two plain plug gages to govern the diameter of the bottom of the thread inside. These gages should be marked "go" and "not go," respectively.

The committee recommends that these thread standards be known as the "American" standard.

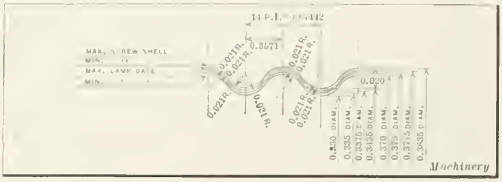

Fig. 1. Miniature Size Lamp-base and Socket Thread

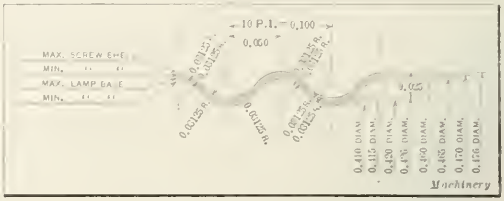

Fig. 2. Candelabra Size Lamp-base and Socket Thread

TABLE I. LAMP BASE AND SOCKET SHELL THREADS—MINIATURE SIZE

	Socket Screw Shell	Lamp Base Screw Shell
"Go" gage, top of thread	0.3775 in.	0.3750 in.
"Not Go" gage, top of thread	0.3835 in.	0.3700 in.
"Go" gage, bottom of thread	0.3375 in.	0.3350 in.
"Not Go" gage, bottom of thread	0.3435 in.	0.3300 in.
Threads per inch	14	14
Depth of thread	0.020 in.	0.020 in.

Machinery

Fig. 1 shows form of thread and repeats the above dimensions.

TABLE II. LAMP BASE AND SOCKET SHELL THREADS—CANDELABRA SIZE

	Socket Screw Shell	Lamp Base Screw Shell
"Go" gage, top of thread	0.470 in.	0.465 in.
"Not Go" gage, top of thread	0.476 in.	0.460 in.
"Go" gage, bottom of thread	0.420 in.	0.415 in.
"Not Go" gage, bottom of thread	0.426 in.	0.410 in.
Threads per inch	10	10
Depth of thread	0.025 in.	0.025 in.

Machinery

Fig. 2 shows form of thread and repeats the above dimensions.

TABLE III. LAMP BASE AND SOCKET SHELL THREADS—MEDIUM SIZE

	Socket Screw Shell	Lamp Base Screw Shell
"Go" gage, top of thread	1.045 in.	1.037 in.
"Not Go" gage, top of thread	1.053 in.	1.031 in.
"Go" gage, bottom of thread	0.979 in.	0.971 in.
"Not Go" gage, bottom of thread	0.987 in.	0.965 in.
Threads per inch	7	7
Depth of thread	0.033 in.	0.033 in.

Machinery

Fig. 3 shows form of thread and repeats the above dimensions.

TABLE IV. LAMP BASE AND SOCKET SHELL THREADS—MOGUL SIZE

	Socket Screw Shell	Lamp Base Screw Shell
"Go" gage, top of thread	1.565 in.	1.555 in.
"Not Go" gage, top of thread	1.577 in.	1.545 in.
"Go" gage, bottom of thread	1.465 in.	1.455 in.
"Not Go" gage, bottom of thread	1.477 in.	1.445 in.
Threads per inch	4	4
Depth of thread	0.050 in.	0.050 in.

Machinery

Fig. 4 shows form of thread and repeats the above dimensions.

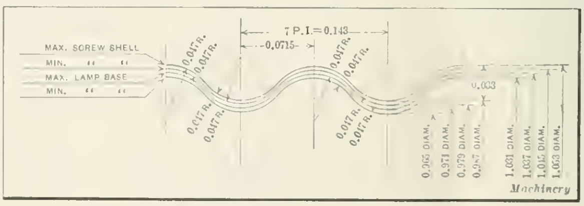

Fig. 3. Medium Size Lamp-base and Socket Thread

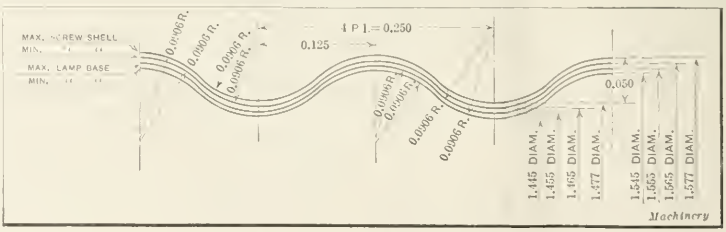

Fig. 4. Mogul Size Lamp-base and Socket Thread

LETTERS ON PRACTICAL SUBJECTS

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A PINCH PRESS TOOL

The work done by a "pinch" tool is really drawing and cutting, and it is accomplished in one stroke of the press. The scope of this type of tool is, of course, limited, but for work of the kind illustrated in Fig. 1 it has distinct advantages. The samples of work shown are parts of jewelry.

An assembly view of the die used is shown at *A*, Fig. 2. This consists of a die-plate and stripper attached by screws and dowels, much the same as in an ordinary blanking die. In drilling the plate for the dowels, it is advisable to drill the holes only part way through the plate from the back, as shown. This is to prevent the dowels from dropping out when the tool is in action. The punch is made to fit the die snugly, but not too tight, as illustrated at *C* in Fig. 4. The outside of the plate is made identical in shape with the inside of the cup that is to be made The travel of the punch into the die is illustrated graphically at *C*. The drawing plate *a* should, of course, be hardened and polished to a mirror finish. This is to insure that the cup will drop off the punch instead of being carried back into the strip. In the case of odd shapes, however, there is sometimes trouble. This can be overcome by the provision of a knock-out, similar to that illustrated at *B* The principle of this device is apparent.

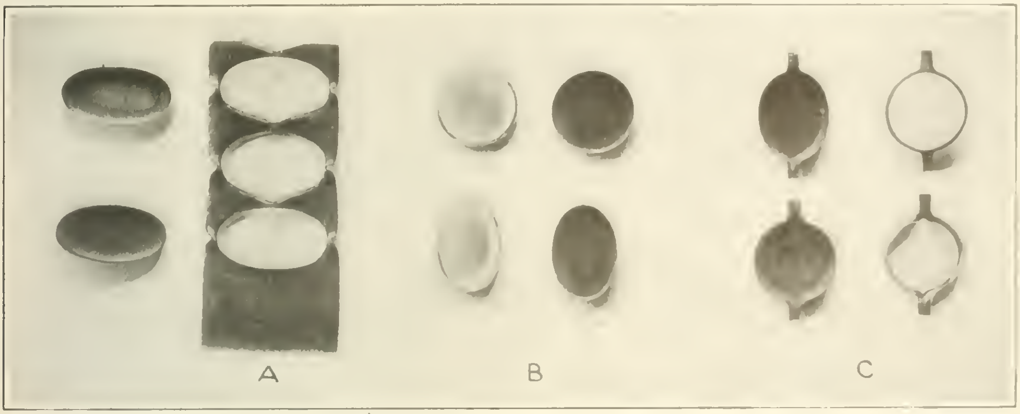


Fig. 1. Samples of Work showing Strips from which Cups are made

The die-plate is shown in detail at *B*, Fig. 2. The hole in the die is made in the customary way by filing or broaching. This hole is relieved in the back to avoid excessive friction and heating. The dimension x is made a little greater than the depth of the cup to be drawn. The mouth of the hole, instead of being left with a sharp corner as in the case of an ordinary blanking die, is curved to a short radius r. This round edge allows the blank to form into a shallow cup instead of shearing when the punch strikes it. The radius of curvature of the edge is dependent largely upon the depth of cup. For a shallow cup a short radius will do, while for a deeper cup the radius must be longer.

The punch used with this class of die is shown at *A*, Fig. 4. This is the same as an ordinary blanking punch except for the drawing plate *a*, which is screwed and doweled in front of the cutting edge. The front edge of the plate has a short radius. The thickness of this plate is approximately equal to the inside depth of the cup. This plate is shown located by two dowels and attached with one flat-head screw in the center. After drilling and tapping the hole for this screw in the punch proper, it is good practice to countersink the mouth. This provision is made so that when the punch is sharpened by grinding the face, and the plate is returned to its place, the head of the screw will not bottom on the punch proper.

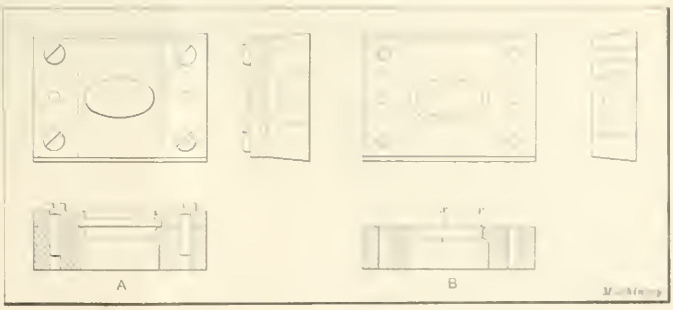


Fig. 2. Assembly and Details of Die

In some cases, where the punch is being made for a very narrow cup, it is impossible to attach a separate drawing plate with screws and dowels. It is then customary to form this shape from the punch.

The maximum depth of cup that it is possible to obtain in this type of tool is dependent somewhat upon the material used, whether silver, gold, brass or gold plate. The depth is also affected by the radius at the mouth of the die, as previously explained, as well as the thickness of the drawing plate. The greatest depth of the samples shown is approximately 1/8 inch. The cups shown at *A*, Fig. 1, have a difference in depth of about 0.020 inch. These were both made in the same die, the difference being obtained by using a thicker drawing plate.

The action of the tool in operation is as follows: As the punch descends upon the stock the drawing plate immediately begins to cup the metal. The cupping is continued until the cutting edge of the punch has traveled a little below the surface of the die. At this point the cup is pinched from the strip, rather than sheared from it as is the case in an ordinary

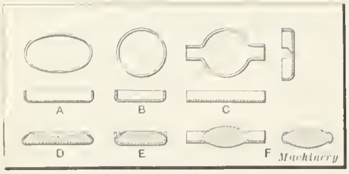


Fig. 5. Samples of Work shown in Section

blanking die. The strips of metal are well oiled before being fed to the tool. It is customary to use this tool in a common blanking press, using a roll feed. The action as compared with a double-action press tool is exactly the reverse. In the double-action press tool the blanking takes place first and is followed directly by the drawing. In this tool, the drawing or cupping takes place first, and the blanking or pinching last.

Various shapes of cups that have been successfully made with this punch and die are illustrated in Figs. 1 and 3. At *A*, *B*, and *C*, Fig. 3, are illustrated in detail the shapes of these various cups. The same cups are illustrated at *D*, *E*, and *F*, Fig. 3, with jewels or stones in them. The cup *C*, Figs. 1 and 3, is of special interest because of its complicated shape. This is cupped in the ordinary way, after which the bottom is pierced out, leaving virtually a ring of metal with two lugs attached. The stone is then dropped in and the top part of the ring rolled over, holding it securely.

The pinch type of press tool is quite satisfactory in certain classes of jewelry work, and it is probable that there may be other lines of work for which it would be equally adaptable.

T. E. W.

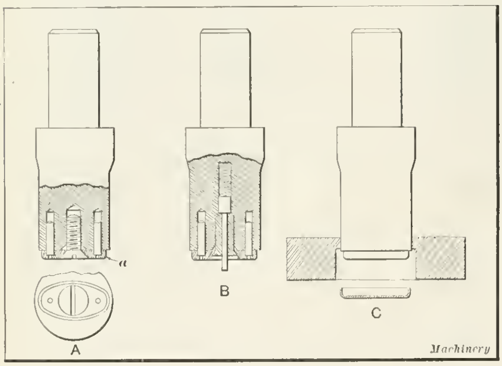


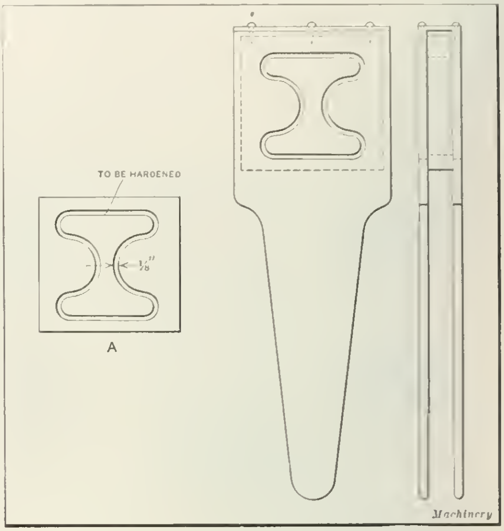
Fig. 4. Punch used with Die shown in Fig. 2

METHOD OF LOCAL HARDENING

We had a set of dies to harden, in which it was required to quench the metal around the cutting edges and leave it soft enough at other points to retain the maximum toughness. After trying various methods with little success, I hit upon a scheme which gave very satisfactory results. The illustration shows the die *A* to be hardened, in which it was required to have the metal quenched around the edges of the opening for a depth of about 1/8 inch, while the rest of the steel in the die was to be left as soft as possible.

After the dies were finished and ready to be hardened, I took two pieces of soft wood a little wider and larger than the dies. These pieces of wood were carved out to provide a handle at the end, after which a recess was cut in each piece to hold the die in position. The next step was to cut an opening in each piece of wood to correspond to the hole in the dies, but these openings were made 1/8 inch larger all around than the size of the hole in the dies; this opening represents the outline which is to mark the boundary of the hardened steel in the dies. The two pieces of wood were then fastened together at the end with a piece of leather.

The dies were placed in the furnaces and brought to the required quenching temperature. One of the dies was then drawn from the furnace and placed in the socket in one of the wooden handles, after which the other handle was dropped on top of it so that the die was held between the two pieces of wood. This was done as quickly as possible in order to avoid burning the wood, and with the die-block in place the handles and die were plunged into the quenching bath. The result was that the water flowed through the hole in the die and quenched the steel around the hole; but the wooden handles protected the remainder of the die from the action of the quenching bath, and as a result, this part of the metal remained fairly soft.



Die to be hardened around Opening, and Die in Place in Local Hardening Device

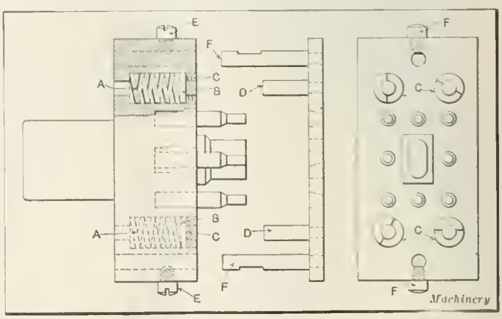
This method of hardening will be found useful in the heat-treatment of numerous parts in which local hardening is desirable.

Hyde Park, Mass. PAUL CYR

DETACHABLE SPRING STRIPPER

The accompanying illustration shows a detachable spring stripper applied to a perforating punch. The advantage of this stripper is that it may be removed from the punch in setting up the tools on the press, which will give greater space for doing this work; and after the tools have been set up, the stripper is put in place ready for use. Anyone who has had experience in setting up spring stripper punches and dies will readily appreciate the advantage obtained by this construction.

In the accompanying illustration, the punch-holder has four holes—one of which is shown in the cross-sectional view—in which are located springs *A* of sufficient strength to strip the work from the punches. In each of the holes a flat plate



Detachable Spring Stripper which is put in Place after Dies are set up on Press

B is held down on the spring by means of a hollow set-screw *C*, and in operation a pin *D* on the stripper-plate presses against each of the plates *C*. Screws *E* enter notches in pins *F* to retain the stripper-plate in place. The pins *D* on the stripper-plate should be just long enough so that the stripper will project 1/64 inch beyond the end of the punches. Any number of springs can be used to give the required power for stripping the work from the punches, but it will always be found advisable to use at least three springs, regardless of the amount of power that is required.

Rochester, N. Y. CARL M. WEBER

ALUMINUM ALLOY FOR PATTERNS AND CORE BOXES

I have made some experiments to find a suitable aluminum alloy of reasonable cost for use in making patterns and core boxes. We wanted an alloy that would be both strong and light. Thinking that the result of my experiment would be of benefit to other master mechanics, foundry foremen, pattern-makers, etc., the following alloy, which at normal metal prices costs about twenty cents a pound, has a tensile strength of 30,000 pounds per square inch: Aluminum, 65 parts; zinc, 25 parts; ferro zinc, 10 parts. This metal finishes beautifully and is easily mixed in the crucible.

Augusta, Ga. EUGENE BART, M. M., Augusta Arsenal.

[Ferro zinc is a commercial product sold by the American Alloys Co., Baltimore, Md. EDITOR.]

PEROXIDE IN BLUEPRINT MAKING

If ten drops of peroxide are added to one gallon of water, a solution will be made that will aid in producing even blueprints. Wash the blueprint as usual in clear running water, then place it in the peroxide solution, after which wash again in water. If a blueprint has been correctly exposed or under-exposed, the solution will have no effect. If, however, the print has been over-exposed, the solution will restore it to the true color.

Another important feature of this solution is that it will restore old blueprints if they have become faded. As an experiment, take a print that has been exposed ten or fifteen times the proper amount, place in this solution and it will be restored permanently to a fair blue color.

Cleveland, Ohio. H. L. JUDD

WASHED GASOLINE FOR CLEANING TRACINGS

Undesirable effects are often produced when a large number of tracings are cleaned with gasoline. Among the effects noticeable are streaks and the outlines of spots after the tracings have been gone over with gasoline in the attempt to remove grease and dirt. The reason for this is found in impure gasoline. Seldom, if ever, can gasoline be obtained that is free from dirt and a certain amount of crude grease.

To overcome this and to produce gasoline absolutely clean for use in cleaning tracings, it should first be washed. This can be done by mixing warm water with all the soap that can be absorbed; then when soapy enough, pour the gasoline into the bath. Place the cover on the receptacle and shake or stir thoroughly. After standing, the cleaned gasoline can be drawn off, as it separates from the dirty water. In this form, it can be used for cleaning tracings without the effects noticeable with impure gasoline.

Somerville, Mass. FRANK H. JONES

DELAY IN OPENING FOREIGN MAIL

Perhaps it has never occurred to the average person that if a large quantity of first-class mail matter, destined abroad and addressed to one person, was distributed among several small envelopes, instead of being put in one large one, not only would delays in delivery abroad be reduced, but the attendant inconvenience and annoyance of having the mail opened at the post office by the custom officers would be almost eliminated.

By way of example: most machinery manufacturers, when a request is made by a foreign prospect for prices, catalogues, blueprints, contracts, etc., invariably insert all this matter into one large envelope. This makes a large and bulky package which looks as though it contains dutiable matter, and warrants the postal authorities in holding it up for the action of the customs people. Then the customs officials make examination of the contents of the package to determine whether or not duty is to be assessed on same. Before the matter is finally disposed of by the customs officers, there is always a delay of several days.

This delay and opening of the mail before it reaches its destination could be entirely avoided if the matter were placed in several envelopes, as, usually, no inspection is made for customs purposes of the contents of small envelopes. It might be suggested that the weight of each envelope be not greater than three or four ounces. While the use of several small envelopes, instead of one large one, will slightly increase the cost of postage, the advantage of obtaining quicker delivery and the avoidance of opening by the custom officials more than outweigh this small additional expense.

New York City. WILLIAM H. MEYER

BRUSHING CHIPS OUT OF COLD SAWS

In the January number of MACHINERY, we note what Mr. Atkins has to say in reference to removing chips from cold saws. We have used this plan for removing chips from cold saws, and the machine exhibited by us at the last convention of the American Railway Master Mechanics and Master Car Builders Associations at Atlantic City, N. J., was so equipped.

We write of this because no mention was made of our machine, and because the subject is brought up as a new idea. On the contrary it is not new, inasmuch as we have used wire brushes for this work for some time. W. S. HOWE,

Hinsdale, N. H. Treasurer and General Manager, Nutter & Barnes Co.

JIG AND FIXTURE DESIGN

Jig and fixture design has often been discussed in MACHINERY, but I would like to add a few words on binding screws and clamping devices. There is practically no limit to the various applications of these which can be recommended, and an attempt to narrow down the subject by confining the discussion to square and knurled-head screws still leaves a very broad field. By making such a classification, consideration must be given to the questions of first cost and suitable size of the jig or fixture, and to the tolerance or clearance that can be allowed on the work; and this practically prohibits the establishment of any standard designs. A good tool designer should disregard all precedents when developing jigs and fixtures for handling a given class of work, but the number of men who actually work along such lines is extremely small. Such designers will use a square-headed screw for one jig and a totally different form of screw for another, they show no preference for one clamping or locating device over another, the choice in each case being based on the requirements of the work in hand.

Part of my experience in tool designing was obtained with an automobile concern whose superintendent boasted that he had $40,000 worth of jigs and fixtures in use and that in all of these tools there was not a single screw used for clamping purposes. Various forms of eccentrics and latches were employed, and limiting the tool designers to these two methods was undoubtedly the cause of a considerable waste of time and money. After leaving this concern I worked under a man who condemned the first design I submitted for his approval on which eccentric clamps were used; after looking over the drawings he gave positive orders never to employ the eccentric principle of clamping. These two cases show the powerful influence which prejudice plays in the work of tool design.

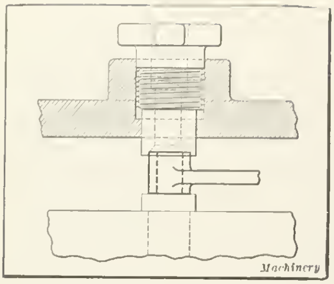


Fig. 1. Screw Bushings give Trouble from Chips clogging the Threads

and it is fair to assume that the objection which certain individuals have for various methods is due to unsatisfactory results obtained with a given method as the result of poor designing or workmanship. About the best advice that can be given to the tool designer who wishes to give satisfaction is to tell him to follow the old adage, "When in Rome do as the Romans do."

Having mentioned the prejudices of two employers for whom I have worked, I will now outline certain opinions which I have formed as the result of a somewhat extensive experience in tool designing. I only tolerate the use of screw bushings when no other means of clamping can be success-

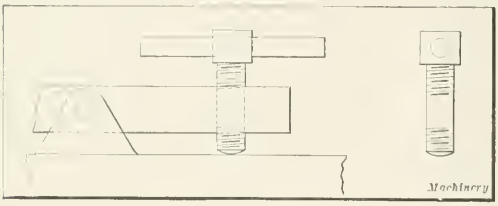
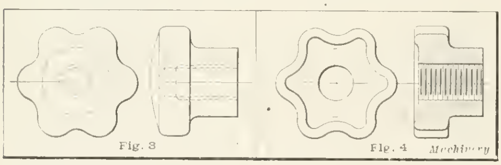


Fig. 2. Binding Screw with Pin through Head

fully employed—assuming that there is such a case. The chief objection to the use of screw bushings is that they all wear loose after being in service for a short time. Reference to Fig. 1 will make it evident that the end of an unfinished boss is not a very desirable locating point, and Mr. Staples' reference to trouble experienced from chips finding their way into threads is certainly based upon fact. Furthermore, ex-



Figs. 3 and 4. Type of Star Knob that excludes Chips and Poor Design on which Collection of Chips accumulates over Threaded Hole

perience will show that it is extremely difficult, if not impossible, to protect the threads of this bushing in such a way that trouble from chips will be entirely overcome.

Star knobs for clamping screws should be made as shown in Fig. 3, so that the threaded hole does not come through; but they are often made as shown in Fig. 4 with a cup-shaped top which collects a nice supply of chips all ready to find their way into the thread, where they are sure to give trouble. In many factories a number of knobs are carried in stock which were designed years ago, and the designer uses them as a matter of economy, but these knobs are often too small to enable a good grip to be secured on the work and so short that the operator rubs his knuckles over the top of the fixture in trying to screw down the knob. For ordinary purposes, such knobs should never be less than 1¾ or more than 2½ inches in diameter. Cast-iron knobs of the form shown in Fig. 3 are cheaper to make than knurled knobs and do not have the same tendency to make the operator's hands sore. There are certain instances, however, in which a knurled knob possesses advantages over the cast knob, a case in point being where there is danger of applying too high a clamping pressure. It is fair to assume that the operator will exert the same effort in screwing down knobs of either type, and the knurled knob does not afford quite such a good grip. Where the work is very thin, the best plan is to have the knob quite small so that it must be turned with the thumb and finger, as shown in Fig. 5.

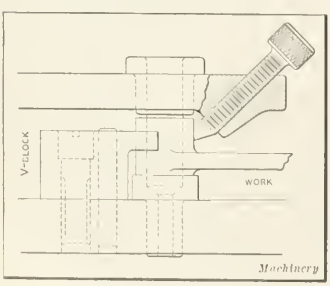


Fig. 5. Small Knurled Knob which is turned by Thumb and Finger

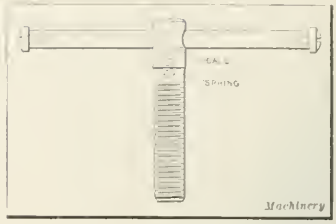


Fig. 6. Binding Screw provided with Vise Handle

There are several objections to the use of a binding screw with a pin through its head, such as the one advocated by Mr. Staples, which is illustrated in Fig. 2. The construction looks cheap, and in my opinion a jig or fixture should be made to look like the precision instrument which it really is. If only a hand pressure is employed, the use of a pin-headed screw of the form shown in Fig. 2 is likely to make a workman's hands sore; and the use of such pins constitutes a standing invitation for the operator to tighten the screw by hitting the pin with a hammer. If the head of the screw is made square, as shown in Fig. 7, there is insufficient room for the use of a wrench in making the final tightening, so that the expense of squaring up the head of the screw is unwarranted. As a substitute for the two preceding types of screws, the writer would suggest the application of a screw provided with a vise handle, as shown in Fig. 6. In this case the ball and spring allow the handle to be located in the center for rapidly turning down the screw, after which the rod is pulled out to one extreme position to provide sufficient leverage for tightening the screw.

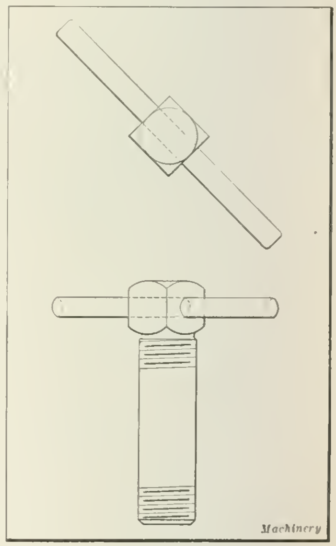
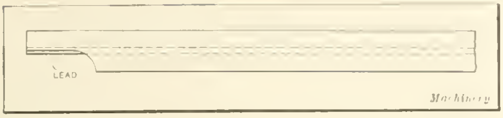


Fig. 7. Square-head Screw with Pin through Head

Dayton, Ohio. GEORGE M. MEYNCKE

TOOL-ROOM KINK

When making blanking dies, difficulty is often experienced in putting a thin even coat of Prussian blue onto the templets to which the dies must be fitted. But unless the Prussian blue is so applied it is practically impossible to get a good impression. I have found that by using an indelible



Indelible Pencil used in fitting Blanking Dies to Templets

blue pencil with the wood cut off from one side as illustrated, very satisfactory results can be obtained if the lead is slightly moistened before rubbing the pencil around the edge of the templet. By this method a better impression is made on the die than can be obtained by the Prussian blue.

Long Island City, New York. E. KERN

HAND-OPERATED WIRE BENDING FIXTURES

The progressive bending of the wires *A*, *B*, *C*, and *D* in Fig. 1 might seem to warrant the use of an expensive wire forming machine especially equipped for the purpose. The fact that the finished part, as shown at *D*, is completed in two simple bench fixtures shows the advisability of looking into

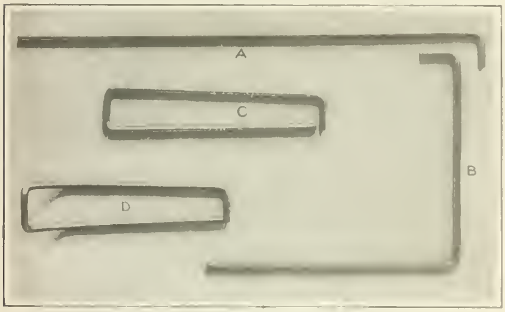


Fig. 1. Wire bent to Shape in Four Operations

the limitations of simple fixtures before tying up an expensive machine with a job of this nature.

Four operations are required to finish the piece after the wire is cut off. The first three are accomplished in the fixture shown in Fig. 2. As illustrated diagrammatically at *A*, Fig. 3, the straight wire is placed in the fixture, being located by the extension gage *a*, and the handle *b* is rotated in such a way that the wiper *c* forms the wire at right angles. The wire is then placed in the fixture in the manner illustrated at *B*. The handle *b* is again operated, and another right-angle bend is accomplished at the other end of the wire. After this, the wire is placed in the fixture as illustrated at *C*. The result is a finished article with the exception of one other operation, as clearly shown at *C*, Fig. 1.

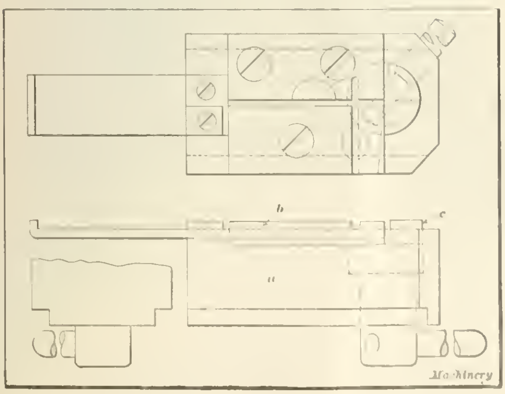


Fig. 2. Fixture for First Three Operations

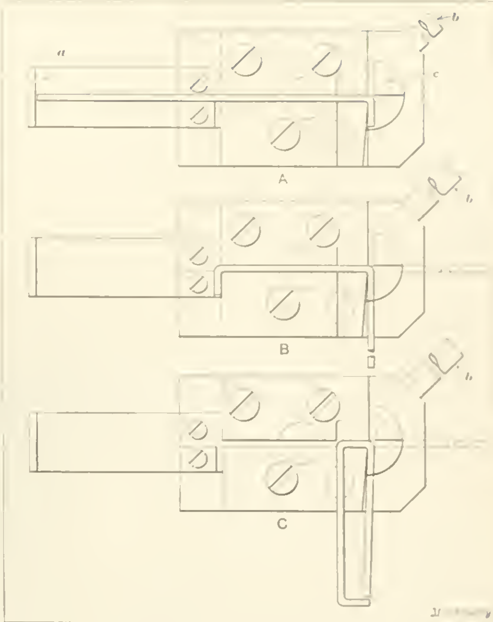


Fig. 3. Diagrammatical View of First Three Operations in One Fixture

The construction of the fixture shown in Fig. 2 is very simple. The base *a* is of cast iron. The inserted block *b* is made

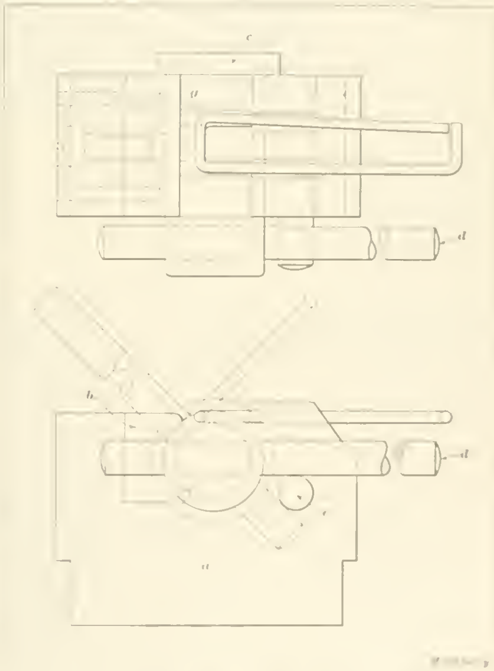


Fig. 4. Fixture for Fourth Operation

of tool steel and hardened, as is also the wiper *c*. Two L-slots are cut in the base to assist in holding the fixture in an ordinary vise.

The final operation of putting the curve on the wire, as shown at *D* in Fig. 1, is accomplished in a simple fixture

shown in Fig. 4. This fixture consists of a mild steel base *a*, a hardened tool steel anvil *b*, a hardened tool steel wiper *c*, a handle *d*, and a stop-pin *e*. The wiper *c* has two channels cut on its outer circumference for the reception of the wire. These two channels are connected by a longitudinal slot. The wall of this slot *g* acts as a hook for the wire.

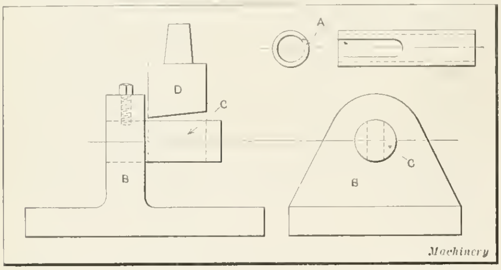
In operation, the wire is placed on the top of the fixture in such a way that the closed end lies in the slot *g*. When the handle *d* is operated in a counter-clockwise direction, the wire is carried with the wiper against the anvil *b*, causing it to conform to the contour of the wiper *c*. The travel of the handle *d* is limited in its forward direction by the stop-pin *e*, at which point the wire has received sufficient bending. Then the handle is reversed and brought back to its original position, when the correctly formed wire may be removed from the fixture.

In any wire bending fixture, it is necessary to bend the wire further than the curve requires, in order to overcome the "spring back" which exists in all wire to a greater or less degree. To obtain the amount of overthrow necessary is largely a matter of experiment. In the case of music wire for springs it is, of course, excessive.

Arlington, R. I. GEORGE P. BREITSCHMID

TUBE SLOTTING DIE

In a shop engaged in the manufacture of textile machinery there are a large number of tubes to be slotted at one end, as shown at *A* in the accompanying illustration; the tubes are 5/16 inch in thickness, and the slot is 5/8 inch wide by 2 inches long. To reduce the amount of time taken to cut these slots on the milling machine, I made a punch and die which has proved to be a great time-saver. The die-holder *B* is bored to



Die used for slotting Ends of Steel Tubes

hold die *C* which is the same diameter as the inside of the tubes to be slotted. The opening in the die is of the required size of the slot, and punch *D* is made so it will just enter the opening in the die. It will be evident that, in operation, the tube is slipped over die *C* and when the press is tripped punch *D* descends and shears the slot in the end of the work. Over 900 tubes have now been slotted with this tool and it is still in excellent working order.

Hyde Park, Mass. PAUL CYR

PRACTICE IN SCRAPING MACHINE PARTS

Referring to the "How and Why" question and answer regarding practice in surface scraping machine parts in the January number, my practice has been to apply a thin coat of Prussian blue mixed with lard oil to the surface plate, distributing it evenly so that the high spots on the work are marked by the color rubbed off the surface plate. Some toolmakers wear colored glasses to reduce the glare of the light reflected from the bright surfaces. The darker the color of the scraping compound, the better, in my opinion.

Moline, Ill. E. O. GRASSLEY

Responding to your request on page 428 for information on scraping, I herewith submit the consensus of opinion of several men who have scraped surfaces exclusively for some years. On cast iron and steel it is preferable to use the compound directly on the surface to be scraped, while on white metal and brass the reverse is true, the compound being placed on the surface plate. The best compounds to use are: for cast iron and steel, venetian red mixed with oil; for white metal and brass, lampblack mixed with oil. The use of these combinations will make the high spots easily discernible. From the information on hand, nothing definite can be said regarding which method will produce the greater wear on the surface plate, but it is the general experience that when the plate is used extensively it will require frequent truing up and should be checked with a master plate kept for that purpose.

Madison, Wis. WILLIAM J. SANSOM

DIAL PRESS KINK

I would like to add another dial press kink to the list of useful suggestions along this line which have appeared in MACHINERY from time to time. The present idea is somewhat similar to the one described in the November, 1914, number, which explained a method of removing a flat bottomed shell from a dial plate in case the shell was put in upside down, the method consisting of pushing a second shell into the dial in the correct position with its bottom covered with oil.

It often happens, however, that shells are formed with a round bottom and when one of these shells is put in the dial plate upside down, it cannot be removed by the method referred to. In such cases I have found that a piece of wood about 1/2 inch in diameter by 4 inches long, one end of which has been dipped into the pail containing belt dressing, will stick tight enough to enable the shell to be drawn out of the dial regardless of its shape. The use of this kink has been the means of saving a great amount of time in our dial press department. DIAL PRESS

* * *

THE ADVANCING PRICE OF GASOLINE

The large number of motor cars in use and the great export trade in petroleum and petroleum products that has developed since the outbreak of the war have produced a shortage of gasoline. The price has gone up from eleven or twelve cents to twenty-five cents a gallon in the past year, and the prospect is that it may reach thirty-five or forty cents a gallon before the end of 1916. Earnest efforts are being made to find a substitute for gasoline. Denatured alcohol which a few years ago gave so much promise of becoming a cheap substitute is no longer considered seriously because the demand for the vegetable products from which it is made is so great that to convert them into alcohol is prohibitive. In 1915 the gasoline consumed by automobiles was 13,000,000 barrels, and lubricating oil, 20,000,000 gallons. The cheapest sources of gas, of course, are coal, coke, lignite and peat. Inventors are working on the problem of designing a portable gas producer which will be light, efficient and capable of making producer gas for motor cars and motor trucks. The problem is not new, and some progress has been made in the direction of developing a light and portable gas producer plant. Diesel type motor car engines would also tend to relieve the situation, as a whole barrel of oil could be utilized as fuel instead of a few gallons only, which is the condition now. One reason for the high cost of gasoline not mentioned in the foregoing is the closing of the Panama Canal by the great slides. The closing of the canal has stopped the cheap transportation of oil from the California oil fields, and all that comes east now must either be transported by the transcontinental railroads or take the long course through the Straits of Magellan.

* * *

The following aluminum alloy, which was patented by W. H. McAdams, April 7, 1914, is claimed to possess great fluidity in the molten condition and to make strong castings that do not tarnish: aluminum, 70 parts by weight; zinc, 26 parts; copper, 3 parts; silver, 1 part. The castings have a silver-like surface and are sufficiently strong to be used in the great majority of cases where brass is now used. The alloy resists acids and alkalis to such an extent as to make it desirable for general use. The small quantity of silver required adds but little to the cost.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE "WARREN" AUTOMATIC HYDRAULIC LATHE

The features that distinguish this lathe from the general run of lathes is that it is hydraulically operated, and the feed is secured by advancing the spindle, rather than advancing the turret. Because of the fact that the spindle is hydraulically operated the thrust resistance which consumes so much power in all common machine tool design is largely eliminated, and the power efficiency of the machine is high.

In the design of the "Warren" automatic hydraulic lathe, which has been developed by the Lombard Governor Co. of Ashland, Mass., the experience of the company in building hydraulic governors has been utilized and applied to the operation of machine tools. A general view of the machine is shown in Fig. 1, while Fig. 2 shows a side elevation of the machine from the rear, the indexing mechanism, and the spindle in section. The indexing and spindle control mechanism as shown in Fig. 1 varies from that shown in Fig. 2, but the latter shows the present design to best advantage. From these two views, in conjunction with Fig. 3 which shows end elevations of the machine, an idea of the principles involved and the operation of the machine may be obtained. This machine is for the automatic production of turned work from the bar, or for work that must be handled by chucking. The particular machine illustrated in this article has been made without a cross-slide because the work on which it will be used can be handled without a cross-slide, but it is the intention of the Lombard Governor Co. to furnish these machines with cross-slides for general work. The machine in the illustrations has been tooled up for the manufacture of 18-pound British high-explosive shells, and the operations are illustrated in the following

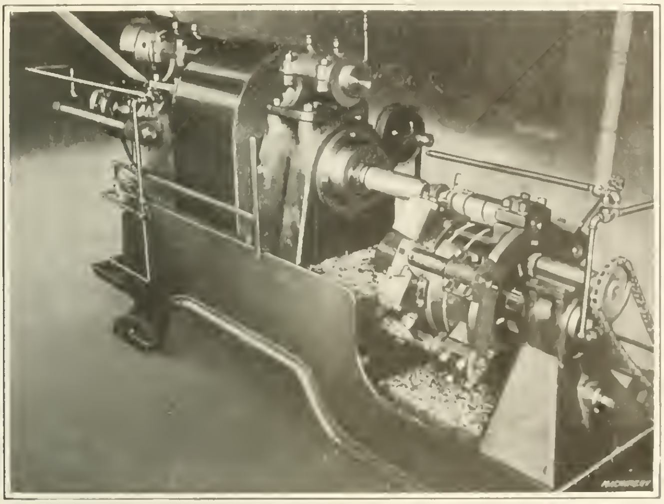


Fig. 1. "Warren" Automatic Hydraulic Lathe

Features of the Machine

Briefly, the design of the machine includes a large spindle 9 inches in diameter mounted in a massive frame. This spindle is hydraulically advanced to and withdrawn from the tools that are held in the turret at the opposite end of the machine. The turret has no longitudinal movement, and its only function is to carry the tools and index for different operations. The moving parts of the machine are very simple and few in number, and there are no slides, gibs or adjustable parts to wear or introduce lost motion. The frame itself is very

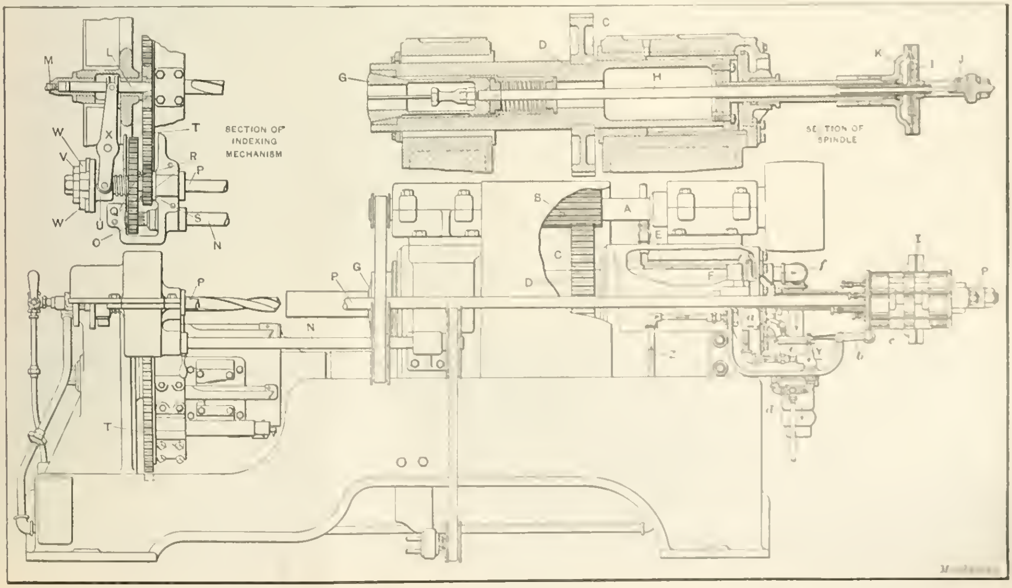


Fig 2. Side Elevation of Lathe from Rear and Sections of Spindles and Indexing Mechanism

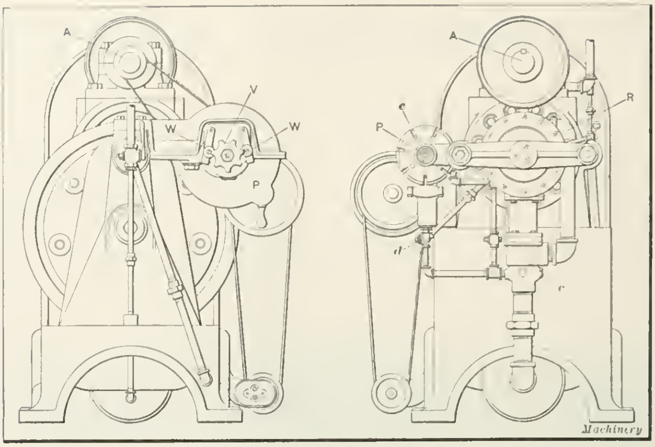


Fig. 3. End Elevations of "Warren" Automatic Hydraulic Lathe

heavy, and is cast with the spindle and turret bearings integral. Referring now to Fig. 2, the details of the construction may be observed. The drive is through a spindle pulley from the overhead countershaft to the main drive shaft *A* of the machine. This drive shaft is 3 inches in diameter, has bronze bearings 12 inches long, and 36 inches is the distance between the centers of the bearings. This drive shaft is operated by a 15-horse-power motor through the overhead countershaft and an 8-inch double-thickness belt. Integral with this drive shaft is a pinion *B*, 15 inches long, that drives the spindle through a driving gear *C* on the spindle. The ratios between this pinion and gear are $5\frac{1}{4}$ to 1. The object of the long pinion *B* is to provide means for driving under the varying positions of the spindle as it advances or withdraws.

The Spindle Mechanism

The spindle, which is shown at *D* in the sectional view at the upper part of Fig. 2, is made of cast iron and ground to size. It is made hollow to receive the chuck operating mechanism, the chuck and work. The spindle runs in cast-iron bearings at the front that are 12 inches long. The rear bearing is in two sections; one of these is $5\frac{7}{8}$ inches long, and the other is formed by the contact of the piston as it slides on the cylinder wall. The action of the spindle is practically frictionless, as it is surrounded by a light film of oil. Moreover, there is no thrust friction whatever, as the pressure is taken entirely by the oil in the cylinder.

The spindle is kept normally withdrawn by means of the pressure of the oil in the cylinder *E*. This oil is piped direct from the accumulator, and is at a pressure of 150 pounds. The advancing of the spindle is by means of oil pressure at the rear end of the spindle piston in chamber *F*. It is obvious that before the spindle can be advanced the pressure of 150 pounds must be overcome, and the method of admitting oil to the chamber at the rear of the piston for the advancement of the spindle will be taken up in detail later.

The hollow spindle is recessed at the front end to accommodate the collet chuck *G*. This has the customary tapered end, that fits in an inserted steel seat in the spindle end. The chuck is provided with a positive stop for the location of the work, and a chuck operating rod *H* extends back through the entire length of the spindle to the chuck-closing diaphragm *I*. The stock is gripped in the chuck by hydraulic pressure through opening *J* that admits oil into the diaphragm chamber *K*, thus forcing back the diaphragm. As the chuck rod connects the diaphragm with the chuck, any backward motion of the diaphragm carries the chuck back into its tapered seat and causes it to grip the stock.

Turret Mechanism

Referring now to the left-hand end of Fig. 2, the turret may be observed. The shaft upon which the turret rotates is $3\frac{1}{2}$ inches diameter and is supported at each end in bearings 5 inches long. This shaft does not rotate, but acts as a tie-rod between the outer bearing and the frame of the machine, and supports the turret proper. The turret bearings are bronze-bushed. The turret tool line is 20 inches diameter, and for the job for which the machine is set up, seven tool holes are provided. The turret has no motion save indexing, and it is held in the working positions by a locking pin *L* that seats in steel bushings inserted behind the tooling position at the various stations. From the plan view of the turret operating mechanism, shown at the upper left-hand corner of Fig. 2, the method of indexing may be seen. The locking bolt *L* is kept normally seated by oil pressure entering behind the pin at *M*. This oil pressure is at 150 pounds and before the pin can be withdrawn it is obvious that this pressure must be overcome. On the outer left-hand end of the drive shaft *A* is a small pulley that carries rotation to the indexing shaft *N* at the rear side of the machine. This may be seen in the foreground of Fig. 2. On the shaft at the extreme left-hand end is an integral pinion that carries rotation to a sleeve gear *O* rotating loosely on intermediate shaft *P*. In addition to being free to rotate on the shaft, sleeve gear *O* may be moved slightly longitudinally so that studs *Q* may be engaged with studs *R* that are on gear *S*. The function of gear *S* is to operate indexing gear *T* and hence the turret, after locking pin *L* has been withdrawn by the mechanism which will now be described.

Shaft *P* extends the full length of the machine and reciprocates with the main spindle of the machine through its connection with the bracket that holds cam-strips c. Keyed to the extreme left end of this shaft is a star plate *V* that may best be seen in Fig. 3. On the frame between plate *V* and gear *O* is a sliding collar *U*. On the outer face of this collar are two swinging arms that carry rolls *W*. When shaft *P* comes back with the return of the spindle, star plate *V* strikes the two rolls *W* on the fingers and pushes collar *U* to the right. This motion carries lever *X* and hence pulls out the locking pin *L*, leaving the turret free to rotate under the action started by gear *O*. Gear *O*, being moved to the right, locks with the indexing gear, and thus rotation is carried to gear *T* on the turret, and the turret is rotated until indexing pin *L*, under pressure of the oil entering through pipe *M*, springs into the next turret hole.

It will be seen from the end view of the mechanism in Fig. 3, that as soon as shaft *P* has turned 1/14 of a revolution, the

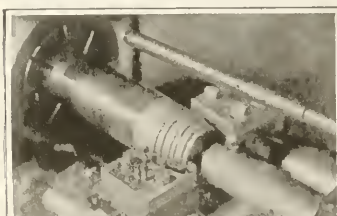


Fig. 4. First Operation—roughing Nose and centering

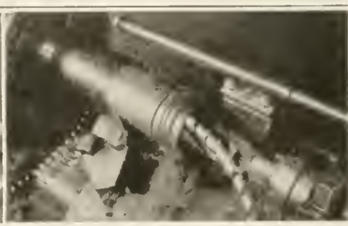


Fig. 5. Second Operation—drilling and rough-turning Outside

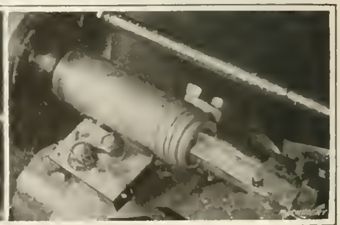


Fig. 6. Third Operation—finish-turning and reaming

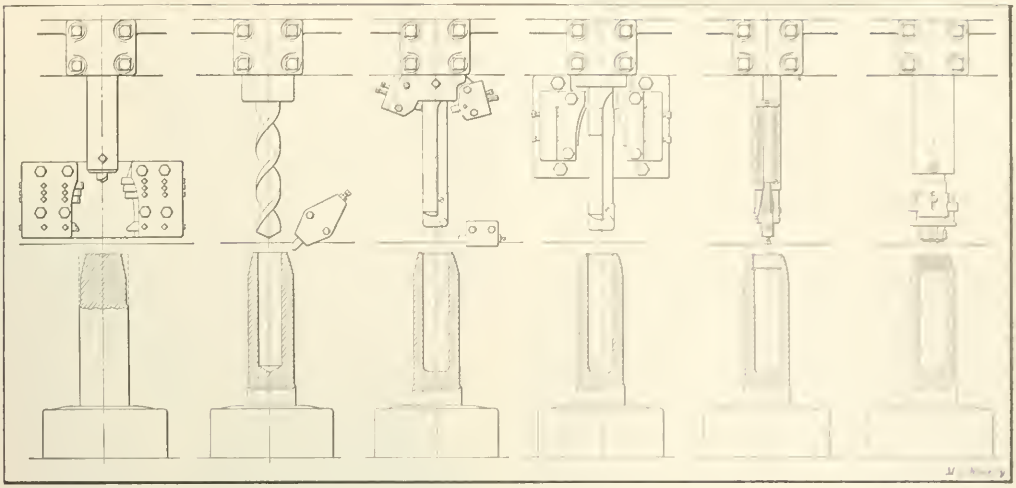


Fig. 7. Tooling Layout for Six Operations in making a High-explosive Shell

two rolls W will be in line with spaces in the edge of the star plate V. This allows bracket U to slip quickly to the left, and the locking pin is thrown in and retained by the oil pressure behind it. The relation between gears S and T is such that six-sevenths of a revolution of gear S is sufficient to rotate gear T one-seventh of a revolution—the amount necessary for indexing from station to station.

Mechanism for Controlling Travel of Spindle

With the hydraulically operated mechanism to be described, the spindle of this machine may be advanced at any rate of feed from the smallest amount possible to as high as one-quarter of an inch per revolution, or even faster if desired. It has been stated before that the constant pressure of the oil supply in chamber E exerts a pressure of 150 pounds to the square inch, which amounts to approximately 1000 pounds total pressure. This constant pressure on the spindle in a backward direction insures that there will be no advancing of the spindle through leakage or other unintentional means, as this pressure must be first overcome before any forward spindle motion can take place. To obtain the different rates of travel for the advance of the spindle, the oil is admitted to chamber F either slowly or rapidly as desired, by means of a spindle control needle valve shown at Y, the oil supply pipe being shown at Z. The course of the oil may be followed through the primary stop valve a, thence down around and through the spindle control needle valve Y which governs the rate of flow of the oil. This needle valve may be opened to any desired orifice by lever b that terminates in a roll that is acted upon by cam strips c. There are seven of these strips, one for each turret operation to be performed. These cam strips are located in a cage, and may be inclined to give a constantly increasing or diminishing rate of flow of oil through the needle valve, or they may be irregularly shaped so as to open or close the needle valve quickly any desired amount. From the needle valve the oil stream flows down past an emergency valve d that may be operated by hand if necessary, thus quickly diverting the oil pressure from the cylinder. Past this valve the oil flows and thence into chamber F to advance the spindle.

By means of this needle valve controlling mechanism, the supply of oil may be cut off at any predetermined point, and the automatic return valve e is operated simultaneously, thus allowing the oil to drain the cylinder quickly through the large automatic return valve. A pressure gage is provided that indicates the cylinder pressure at all times. By thus opening the automatic return valve suddenly, the spindle moves back rapidly. It does not strike against the rear head however, because as soon as the enlarged end of the piston has crossed the entrance point for the oil, the small amount which remains acts as a cushion and prevents further backward motion of the spindle. At the base of the machine and driven from shaft N is a pump that supplies lubricant to the turret tools through the center of the turret shaft. As each turret station is reached, the oil supply is carried to the cutting point through an individual outlet that is cut off as soon as the station passes the operating point.

Operation of "Warren" Hydraulic Lathe on High-explosive Shells

A good illustration of the capabilities of this machine is the turning of a high-explosive shell. Figs. 4 to 6, and 8 to 10 show the work and tooling for each station, and Fig. 7 gives a general summary of the way the work is handled. The rough stock is 3½ inches diameter and is cut off in lengths 19 9/16 inches long—enough to produce two shells. This double length blank is gripped in the chuck, allowing stock enough for one shell to extend from the chuck.

At the first turret position, a series of step tools rough the nose of the shell down to shape, and a center drill is run in the end. At the second turret station, the hole is drilled the entire depth of 8 inches, in exactly four minutes, and a roughing cut taken over the length of the shell. At the third sta-

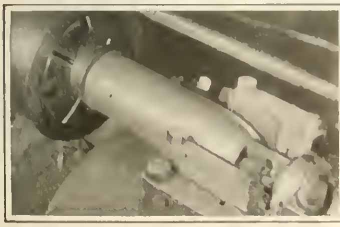


Fig. 8. Fourth Operation—forming Bottom of Hole and shaping Nose

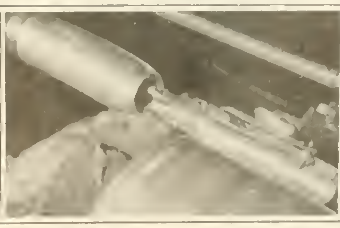


Fig. 9. Fifth Operation—recessing for End of Thread

Fig. 10. Sixth Operation—tapping out Nose of Shell

tion, the shell is finish-turned on the outside, the end of the shell is sized, and the hole reamed. At the fourth station, the bottom of the hole is finished and the nose is finished with wide forming tools. At the fifth station, the recess for the end of the internal thread is cut, and at the sixth station the hole is threaded for the fuse plug. The seventh station is not required on this job. The total time for all these operations is less than fifteen minutes. The bar is now reversed and the same operations performed on the other end, after which it may be cut apart and the base end of each shell finished.

A modification of these machines is being built by the company to rough-turn the entire outside of 9.2-inch shell forgings, including cutting off at the large end, turning the nose, and boring a hole for the fuse, in a time interval of less than twenty minutes. This hydraulic lathe has been so designed as to require for its operation a minimum amount of skill and muscular effort. One operator can easily attend to several machines. Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City, are the United States agents for these lathes.

TAFT-PEIRCE THREAD MILLING MACHINE

This machine is of the type which uses a multiple cutter, the length of which is the same as the width of the threaded portion of the work. To complete milling a thread, it is merely necessary to advance the spindle through a distance equal to the pitch of the thread, and to have the spindle make one complete revolution. This principle enables a high rate of production to be attained. The regular capacity of the machine is for work up to $4\frac{1}{2}$ inches in diameter by 18 inches in length; but work up to $17\frac{1}{2}$ inches in diameter by 8 inches in length can be handled provided it is of a character that can be driven from a center hole or in some similar way. The machine is adapted for the performance of both internal and external threading operations, and one operator can look after two to four machines according to the character of the work.

The Taft-Peirce Mfg. Co., Woonsocket, R. I., has recently acquired the manufacturing and selling rights in the United States for a thread milling machine which was originally developed by J. Archdale & Co., Ltd., Birmingham, England. This machine is of the type that employs a milling cutter which is virtually a straight threaded hob, *i. e.*, there is no lead to the thread; the cutter is of the same width as the length of the threaded part of the work, and one complete revolution of the work-spindle plus a slight over-travel completes the threading operation. The machine is particularly adapted for a high rate of production in milling the threads on various parts of relatively short length, and is capable of a high degree of accuracy. The general features of the design will be readily understood by reference to Figs. 1 and 2. An idea of the range of work for which this machine is adapted will be obtained by referring to Fig. 3, and it will be of interest to note that one operator can attend to from two to four machines, according to the nature of the work.

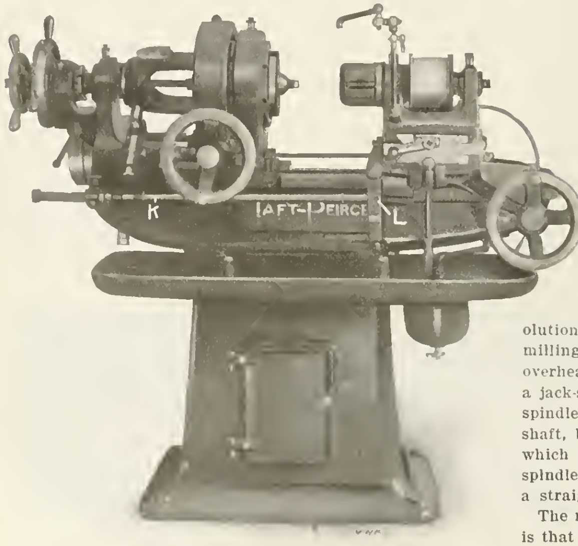


Fig. 1. Archdale Thread Milling Machine built by the Taft-Peirce Mfg. Co.

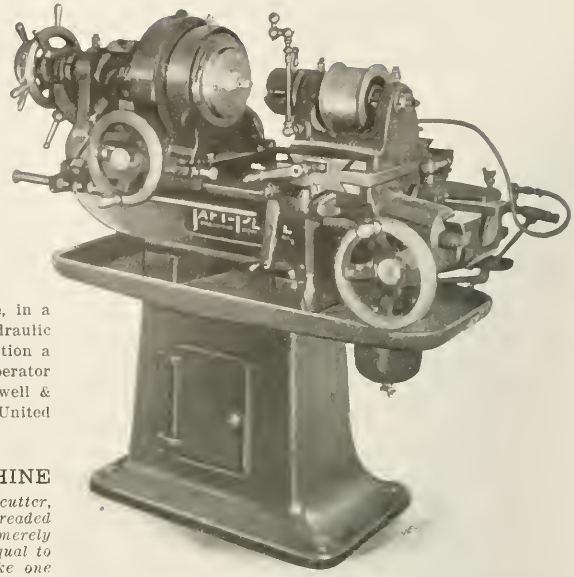


Fig. 2. End View showing Arrangement of Slides on Cutter-head

In order to explain the operation of the machine, the more important parts of the mechanism will be described in detail. Figs. 4 and 6 show the work-head, and it will be evident from these illustrations that all parts have been liberally proportioned. The work-spindle is a large cylindrical member which is bored out at A to receive special faceplates on which various forms of work-holding fixtures are mounted. The work is held in place by a draw-back mechanism which is operated by a handwheel B at the extreme left-hand end of the spindle. The spindle bearings are provided with tapered bronze bushings and effective means of lubrication. The front bearing is $6\frac{7}{8}$ inches in diameter by 4 inches long, and the rear bearing $2\frac{1}{8}$ inches in diameter by $2\frac{1}{2}$ inches long; the distance between the centers of the bearings is approximately 15 inches.

The pitch of the thread to be milled on the work is governed by a lead-screw C and nut D located at the left-hand end of the spindle. The lead-screw is a shell that fits over the end of the spindle, and it will be seen that it is made in two sections, the positions of which may be adjusted to compensate for wear. The end of the spindle is turned down to receive the lead-screw, and it will be evident that screws of the required pitch must be furnished for each class of work that is handled on the machine.

It has already been mentioned that one complete revolution of the work-head is required in order to finish a thread milling operation on this machine. Power is taken from an overhead countershaft which drives a five-step cone pulley on a jack-shaft at the rear of the machine, five changes of work-spindle speed being provided in this way. From the jack-shaft, bevel gears transmit the motion to the worm-shaft E, which is located beneath and at right angles to the work-spindle. The worm on this shaft drives the spindle through a straight-toothed worm-wheel.

The reason for employing a worm-wheel with straight teeth is that the work-spindle must be advanced through a distance equal to the pitch of one thread in order to secure the required

Fig. 3. Examples of Pieces threaded on Taft-Peirce Machine

pitch for the thread milled on the work. As previously explained, this advance of the work-spindle is secured by means of lead-screw *C* and nut *D*. Worm-shaft *E* is made hollow in order to receive clutch shaft *F* which extends through it and operates a clutch on the driving shaft of the machine. A handwheel *G* is provided on worm-shaft *E*, and at the center of this handle there is a push-knob *H* for operating the clutch, both of which are shown in Fig. 4.

Fig. 5 shows the relative positions of the cutter-spindle and work-spindle when in operation; and Fig. 7 shows a partial cross-sectional view through the cutter-head. The cutter-spindle is carried by tapered bronze bushings and is belt-driven from an overhead countershaft which provides three changes of cutter-spindle speed. It will be seen from Fig. 7 that the entire cutter-head is mounted on a compound slide. The position of the cutter-head may be adjusted by the upper slide to

Fig. 4. Close View of Work-head and Cam for releasing Cutter-head

secure the required setting for the work to be threaded, and after this setting has once been made, it needs no further adjustment while the machine is engaged on the same class of work. The lower slide provides means of withdrawing the cutter from the finished work and returning it to the cutting position after a fresh blank has been mounted on the work-spindle.

The withdrawal of the cutter from the work after the thread milling operation has been completed is accomplished by a cam mounted on the work-head. At the time that the revolution of the work is completed, this cam—which is shown at *I* in Fig. 4—engages a trip-pin *J*. In Fig. 4 the cam is shown in contact with the trip-pin, and the manner in which the withdrawal of the cutter from the work is effected may be briefly described as follows: The engagement of the cam with the trip-pin results in transmitting motion through a link mechanism consisting of two bellcranks to the horizontal shaft *K* which will be seen at the front of the machine in Fig. 1. The result is that this shaft is moved to the right and disengages the locking lever shown at *L* in Fig. 7. When the cutter is in the working position the upper end of locking lever *L* is located in a slot extending across the lower slide and its frame, the transverse position of the slide being held constant in this way. When the cam on the work-head operates the trip mechanism, locking lever *L* is withdrawn, which allows a spring to throw the cutter-slide back so that the cutter is withdrawn from the work. After cam *I* has passed over pin *J*, shaft *K* is returned to its original position by a spring at its right-hand end.

Before any thread milling operation can be started, it is first necessary to draw the work-spindle back to the starting point, *i. e.*, through a distance equal to the pitch of the thread

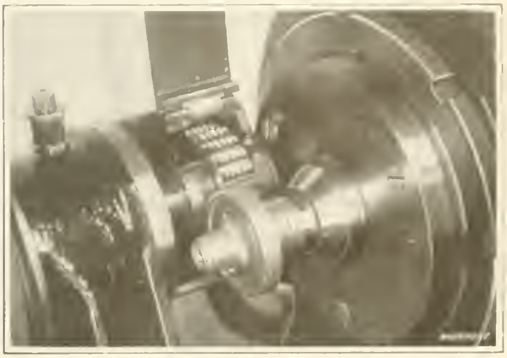


Fig. 5. Close View of Cutter engaged in milling a Thread

on the work. This is done by turning handwheel *M* on the work-head spindle, shown in Fig. 6; but before this handwheel can be operated, it is necessary to withdraw locking pin *N* that holds the handwheel while the machine is in operation. The withdrawal of the locking pin is effected by lever *O* which carries a pinion that meshes with rack teeth cut in the locking pin. As soon as handwheel *M* has been turned sufficiently to withdraw the work-spindle to the starting point, locking pin *N* comes into alignment with another hole in the handwheel, and spring *P* then pushes the pin into this hole.

When this part of the work has been completed, a fresh blank is set up on the work-spindle, after which it is necessary to return the cutter-slide and cutter to the working position, which is done by pulling up lever *Q* at the front of the cutter-head. This results in advancing the cutter into the work a distance equal to the depth of the thread, and when this position of the cutter-head has been reached the locking lever *L* drops into position in the slots in the slide and frame of the machine—which have been brought back into alignment—and the cutter-head is locked in this way until the thread milling operation is completed.

The preceding description of the method of procedure in

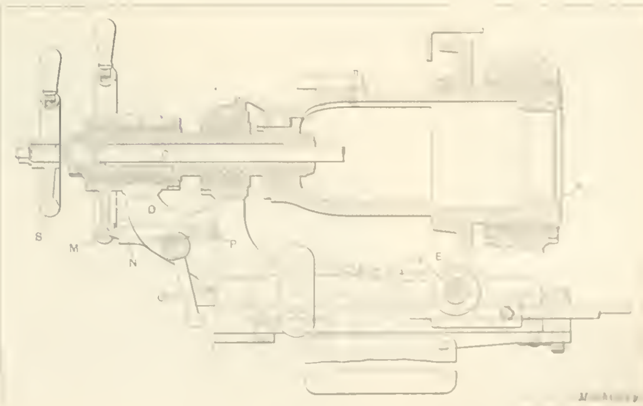


Fig. 6. Partial Cross-sectional View of Work-head

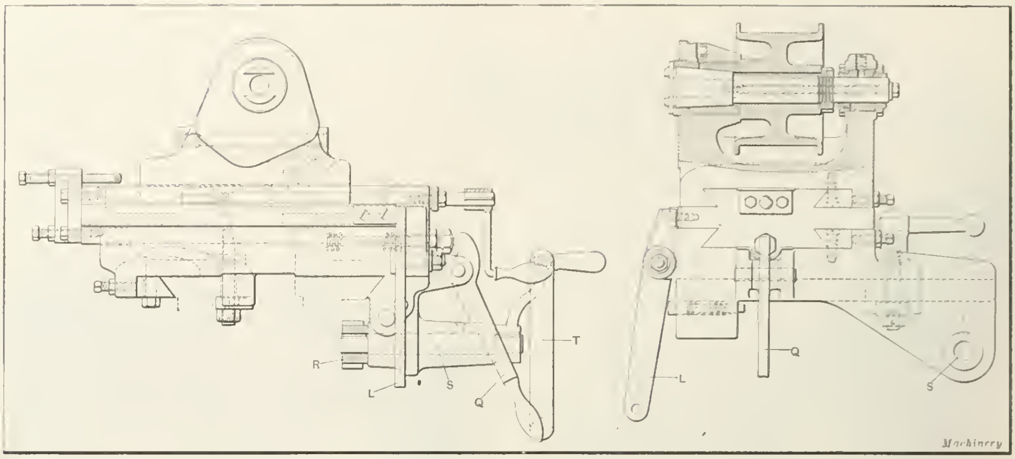


Fig. 7. Partial Cross-sectional View and End View of Cutter-head

preparing the machine for the performance of the next milling operation applies in cases where the thread is on the outside of the work. For internal threading operations it will be obvious that the cutter-head must also be traversed along the bed of the machine to withdraw the cutter from the work so that the piece may be removed from the work-spindle. Provision for traversing the cutter-head in this way is made by means of a pinion R carried on the shaft S which meshes with a rack secured to the bed of the machine. A stop is provided on the bed for locating the cutter-head in the desired position when it is returned for the performance of the next thread milling operation. This longitudinal movement of the cutter-head is obtained by turning handwheel T.

The machine may be provided with a special hollow work-spindle so that external threading operations may be performed on long pieces of work of any size up to 1⅛ inch in diameter. With the regular spindle, the capacity of the machine is for work up to 4½ inches in diameter by 18 inches in length, although longer work can be handled by using a back-rest. Work larger than 4½ inches in diameter—of any size up to 17½ inches in diameter, which is the maximum swing of the machine—may be handled, provided its length does not exceed 8 inches, but large work of this kind must be of such a form that it can be driven from a center hole or in some similar way. Using a cutter of not more than 1 inch diameter, external threading operations may be performed on work up to 6¼ inches in diameter. Using a cutter 3 inches in diameter, internal threading operations may be performed on work up to 7¼ inches in diameter. An idea of the rate of production attained on this machine may be gathered from the fact that the threads are being milled on aluminum fuse bodies at the rate of 40 per hour; on this work the threaded portion is 1⅜ inch in diameter by ¾ inch long, and the thread is of the Whitworth type and 6 pitch. The principal dimensions of the machine are as follows: Length of bed, 3 feet, 10 inches; travel of cutter-head along bed of machine, 3¾ inches; floor space occupied, 3 by 6 feet; and approximate weight of machine, 2380 pounds.

NEWTON TORPEDO FLASK BORING MACHINE

The Newton Machine Tool Works, Inc., Philadelphia, Pa., has recently added to its line the torpedo flask boring machine, three views of which are shown in the accompanying illustrations. The claim is made that this machine has a capacity for doing work in 25 per cent of the time required by previous types of machines used for the same purpose. The outside of the flask that is to be bored is gripped by two revolving chucks which are rotated in unison by a common shaft. The boring-bar is held stationary and is equipped with tool-heads on each side which pass each other without interference. Each tool-head is provided with power feed along the bar and automatic release; and each head has adjustment in a direction at right angles to the axis of the bar, this movement being controlled by forms which conform to the contour of the flask that is being operated upon.

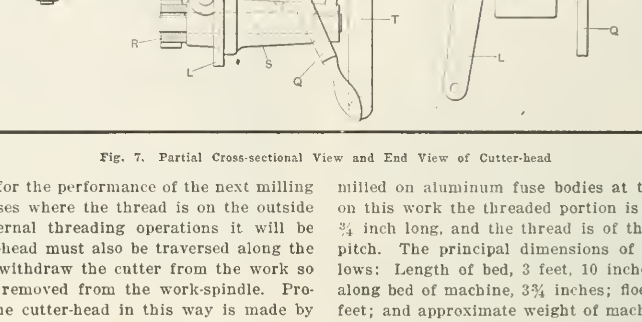


Fig. 1. Newton Torpedo Flask Boring Machine

The main head, on which the driving motor is mounted and to which the boring-bar is attached, has reversing fast power traverse on the base to permit of the insertion and withdrawal of the boring-bar after the flask has been located in the revolving chucks. When setting up the flask, the idea

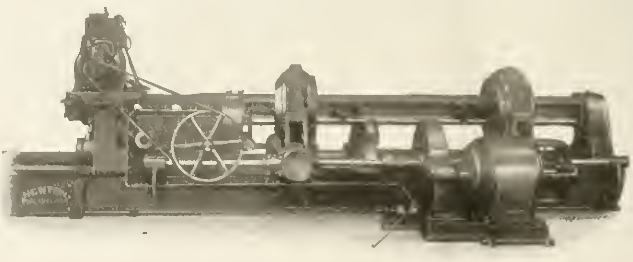


Fig. 2. Opposite Side of Machine shown in Fig. 1

is to traverse the movable head away from the stationary or end head, as shown in Fig. 3, in order to provide a distance greater than the length of the flask. The flask is then moved horizontally through the chuck on the stationary head and the movable head is adjusted back over the flask until it has been brought to the desired position. The chuck jaws are of a special broad design in order to prevent crushing the flask, which would occur if ordinary narrow chuck jaws were used for supporting the work. The machine occupies a floor space of 8 by 40 feet, and weighs 70,000 pounds.

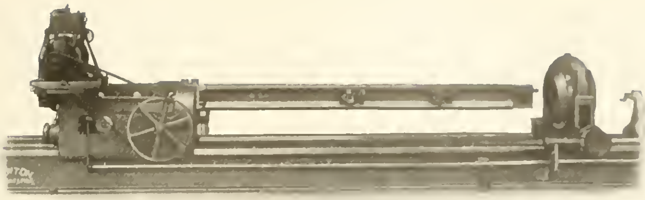


Fig. 3. Method of setting up a Flask on Machine

BRIDGEPORT WIDE-WHEEL GRINDER

To provide for the accurate and rapid grinding of cylindrical work up to 10 inches in diameter by 32 inches in length, the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn., has added to its line a No. 106 grinder, three views of which are shown in Figs. 1 to 3. This machine is equipped with a wheel 20 inches in diameter by 8 inches face width, and if the piece to be ground is not over 8 inches long the work does not have to be traversed. This makes the machine suitable for using a shaped wheel for the performance of form grinding operations on pieces that come within its range. Work of more than 8 inches in length is traversed by means of a handwheel located at the center of the bed, the motion being transmitted through a rack and pinion.

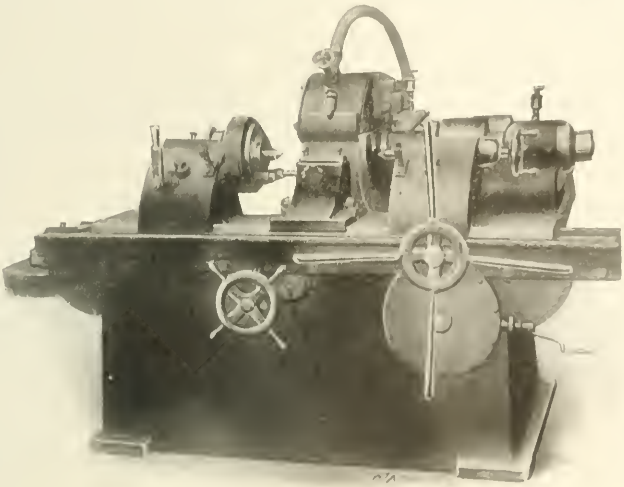


Fig. 1. Bridgeport Grinding Machine with Wide Faced Wheel

The work-table is mounted on flat ways on the bed, which is of the cabinet type; the top of the work-table has a wide flat bearing surface, and the top and front of the table are planed at right angles to each other, which provides means for securing the horizontal and vertical alignment of the headstock and tailstock. A channel is formed in the table casting along the front, rear and ends to provide for carrying away the drippings from the work to a water pan located at the rear of the carriage, and thence to the reservoir contained in a back extension. The bases of the headstock and tailstock have long bearings on the table, and the spindles are liberally proportioned. The headstock faceplate for driving the work is back-geared in the ratio of 3 to 1, and is provided with a long bronze bearing running on the spindle so that the work is supported on two dead centers. A hand-lever at the front of the headstock operates a clutch on the back-gear shaft to provide for stopping or starting the rotation of the work.

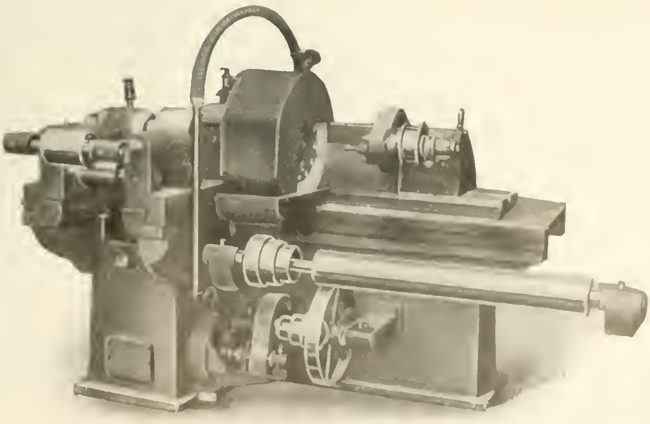


Fig. 2. Rear View of Machine shown in Fig. 1, equipped for Belt Drive

The grinding-wheel head is mounted on ways on an extension cast at the rear of the base. The spindle bearings are liberally proportioned and provided with the bronze taper sleeve construction employed on other machines of this company's manufacture; these sleeves are adjusted by screw collars at the ends. The bearings are lubricated by felt pads which receive oil from sight-feed cups. The grinding wheel is mounted between safety collars on a heavy spindle, and provision is made for accurately balancing the wheel by weights introduced into tapped holes in the loose safety collar. These features are clearly shown in Fig. 4. It will be noticed that eight bolts are provided for holding the safety collars together, and that these bolts are placed well out toward the periphery of the collars where they provide an effective pressure.

When individual motor drive is employed the motor is located at the back of the machine, and a pulley on one end of the motor spindle drives the grinding-wheel spindle by means of an endless belt. An automatic belt tightener and suitable idler pulleys take care of the changing conditions due to the wear of the grinding wheel and its forward and backward movement. On the opposite end of the motor shaft there is a pulley which drives a back shaft, and this shaft, in turn, drives the drum shaft, the drum is belted to the work pulley in the headstock. Three changes of speed are obtained by means of cone pulleys. The water pump is

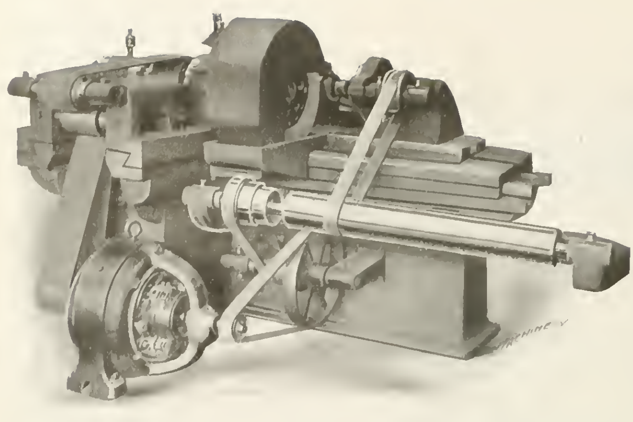


Fig. 3. Rear View of Machine shown in Fig. 1, equipped for Individual Motor Drive

driven from the back shaft, and both the back shaft and drum shaft are supported in bearings rigidly bolted to the main base.

The grinding wheel is fed to or withdrawn from the work by means of a pilot handwheel on the front of the base, which is back-geared to a lead-screw that engages a nut bolted to the under side of the grinding-wheel head. Outside of this lead-screw and concentric with it—but operated independently by means of a worm and worm-wheel—is an adjustable stop with micrometer adjustment which limits the forward movement of the wheel to the work. The object of employing a stop that is concentric with the lead-screw will readily be seen, as no side strain can be developed with its consequent change in the alignment of the grinding wheel.

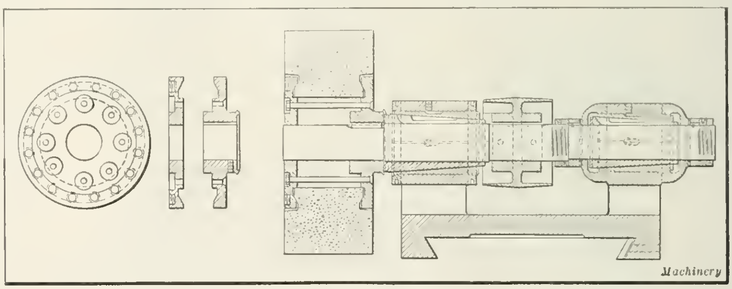


Fig. 4. Arrangement of Wheel-spindle Bearings and Mounting of Wheel on Spindle

The waste water and sediment are conducted through suitable channels to a removable pan, where the sediment settles and the water overflows into the main reservoir carrying little sediment with it. The pump takes its supply from this main reservoir. The principal dimensions, floor space, weight, etc., of the machine are as follows: Diameter of headstock spindle, 3 inches; diameter of tailstock spindle, 2½ inches; distance from top of table to centers, 8 inches; distance from floor to top of work-table, 32 inches; distance from floor to center of wheel-spindle, 40 inches; floor space occupied, 61 by 38 inches; and complete weight of machine packed and ready for domestic shipment, approximately 5500 pounds.

GENERAL ORDNANCE LATHE

The 22-inch heavy-duty single-purpose lathe which has recently been placed upon the market by the General Ordnance Co., Denver, Colo., was especially designed to meet the requirements of manufacturers of shrapnel and high-explosive shells, although this machine is also well suited for use in factories engaged in the manufacture of various other products. In order to provide the degree of rigidity in the headstock that is required for severe service conditions, the lower gear casing is designed to form connecting members between the front and rear main spindle and driving shaft bearings. The spindle is made from a solid steel forging and finished to size by grinding; it runs in renewable phosphor-bronze bearings which have exceptional resistance against wear. The thrust bearing is formed of alternate heat-treated steel and phosphor-bronze washers, and the driving gears on the spindle are cast steel with cut teeth. The driving shaft is also supported in bronze bushed bearings, and the two pinions are integral and splined to the shaft so that either may be brought into mesh by operating the hand-lever. The arrangement is clearly shown in Fig. 2.

The exceptional depth and width of the bed, combined with the internal bracing employed, insure rigidity under the heaviest cuts that can be taken with high-speed tool steel. The carriage ways are carefully fitted; they are of 90 degrees included angle with the tops rounded. To facilitate the quick removal of the tailstock or turret the bed is cut away at the rear end. The feed rack is in one piece and is made of steel. The carriage is heavily ribbed to provide the necessary rigidity, and the bearings are scraped to a perfect fit on the ways. The apron is shouldered into the carriage and has a bearing over its entire length; it is held in place by six screws. All the gears in the apron are made of steel and those which run on steel studs are bushed with phosphor-bronze.

The tailstock spindle is of large diameter and is constructed with a phosphor-bronze nut on a screw of medium pitch; the screw is operated by an unusually large handwheel which makes it an easy matter to drill holes of large diameter. Provision is also made for setting over the tailstock to provide for the performance of taper turning operations. The tailstock is moved along the bed by a removable pinion which engages the rack. The lead-screw is made of high-carbon steel with a chased thread, and the nut is of the split pattern. Thrust in both directions is taken by a bearing composed of heat-

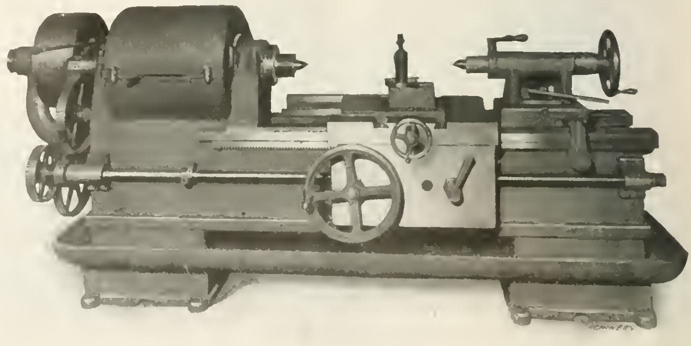
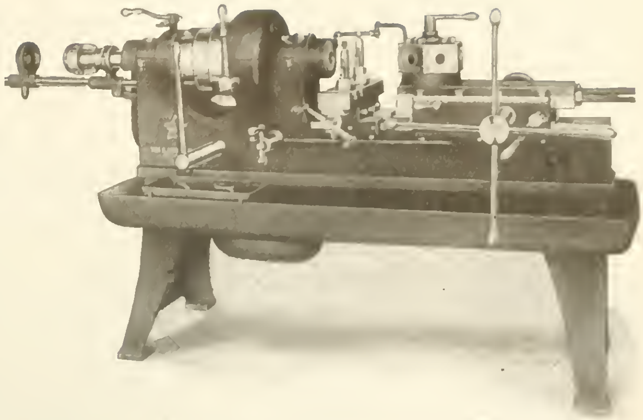


Fig. 1. Heavy-duty 22-inch Single-purpose Lathe built by the General Ordnance Co.

treated steel and phosphor-bronze washers. The equipment furnished with the machine includes a driving plate, change-gears, toolpost and the necessary wrenches. The following may be furnished as special equipment: A four-way toolpost, profiling attachment, waving attachment, collet chuck, steadyrest, standard faceplate, compound rest, combination toolpost and cross-slide, oil pan, oil pump and piping, boring-bar guide, and two-speed countershaft.

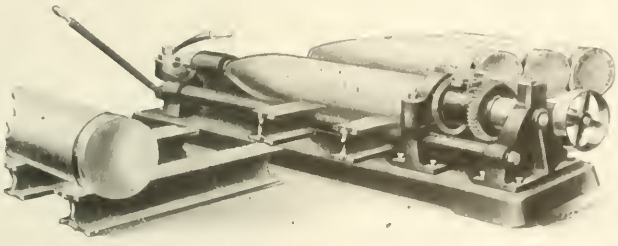
The principal dimensions of the machine are as follows: Swing over shears, 22 inches; swing over carriage 13¾ inches; swing over profiling carriage, 9⅛ inches; capacity between centers for a machine with an 8-foot bed, 3 feet 2 inches; maximum travel of tailstock spindle, 10 inches; number of changes of spindle speeds, 2; diameter of driving pulley, 20 inches; width of driving belt, 8 inches; height of centers above floor, 41½ inches; floor space occupied by machine with 8-foot bed, 4 by 11 feet; weight of same machine, 8000 pounds; and weight per extra foot of bed, 315 pounds.



"Star" 1½-inch Hand Screw Machine made by the E. H. Wachs Co.

LARGE NOBLE & WESTBROOK SHELL MARKER

The machine which forms the subject of this description, and which is shown in the accompanying illustration, has been developed by the Noble & Westbrook Mfg. Co., Hartford, Conn., for the purpose of marking the ends of large heavy shells. The machine is said to produce clean-cut impressions, and it can be successfully operated by unskilled labor.



Noble & Westbrook Machine for marking Base of Large Heavy Shells

In operating the machine, a rack is built on each side and the shells to be marked roll down this rack to the machine. Only a few seconds are required to complete the marking operation, after which the operator pulls a lever provided with cam adjustment, which raises the shell from the machine and allows it to roll away down the rack at the far side. At the same time, another shell drops into place ready to be marked. As no lifting of heavy shells is involved, the men do not become unduly fatigued and there is no falling off in the rate of production from this cause during the latter part of the day.

An important feature of the machine is that the die is constructed with each letter and figure a separate unit, so that any unit of the die may be replaced if it becomes worn or damaged, without the necessity of providing a complete new die. In the marking of heavy shells, this is the means of effecting a material saving. The machine runs by power, being equipped with a tight and loose pulley for belt drive; no countershaft is required. This marking machine is particularly intended for the marking of heavy shells, and the design has been worked out along simple lines, with ample strength provided to enable it to stand up under severe service conditions.

WACHS HAND SCREW MACHINE

The 1½-inch hand screw machine shown in the accompanying illustration is the latest product of the E. H. Wachs Co., 141-149 West Grand Ave., Chicago, Ill. This machine is equipped with a friction geared head, positive power feed to the turret slide, independent stops, an automatic chuck and wire feed, and an oil pump. The design has been worked out along lines which provide for the rapid production of accurate work.

Reference to the illustration will make it evident that all operating levers are located within easy reach of the operator. The machine is driven by a three-step cone pulley and back-gears, so that three direct and three back-geared speeds are available. Reverse is obtained through the countershaft. The collet has a capacity for work up to 1½ inch in diameter, and pieces of any length up to 9 inches can be turned. Stock of the full diameter capacity may be passed through the turret. The net weight of the machine, including the countershaft, is 2925 pounds.

It will be recalled that the E. H. Wachs Co. manufactured a hand screw machine some years ago, but the present tool has been entirely redesigned in order to produce a machine suitable for the requirements of modern factories. It is the intention to bring out other sizes of machines in order to make a complete line, and a building which is now in course of construction will be given over to the manufacture of these machines.

Fig. 2. Opposite Side of General Ordnance Machine shown in Fig. 1, showing Arrangement of Drive

THE SYMINGTON LINE OF SPECIAL SHELL MANUFACTURING MACHINERY

The Symington line of shell manufacturing machinery embraces a machine for each operation in making a given shell. All are single-purpose machines, intended for intensive production on munition work only. Features common to all these machines are: massive design, large spindles and generous bearings, simplicity of operation, which permits the employment of unskilled labor, and high productive power.

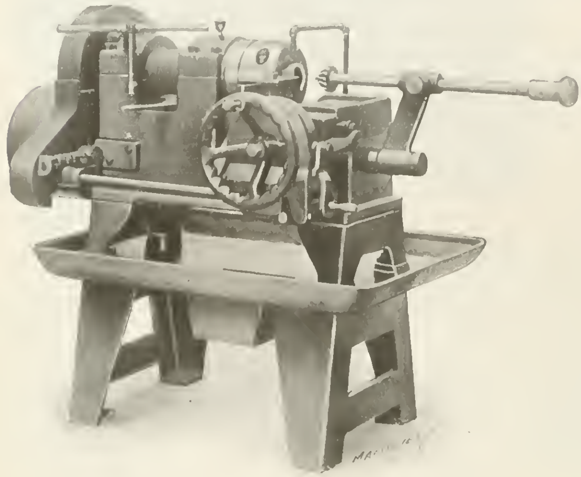


Fig. 1. Type A Shell Lathe as equipped for cutting off

The T. H. Symington Co., Rochester, N. Y., has recently perfected a line of shell manufacturing machinery suitable for the production of high-explosive or shrapnel shells of any size up to 3¼ inches (85 millimeters) diameter and 13 inches (330 millimeters) in length. They have been designed for covering all the machining operations on any type of shell within these size limits, whether made from bar stock or forgings. The line of machines includes means for performing every operation on the shell from the forging to the completed shell. It should be understood that these machines have been designed for the special purpose of shell manufacture, and in their present form are not intended for other operations.

The general characteristics of the entire line of machinery are extremely massive design and few working parts. These machines are very powerful and durable—more so than standard machinery could be for the production of miscellaneous work. Above all, they have been designed to be operated by unskilled labor, and are as nearly foolproof as it has been possible to make them. Being strictly single-operation machines, they will carry heavier cuts and coarser feed than standard machinery of much greater capacity. Each machine is furnished with single-speed drive, suited to the particular operation it is to perform. All machines are sent out tooled with the simplest and strongest chucks and tools possible. The line of machines and the operations they perform is graphically shown in the accompanying table which gives the types of machines used for the various operations. The number of machines handled per operator and the productions are also included. In all, there are five distinct types of machines in the line, and these are shown in the illustrations accompanying this article. For each operation, the machines are equipped with different chucks, tools, etc. The types are designated by letters and the equipment by numbers—thus the B-4 machine is the B type machine with No. 4 equipment.

The machines for shell turning proper are of two general types, known as types A and B. The type A machine, illustrated in Figs. 1 and 3, is used for the operations that are performed while the shell is held in a chuck or by other means not requiring a tailstock. These are cutting off, base-facing, wave-groove finishing, and band turning. On account of the nature of the operations, the machines do not require a traveling carriage, and hence it has been possible to make the design compact.

The type B machines are for turning and boring. This type of machine is of longer bed design and carries a power-fed carriage, as contrasted with the type A machine which has only a cross-slide. The type B machine is illustrated in Figs. 2 and 4, and is used for all outside turning and inside boring operations as indicated in the table. As these types are quite different in operation, they will be described separately.

In addition to these two general types of machines, there is the type W machine for nicking the open end of the shell, the type X machine for center drilling the closed ends of the shell, and the type H machine for the manufacture of fuse sockets, as shown in Fig. 5.

Cutting-off Machine—Type A-1

The Symington shell cutting-off machine, which is of the A type, is shown in Fig. 1. This is used for the single purpose of trimming shell forgings to length at the open end. It is provided with a very strong chuck of the hinged variety for holding the forging. The shell is pushed into the chuck with the bar gage shown at the right-hand end of the machine. The cutter shown on the end of the bar slides back out of the way. In locating in the chuck, spring pressure behind the shell must be overcome, so that there is no chance for misplacement. After locating, the hinged chuck is closed on the work, bringing the three gripping jaws tightly in place. The gage is withdrawn and the power feed is now thrown in and the ¼-inch wide cutting-off tool is fed in. This power cross-feed is secured from a shaft at the front that operates the large worm-wheel through a worm, and thus through the 1½-inch lead-screw to the carriage.

A stream of lubricant is supplied to the cutting-off tool to enable it to withstand the heavy feed. An automatic throw-off is provided to disengage the feed as soon as the shell has been cut. After cutting the excess length from the shell, a cutter or burring tool on the gage, held in place by a removable pin, is thrust by hand pressure against the inside, and the cutting burr removed. To allow for any irregularities of the shell forging, the bracket through which the gage bar passes is bored large enough to allow a little play. It is claimed

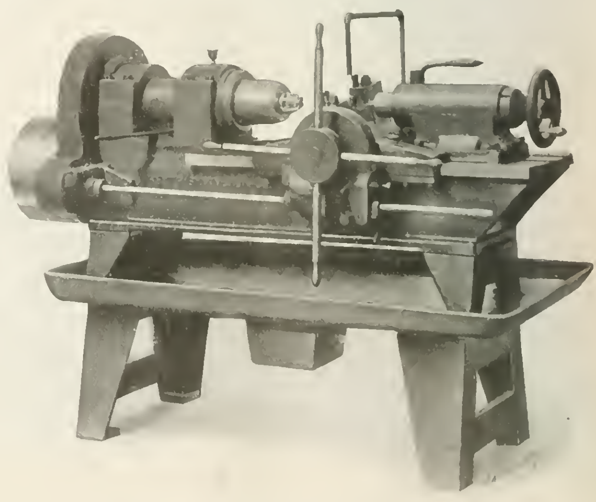


Fig 2. Type B Shell Lathe as equipped for rough-turning

that this machine will exhaust the capacity of any steel cutting tool, and the production is fifty shells per hour from floor to floor.

Center Nicking Machine—Type W-1

There is a special machine for nicking the mouth of the trimmed forging to provide a means for driving during the turning operations. This machine (not shown) is a drop-hammer having a head weighing about 200 pounds. Mounted on the bed is the nicking tool, which resembles a short, stubby six-fluted taper reamer, except that the taper is extreme and the flutes have no cutting clearance. The shell is placed open end down on this tool and one drop of the hammer embeds the tool in the mouth of the shell, leaving six distinct nicks that provide means for driving as previously mentioned. For quick operation, a hand-lever trips the ram, so that the nicking operation may be done as rapidly as the shells can be handled.

Center Drilling Machine—Type X-1

Before going to the center drilling operation, the end of the forging is lightly faced off on a disk grinder. The machine for center drilling the closed end of the shell corresponds to the average 16-inch drilling machine. This is belt-driven and has but a single speed. The spindle carries a 3/4-inch drill that operates through a bushing in a bracket supported from the column. On the base of the machine is the arbor upon which the shells are supported for center drilling. This arbor tilts forward from the bottom to allow the shell to be picked off or put on rapidly. The shell bottoms on the arbor, and before drilling, the operator presses a foot-treadle that expands three lugs at the top of the arbor and raises a tapered collar at the bottom that centers the open end of the shell. While the shell is held in this position, the lever feed is operated that brings the centering drill down into the work. The production from this machine is only limited by the rapidity with which the operator can handle the shells.

Rough-turning Machine—Type B-1

One of the most important of the machines of this line is the rough-turning machine shown in Fig. 2. This is a B type machine, and here, especially, the massive construction has been followed, and the six-inch diameter bearings are especially valuable. The shell is supported on centers, being driven by the six nicks in the open end that fit on a hardened and ground driving bit on the live center. An extremely heavy tailstock is provided, and the carriage that carries the turning tool is of more than ordinary weight and extremely long in its bearing upon the ways. These ways, it will be seen, are of the square type, and the carriage is fitted closely from both sides and bottom. The cutting tools are two in number, one being at the front and the other at the rear. The rear tool is set to cut slightly deeper than the front tool, so as to leave the shell turned to close limits when it comes from the machine. The carriage is driven from a rack at the center of the bed, operating through a worm and worm-gear. It is claimed that this machine will hold the diameter of the rough-turning to within one and one-half thousandth inch with reference to size and eccentricity, even though the shells be forged eccentrically. Shells may be handled on this machine at the rate of twenty-five per hour. The average feed used is 3/32 inch per revolution, but this can be increased if the nature of the shells warrants it.

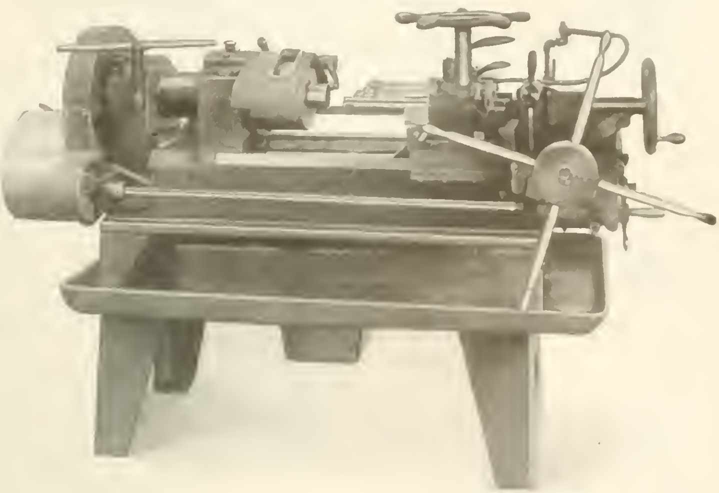


Fig. 4. Type B Shell Lathe as equipped for inside boring and reaming

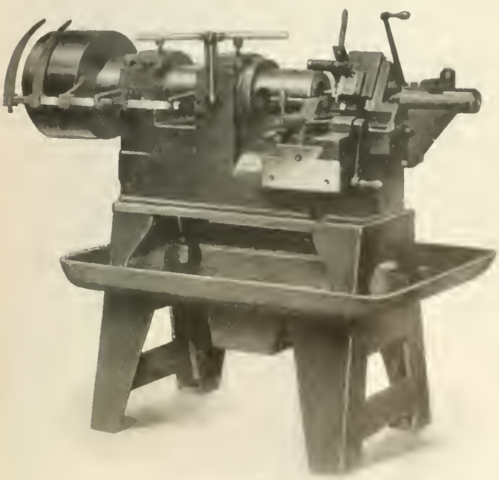


Fig. 3. Type A Shell Lathe as equipped for band-turning

Shell Boring Machine—Type B-2

The next operation in shell production is the inside boring and reaming, and the Symington machine used for this purpose is illustrated in Fig. 4. While this is a B type machine, it differs from the B-1 machine in that there is a special carriage with a heavy cross-slide that corresponds to the turret of the ordinary turret lathe. This turret slide has three positions and is indexed by hand and locked in position by the locking-pin that may be seen near the center of the slide. The three operations that this machine performs are the profiling or boring of the inside of the shell from the nose to the diaphragm seat. In case the shell is not to be finished for the entire inside length, it is only necessary to finish the diaphragm seat. The next tool rough-bores and cuts the powder pocket and also the diaphragm seat. The third tool finish-reams the diaphragm seat and powder pocket.

Base Rough-facing Machine—Type A-2

The machine which performs the next operation on the shell is the A-2 machine. This is very similar to the A-1 type for cutting off, and its purpose is to rough off the back end of the shell, including the section that has been centered. The shell is placed within a hinged chuck and solidly clamped. In chucking, it is placed against a stop that reaches into the shell and gages the length from the bottom of the powder pocket. There are two tools used in the tool-block on the

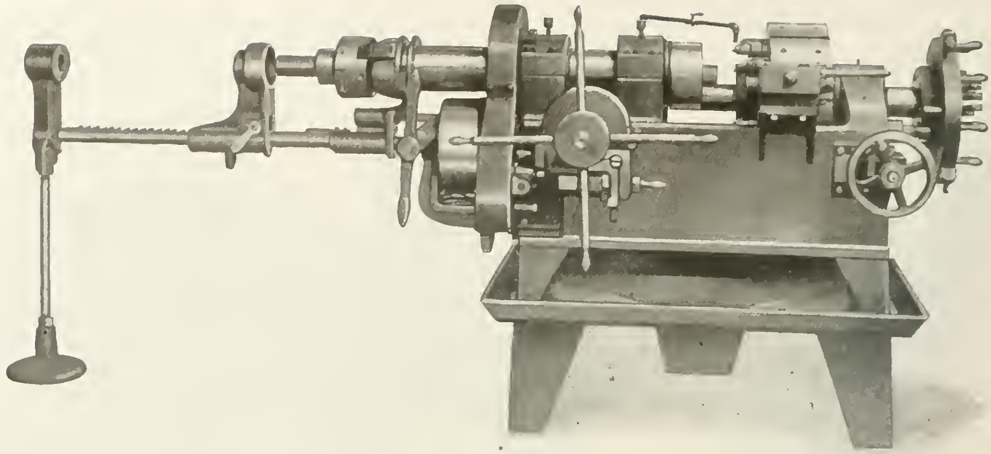


Fig. 5. Type H Semi-automatic Fuse Socket Lathe

heavy carriage; one removes the stock and the other takes off the corner of the shell. The carriage feed is through a shaft at the front, the same as in the cutting-off machine. An automatic stop is provided to throw off the cut when the operation has been concluded.

Shell Finish-facing and Forming Machine—Type A-6

The next machine in the Symington line is for finishing the face of the shell and forming it. This is very similar to the rough-facing machine, and is of the A type shown in Fig. 1. It has a positive stop for the movement of the cross-slide, and at the front are tools for facing the end of the shell, roughing out the band groove, cutting the crimping groove for the cartridge case, and rounding the corner of the shell. These tools are on the carriage and are fed to the work by hand.

Shell Waving and Undercutting Machine—Type A-3

A machine of the A type is used for waving and undercutting the band groove. The undercutting is done with special tools on the front carriage, operated by hand. The waving or knurling, as the case may be, is done from the back of the cross-slide. In the case of wave-cutting, the carriage is reciprocated by the action of a roll contacting on a cam-form on the chuck that holds the shell. In the case of knurling, it is simply drawn into the work until the right depth of knurling is secured.

Shell Nose-finishing Machine—Type B-3

The next machine in the Symington line is the finishing machine for the nose of the shell—a machine of the B type similar to the one in Fig. 4, except that there is no power feed, and the tooling equipment is held on a four-station turret slide. The chuck is also of a different type, being of a split-spring style that grips the shell centrally from the outside.

Shell Finish-turning Machine—Type B-4

For finish-turning the outer diameter of the shell after heat-treatment, a machine of the B type is used. This machine has a heavy tail-block provided with a quick-acting center. A screw-plug center is put in the open end of the shell and the dead center engages this for support, while the finish closed end is held in a spring chuck. The machine carries but one cutting tool and this has a feed of 1/64 inch per revolution at the start, which is made at the nose end of the shell. This, it will be remembered, is a formed shape, and in order to secure it, a profiling fixture at the back of the machine is used to guide the tool. This is of the ordinary type, having a hardened cam, against which a roller on the carriage is drawn by a heavy spiral spring. After the nose section has been turned, the feed is automatically increased to 3/64 inch per revolution; this is maintained until the band groove is reached, which is the end of this cut. An automatic throw-off is fitted for dropping the feed at the end of the cut. At this point in the shell making the band is pressed in place.

Shell Band Turning Machine

The final machine in the Symington line is the band turning machine illustrated in Fig. 3. This machine is of the A type, but carries very interesting tooling which makes it quite different in its operation. The closed end of the shell is gripped in the chuck on the spindle. The cross-slide is of compound design, having a tool at the front that is fed in to trim the edges of the copper band; this tool does not form the band, however, the band-forming operation being done by the formed tool on the inclined slide at the rear that is fed down with a lever feed. After the band has been brought

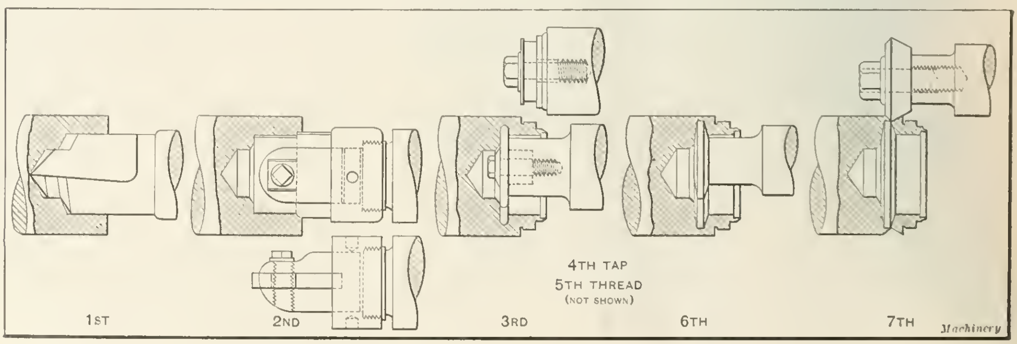
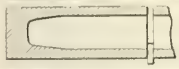
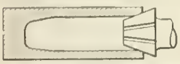
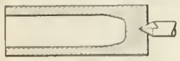
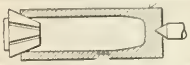
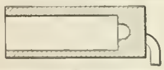
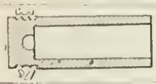
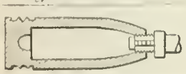
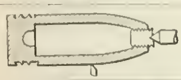
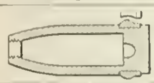
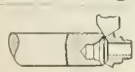


Fig. 6. Sequence of Operations in making Fuse Socket

to the right width and the face has been properly formed with the inclined tool, a third tool located on the top of the inclined slide is brought over with a hand-lever. This is merely a scraping tool that cleans off the last vestige of copper band that may be clinging to the sides of the shell. This completes the machining of the shell.

The Symington machines may be obtained singly or can be furnished in unit batteries, consisting of the right number of machines for balancing up the different operations.

TABLE SHOWING OPERATIONS IN MAKING A TYPICAL SHELL ON SYMINGTON MACHINES, WITH NUMBER OF MACHINES PER OPERATOR AND PRODUCTION

	Oper. No.	Operation	Type Mach.	Mach. per Oper.	Prod. per Hour
	1	Cut Off	A 1	1	50
	2	Nick Center	W 1	1	300
	3	Center Drill	X 1	1	200
	4	Turn on Centers	B 1	2	25
	5	Finish Inside	B 2	1	10
	6	Rough-face Base	A 2	1	35
	7	Finish-face and Form	A 6	1	30
	8	Wave and Undercut	A 3	1	25
	9	Bore, Ream and Tap Nose	B 3	1	30
	10	Finish-turn	B 4	2	10
	11	Turn Band	A 4	1	60
	12	Make Adapter	H 1	1	12

Machinery

Symington Fuse Socket Machine

In addition to the machines for the production of shells, the Symington line includes the machine shown in Fig. 5, which is known as the type H machine and is for producing fuse sockets for 3-inch shells. This machine, in common with the other machines in the line, is a single-purpose machine, although it can be adapted to the production of any parts of similar size and shape. Fig. 5 shows the machine as viewed from the rear.

The features of the machine are its extremely heavy spindle and other working parts. This insures great rigidity. The machine operates on a bar of 2 11/16-inch cold-rolled steel that passes completely through the hollow spindle. The cutting tools are mounted in a heavy turret that has, in the present instance, seven stations. Any lateral feed necessary is secured by rotating the turret on its axis as will be more fully described later.

The main spindle of the machine is mounted in bearings 6 inches long, and as the spindle is 6 inches in diameter it will be seen that the spindle support is very generous. The spindle is ground to size and runs in babbitt bearings, bored and scraped. A 3¼-inch hole runs through the spindle from end to end, thus providing for carrying stock up to 3¼ inches diameter. For the present job, steel 2 11/16 inches diameter is used and is held by a spring collet with tapered nose that is closed by being pushed into a taper sleeve, just as in general screw machine practice. The stock is fed and the chuck opened and closed by hand from the front of the machine. This is a ratchet type of stock feed and similar to that used on several standard hand screw machines.

The Turret

The turret shaft is behind and below the main spindle, and so located that the spindle line and the turret line are at an angle of thirty degrees from the horizontal. The forward feed of all tools is secured by advancing the turret shaft, turret and tools. The drive of the machine is from a two-speed countershaft, down to a 5-inch face pulley on the stock feed shaft below the spindle. Integral with this pulley, is the drive pinion that engages the gear on the spindle and thus furnishes the drive.

On the turret are seven tool stations placed at various distances according to the space required for the tools for each station. All seven tools, however, are spaced within an arc of 270 degrees so that the rest of the space is left clear for chip room. The indexing is done by hand, using the handles on the turret stop disk at the extreme right-hand end of the machine as viewed in Fig. 5. The turret is locked at each station by a wide tongue on the bracket at the front and the engagement of this tongue in a slot in the turret locks it in position. The slots in the turret are fitted with hardened steel inserts. The locking tongue is withdrawn with a hand-lever, and when in engagement is held with a stiff spiral spring. The turret stop disk also carries stops for limiting the turret travel for each station. While the turret shaft power feed is used for bringing the tools up nearly to the limit of their cut, the hand feed is used for finishing each cut. The extreme length of turret travel is seven inches.

The tools are located around a 13-inch circle. For certain of the operations, where forming or recessing tools are to be used, it is necessary to give the tools lateral feed. This is accomplished by rotating the turret slightly, thus carrying the tools sideways for the cut. In making this fuse socket, three of the seven operations require side travel of the tools On the inner face of the turret disk are three one-inch steel pins, each two inches long. One of these pins is shown in Fig. 5. At the time of indexing for one of these side feeding operations, the locking tongue, instead of dropping into the deep slot in the turret, drops into a shallow groove, the function of which is to engage the tongue, and lightly hold the turret in position while the tools are entering, but permits the tongue to slip out when the turret is turned. The pins in the turret disk, previously described, engage in a hole in the side of the turret operating slide at the extreme right of the machine. This carriage is operated by hand, and by reciprocating it the pin connection to the turret disk causes the turret to turn and the tools to describe an arc in the work. The limit of rotation is reached when the set-screws on the edge of the turret disk strike the square stop stud that extends from the frame of the machine.

Tools

The operations in making the fuse socket are shown in Fig. 6, and after feeding the stock are: first, rough-drilling with a two-diameter drill; second, boring inside to size; third, internal necking and outside forming; fourth, tapping; fifth, cutting external thread with die; sixth, finishing the taper seat with internal tool; and seventh, forming outside and cutting off.

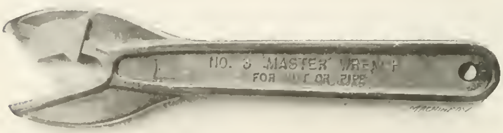
On the third, sixth and seventh operations, the cross-feeding

operation just described is necessary. A lubricant pump at the rear of the machine carries oil to the cutting tools. This machine will turn out fuse sockets complete from bar stock at the rate of twelve per hour.

SHEPHERD-PRINCE "MASTER" WRENCH

The "Master" wrench which is a recent product of the Shepherd-Prince Co., Inc., 18 E. 41st St., New York City, has been designed in such a way that it works equally well on square or hexagonal nuts and pipe or other cylindrical pieces, adjusting itself for all different sizes which come within its range. It will be noticed that the wrench is composed of only two parts and these cannot become separated. This wrench is made of drop-forged machine steel and finished in black enamel and polished steel.

In applying the wrench to a nut, it is held with the head down to allow the sliding jaw to drop to the position which



Shepherd-Prince "Maater" Wrench for turning Square, Hexagonal and Round Nuts and Fittings of Various Sizes

gives an opening of the maximum width. The wrench is then pushed forward until the nut or other part to be turned engages both jaws. To tighten a nut or pipe fitting, the wrench is held with the sliding jaw at the top; conversely, the loosening of a nut is done with the sliding jaw at the bottom. On each side of the wrench there is a small arrow which indicates the proper direction in which to turn the wrench when in either of these positions.

XANDER UNIVERSAL ELECTRIC TEST INDICATOR

The universal electric test indicator illustrated and described herewith is in reality an attachment for the standard surface gage used by machinists and toolmakers. Its purpose is to save the operator from eye strain while watching for the contact of the surface gage needle with the work which is being trued up. With this tool, the moment the ball point of the needle touches the highest point on the work, either internal or external, an electric light flashes in the end of the tube, thus indicating the direction in which the work

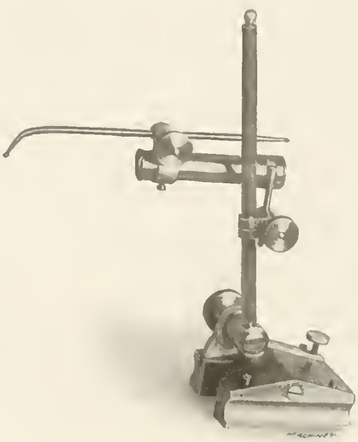


Fig. 1. Xander Electric Test Indicator mounted on Surface Gage

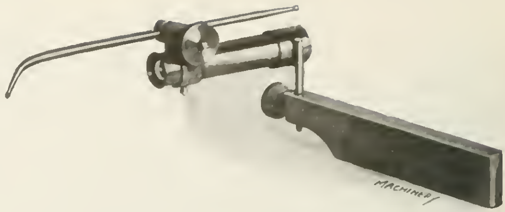


Fig. 2. Xander Electric Test Indicator provided with Holder to mount in Toolpost

must be moved. When a perfectly true position has been obtained, the light will burn continuously.

This indicator is extremely sensitive, as the lightest touch of the needle with the work will cause the electric light to flash. The tool is self-contained, the electric battery being enclosed in the main body of the indicator so that it can be connected with the electric light bulb without requiring the use of external wires or connectors of any kind. The battery can be renewed at small expense, but it has a capacity for several months' hard service before it is worn out. A holder is furnished for use with the indicator, which provides for mounting it in the toolpost of a machine in cases where it would be inconvenient to use a surface gage. This tool has been developed by J. G. Xander, 30 N. 9th St., Reading, Pa.

SCHATZ UNIVERSAL ANNULAR BALL BEARING

An annular ball bearing which is capable of sustaining a thrust load equal to 50 per cent of the rated radial load in either direction and without adjustment, has recently been developed by the Schatz Mfg. Co., Poughkeepsie, N. Y. This bearing is known as the Schatz universal annular ball bearing, and its ability to withstand end thrusts is due to the arrangement of the outer race which provides two points of contact for the balls. As a result, the balls have three points of contact, two of which are in the outer race rings and the third in the inner race ring.

The outer race is made in two parts, each of which has a curved recess generated on the inner periphery to form the raceways for the balls. This explains how each ball obtains a two-point contact on the outer race. The usual form of ball track is generated on the outside of the cone or inner race ring, and is designed to provide precise co-axial rotation. The curvature of the raceways is 4 per cent greater than that of the balls, so that a theoretical point contact is secured. The two points of contact on the outer race are so arranged that lines drawn through them and intersecting at the center line of the bearing form equal angles with the center line of the bearing. The contact point on the inner ring is located on the center line of the bearing, and the three-point contact provided affords a triangular support, the resultant of which is in a direction that enables the high thrust loads to be carried. The condition will be understood by referring to Fig. 2. Although this cannot properly be called a thrust bearing, the capacity for thrust loads is sufficiently high so that in many cases it is

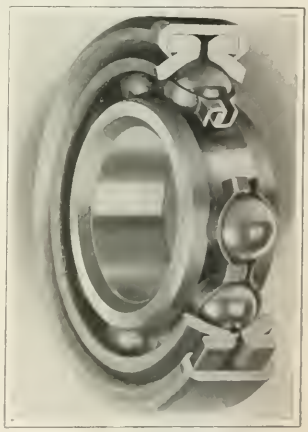


Fig. 1. Schatz Universal Annular Ball Bearing

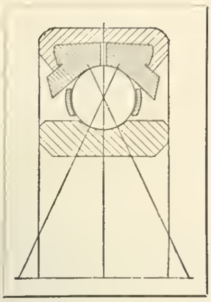


Fig. 2. Diagram of Contact Points of Balls on Races

unnecessary to provide a separate thrust bearing.

The outer race rings are a pressed fit in the case, and after assembling, the case is closed over the rings, thus fixing the relative positions between different parts of the bearing. The ball separator is made of pressed steel and is of a self-locking design which does away with the necessity of using rivets. The principle upon which the separator is constructed allows the maximum number of balls to be used, and also supports them upon their axes of rotation or at the points of minimum friction and wear. The accuracy of the balls is checked to be sure that they come within limits of 0.0001 inch, and the surface finish is carefully inspected to insure smooth and quiet running. All parts are made of high carbon chrome alloy steel with the exception of the case and ball separator. The dimensions of the bearings, such as the diameter, width, bore, etc., are in accordance with international standards, so that the bearings are interchangeable with those of other makes. S. A. E. standards are used throughout.

BOX DRILL JIG FOR REAR AXLE HOUSINGS

The Gem City Machine Co., Springfield, Ohio, has recently developed a box drill jig for use in drilling, reaming, tapping, chamfering and spot-facing holes in automobile rear axle housings. It will be seen from the illustration which accompanies this description that the jig swings on trunnions fitted in the cradle or base, and that the base is equipped with index pins for locating the jig in any of five positions. There is an index pin at each side of the base and these pins are operated simultaneously by a single hand-lever.

The rear axle housing is put in the jig through an opening covered by a hinged and latched lid; and the work is held in

Gem City Box Drill Jig for Use in machining Automobile Rear Axle Housings

place by means of hardened steel plugs which insure positive location. All parts of the jig which are subject to wear are hardened and ground to size, thus greatly reducing the possibility of inaccuracy of the work as a result of wear. At the bottom of the jig there is an interchangeable plate which has one direct and one angle hole. This plate may be interchanged from one end of the jig to the other and gives a positive location of the holes. The weight of the tool is 1100 pounds and it is equipped with rollers carried by hardened and ground steel pins. These rollers run on tracks which carry the jig under the machine and also enable it to be easily run back to remove the work.

SCHUCHARDT & SCHUTTE DIVIDED MACHINE VISE

To save time which is often lost in looking for suitable straps to secure a piece of work to a machine table, and to extend the capacity of the machine vise so that it will hold work of any size, Schuchardt & Schütte, 90 West St., New York City, designed the divided machine vise shown in the accompanying illustration. It will be seen that although the gripping surfaces of the jaws are vertical, their supporting bearings are inclined downward, and when the jaws are tightened up on the work this downward inclination overcomes any possible tendency of the work to rise from the table. As a result, it is unnecessary to resort to the practice of hammering the work down into place after it has been clamped on the platen.

It will be evident that while the two parts of this tool constitute the equivalent of a standard machine vise, the divided

Schuchardt & Schutte Divided Machine Vise

construction enables the two parts to be secured to the platen in suitable positions to accommodate any size of work that comes within the capacity of the machine on which the vise is used. By setting the jaws at the required angle, this divided vise may also be employed for holding tapered or angular work. It will also hold thin plates without danger of distortion. This vise is suitable for use on planers, milling machines, shapers, slotters, drill presses, and all other types of machine tools provided with tables having the usual arrangement of T-slots for clamping down the work.

PEERLESS HIGH-SPEED HACKSAW

The Peerless high-speed hacksaw built by the Peerless Machine Co., 1611 Racine St., Racine, Wis., is designed to operate at a speed of 250 revolutions per minute. Working at this rate it is suitable for cutting low carbon steel, soft

Fig. 1 Front View of Peerless High-speed Hacksaw

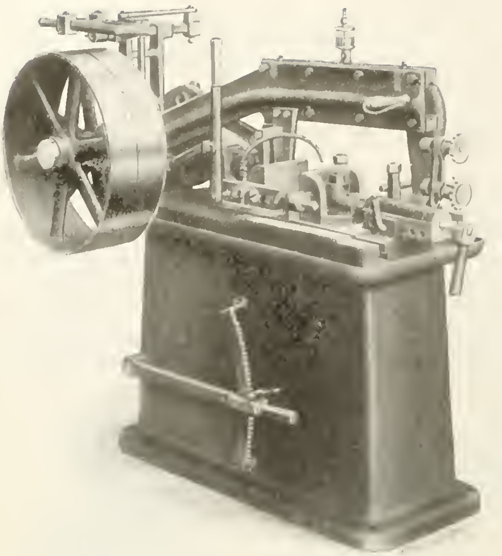


Fig. 2. Opposite Side of Hacksaw shown in Fig. 1

metals of numerous kinds, fiber, hard rubber, and a variety of other materials. The machine is built for both heavy and light work, and it will be evident from the illustrations that ample strength is provided for severe conditions of service; but the machine is so sensitive that common blades 8 by ½ by 0.027 inch in size, of the kind used in hand frames, can be successfully driven when the machine is running at a speed of 125 revolutions per minute. At this speed, 1-inch round cold-rolled steel can be cut in less than one minute. Tests have also been conducted to determine the possibility of cutting sheet steel 1/16 inch thick, that is one of the most severe tests to which the sensitiveness of the machine could be subjected, and the results of such tests are said to have been favorable. The use of thin blades results in a substantial saving of the amount of material wasted by each cut, and this is a particularly important consideration at the present time, owing to the scarcity and excessive cost of high-speed steel.

It will be seen that the frame of the machine is of the cabinet type which affords ample strength and avoids danger of springing the machine in cutting heavy work. The bottom of the cabinet forms a tank for the cutting compound, and the pump is located inside of the cabinet where it is out of the way. The cutting compound and chips are collected in a separate pan located just inside of the door in the cabinet; the chips are held in this pan and the cutting compound escapes into the reservoir. A point should be made of emptying the chip pan every morning when all the cutting compound has drained off from the chips, leaving them dry, as this is the means of saving cutting compound and of insuring uniform operation. The saw blade travels on the center line of the saw guide and connecting-rod, so that there is no chance for any side pull. The blade is secured by a clamping device which holds it at each end with straight hardened steel pins; and the saw tightener is designed in such a way that it also provides for holding saw blades of various lengths. The table has T-slots at each side of the vise by means of which irregular-shaped work can be clamped. The vise is of the quick-acting type and has a screw adjustment of 1 inch, the screw being enclosed to protect it from damage when setting up heavy bars on the machine. A quick-acting attachment is used when cutting flat pieces, which prevents the jaws from tilting.

The feed mechanism is operated by a spring which is so arranged that it has exactly the same effect as if a weight were employed; the feed pressure may be instantly changed by means of a lever located at the left-hand side of the machine. When this lever is down, there is no pressure on the blade, and with the lever in the top notch the feed pressure on the blade is 125 pounds. The blade is automatically lifted from the work on the idle stroke by means of a spring, and there is a cam on the main shaft which only allows the feed pressure to act on the cutting stroke. At the end of the cutting stroke the cam releases the feed pressure and the frame is automatically raised to clear the blade from the work until the end of the idle stroke is reached. The action of the mechanism is entirely positive, making it impossible for either the feed pressure to be applied or the blade to drag over the work on the idle stroke.

The feed mechanism is controlled by the belt shifting lever. When the belt starts to shift, the machine commences operation, but the feed does not come into action until the belt has been shifted through three-quarters of its movement. At this point the feed mechanism is thrown into action. In starting to cut on a square corner, when using the extreme feed pressure and a coarse tooth saw blade, it is advisable to take hold of the handle of the saw guide and allow a light feed pressure to be applied on the cutting stroke until the square corner of the work has been removed; otherwise there may be danger of breaking the teeth of the saw. An alternative method of doing the same thing consists of releasing the feed lever at the left-hand side of the machine, so that there is absolutely no pressure on the feed, and then slowly raising the lever so that the pressure is gradually applied to the blade. In this way the most delicate piece of work can be cut, as any desired feed pressure may be instantly obtained.

In case the saw blade should break, the saw frame cannot drop. Should the blade break, the rate of feed is increased until a position is reached corresponding to the completion of the cut, at which point the machine is automatically stopped in the same way as if the blade had not broken. As the feed mechanism is controlled by the belt shifter, the feed is always released before the machine stops. A height gage may be provided for cutting any size of work, and the gage can be set so that the frame is always brought into position ready for the next cut. All that is necessary is to loosen the vise, shift the stock, and commence taking another cut. The machine is also provided with a depth gage for automatically stopping it at any desired depth of cut; when stopped, the saw frame automatically rises to the starting point, which saves a considerable amount of time in preparing for taking the next cut. When a number of machines are being looked after by one man, the raising of the saw frame serves as a signal to notify him that the cut is completed.

RYERSON PNEUMATIC SPRING BANDING PRESS

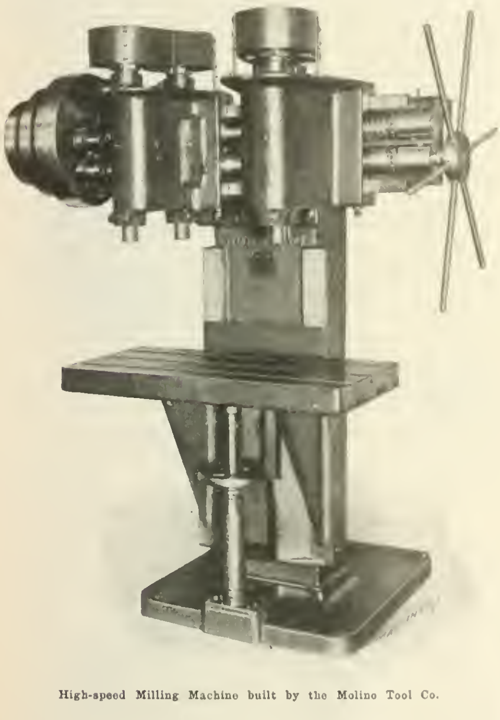
One of the recent additions to the machinery line of Joseph T. Ryerson & Son, Chicago, Ill., is the pneumatic spring band-

Pneumatic Spring Banding Press made by Joseph T. Ryerson & Son

ing press illustrated and described herewith. This press is particularly adapted for railroad and commercial spring manufacturing and repair shops that are not equipped with hydraulic power. The air cylinders are of such a size that with compressed air at a pressure of 100 pounds per square inch, a pressure of 60 tons is exerted on the rams. By means of both horizontal and vertical rams a positive pressure of predetermined intensity is exerted on the spring band which insures uniform results and a rapid rate of production. Each machine is furnished complete with three-way hand-operated valves and pressure gages. The weight of the press is 6500 pounds.

MOLINE HIGH-SPEED MILLING MACHINE

The four-spindle vertical milling machine which forms the subject of this description is a recent product of the Moline Tool Co., Moline, Ill. Reference to the illustration will make it evident that the design embodies a number of the same principles employed in the construction of multiple spindle drilling machines of this company's manufacture. The spindles are driven by the standard Moline spiral gear drive, and the heads are traversed toward or away from each other by

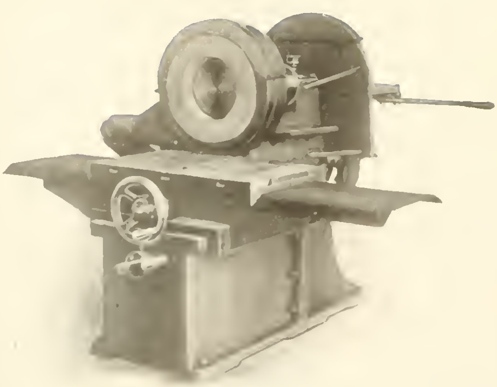


High-speed Milling Machine built by the Moline Tool Co.

right- and left-hand cam grooves in a shaft located below the drive. Only hand feed is provided, as the machine is intended for light work, and quick operation is the point of greatest importance. The table is provided with T-slots and may be made plain or with oil grooves as required. Machines of this type can be built with special heads and equipped with any desired number and arrangement of spindles to meet the requirements of the work.

GARDNER DISK AND RING-WHEEL GRINDER

The Gardner Machine Co., Beloit, Wis., has recently added to its line a combination disk and ring-wheel grinder which has been developed from the regular No. 6 Gardner machine. The special feature consists of the provision of a work-table at the left-hand end of the grinder; the top of this table is 20 inches wide by 30 inches long, and it is provided with the



Gardner Special No. 6 Combination Disk and Ring-wheel Grinder

usual form of T-slots for securing the work or fixtures in place. The table has a longitudinal travel of 20 inches, which is obtained by turning a handwheel at the front of the machine. This handwheel rotates a shaft and pinion which meshes with a rack attached to the under side of the table. The feed toward the wheel is actuated by a finely threaded screw which carries a crank, the length of travel being 6 inches. All parts of the mechanism which are subject to wear have guards which provide for the exclusion of dust and grit.

The machine is equipped with an 18-inch abrasive ring wheel held in one of the Gardner "Perfection" chucks; and the work to be ground is mounted on the table and fed over the wheel in the usual way. The right-hand end of the spindle is equipped with a 26-inch abrasive disk wheel. A universal lever feed table provides for holding the work ground by this wheel. Both the disk wheel and ring wheel are enclosed in dust hoods that are connected to an exhaust system at the rear of the machine. The spindle is 2 inches in diameter and the driving pulley 8 inches in diameter with a face width of 8½ inches. The equipment of the machine includes a 26-inch disk wheel press and the countershaft.

DETROIT BUTT WELDING MACHINE

The type P butt welder which is illustrated and described herewith is manufactured by the Detroit Electric Welder Co., Detroit, Mich. The features of the machine are the extreme simplicity of construction combined with ease of operation, and a capacity for handling a wide range of work. The rated capacity is for welding together two pieces of iron ¾ inch in diameter, but the actual capacity is considerably greater.

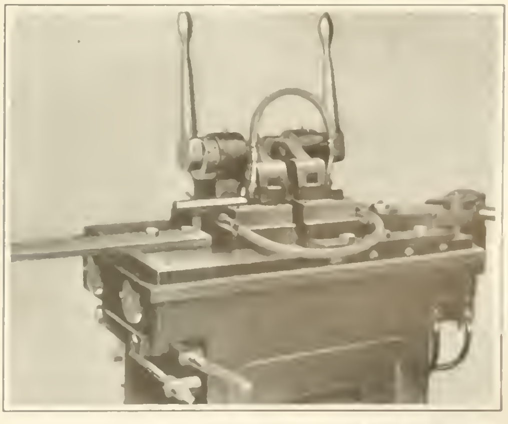


Fig. 1. Close View of Mechanism of Detroit Electric Butt Welding Machine

In addition to the welding of iron, the machine is also suitable for welding copper and brass.

One of the important features of this welder is the equalizing table with which it is equipped. By turning a handle, the table may be moved either horizontally or vertically to suit the convenience of the operator, thus permitting a careful adjustment of the electrodes and the production of a weld of the maximum efficiency. A stop is provided on the stationary frame of the machine so that the length of the metal on each consecutive operation is the same unless it is desired to be otherwise. The jaws and electrodes are both water-cooled, which insures the maximum life of these parts, and

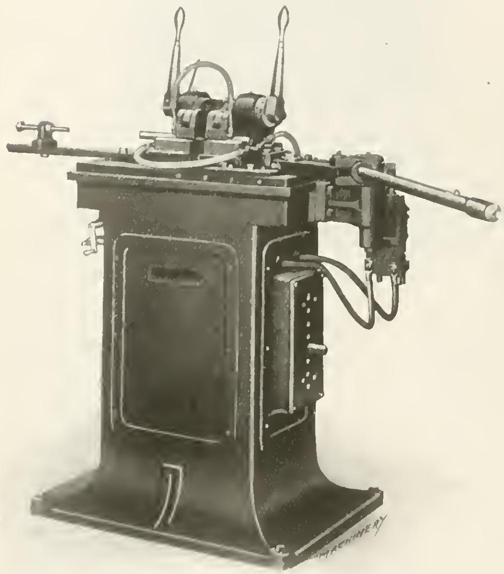


Fig. 2. Detroit Type P Electric Butt Welding Machine

the clamping levers are adjusted to meet the requirements of different work by simply turning an eccentric bushing. The upsetting lever is provided with a similar form of adjustment. Eight heat controls are provided which furnish any required temperature.

UNITED STATES HAND MILLER

The hand milling machine that forms the subject of the following description is built by the United States Machine Tool Co., which is the machinery department of the United States Electrical Tool Co., Sixth Ave. and Mount Hope St., Cincinnati, Ohio. The design and features of the machine are apparent from the illustration, and for this reason the following description is confined to an outline of the principal dimensions and capacity of the tool.

The principal dimensions are as follows: Size of table inside oil grooves, 5 by 22 inches; maximum adjustment of table under spindle, 16 inches; maximum adjustment of table in line with spindle, 7 inches; maximum table feed with hand-lever, 6 inches; maximum table feed with crank, 16 inches; vertical lever feed of spindle head, 5 inches; size of T-slots, 5/8 inch in width; size of tight and loose pulleys on countershaft, 8 inches in diameter by 3 1/4 inches face width; diameter of pulley on back shaft, 6 inches; floor space occupied by machine, 27 by 37 inches; and net weight, 900 pounds.

The standard spindle furnished with the machine is bored No. 9 Brown & Sharpe taper, but spindles bored No. 10 Brown & Sharpe taper can be furnished to special order. It will be of interest to note that the top of the table can be brought on a level with the center of the spindle. The pulleys on the spindle end of the back shaft are interchangeable, and with a three-step cone pulley having steps 7, 8 1/2 and 10 inches in diameter, six spindle speeds of 96, 138, 197, 268, 383, and 547 revolutions per minute are available. With a two-step cone pulley having steps 7 and 10 inches in diameter, four spindle speeds of 96, 197, 268, and 547 revolutions per minute are available. The cone pulleys on the countershaft and back shaft are of the same size.

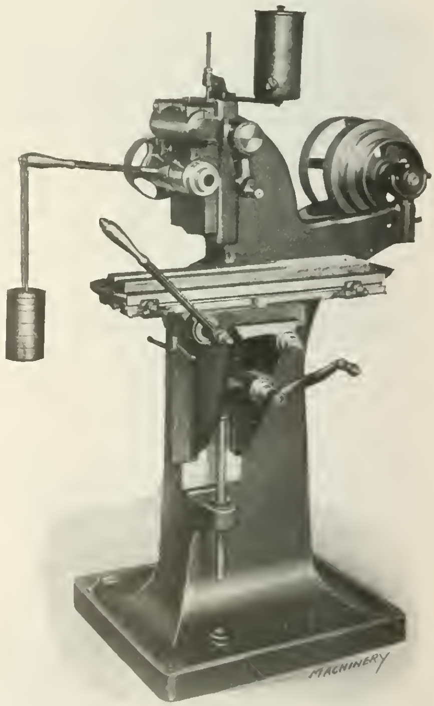
NEW MACHINERY AND TOOLS NOTES

Hydraulic Press: Mackintosh, Hemphill & Co., Pittsburg, Pa. This machine was designed and built for the Knox Pressed and Welded Steel Co., Wheatland, Pa. It has a pressure capacity of 400 tons and weighs 160,000 pounds.

Cutting-off Machine: Etna Machine Co., Toledo, Ohio. A heavy-duty machine adapted for cutting off solid and tubular stock up to 5 inches in diameter. The stock is held in a push-in collet which is bushed down to hold different sizes of work.

Scrap Baling Machine: Tempus Reclaiming & Mfg. Co., 25 N. 7th St., Philadelphia, Pa. A hydraulic machine for use in baling sheet metal scrap, which produces bales of square cross-section by the application of pressure at the top and at one end.

Irregular Curve Ruler: Keuffel & Esser Co., Hoboken, N. J. A flexible ruler for irregular curves. The ruling edge is made of black xylonite and a metal wire at the opposite edge provides for holding the ruler to the shape in which it has been set.



Hand Milling Machine made by the United States Electrical Tool Co.

Expansion Shield for Lag-screws: Diamond Expansion Bolt Co., 90 West St., New York City. A shield intended for use on lag-screws which are subjected to heavy loads. The shield enables screws to be placed in materials that do not afford a good grip for the threads.

Face and Tool Grinder: Mummert-Dixon Co., Hanover, Pa. This is a multiple-purpose machine. At one end there is an arbor which carries a coarse and a fine oilstone for use in sharpening cutting tools. At the other end of the machine there is a face grinding wheel for general grinding operations.

Forcing Press: Metalwood Mfg. Co., Detroit, Mich. A horizontal forcing press designed to give a high-speed stroke and quick return. The machine may be provided with belt drive, direct-current motor drive, or arranged for connection with an accumulator. The pump is of the duplex type with the body made of bronze.

Electric Welder: National Electric Welder Co., Warren, Ohio. A machine designed for the purpose of welding the ring section to the rim of pressed steel pulleys. In performing the welding operation one-half of the pulley rim is locked to a rotating carrier with the ring section and spokes in place, after which the welding operation is performed.

Planer Controller: Cutler-Hammer Mfg. Co., Milwaukee, Wis. A mechanical controller for use on planers equipped with reversing electric motor drive. The chief advantage claimed for the mechanical device is that it will be more readily understood by the average planer operator than an electrical device, and as a result it will receive the proper care and adjustment.

High-duty Lathe: Duff Mfg. Co., Pittsburg, Pa. A machine particularly adapted for turning work of small diameter. The swing over the saddle is 12 inches, and work may be turned which is of any diameter below 12 inches at approximately the most efficient cutting speed. The machine may be driven by a silent chain, it may be arranged for group drive from a common lineshaft, or a geared drive may be employed.

Shaft Straightening Press: Metalwood Mfg. Co., Detroit, Mich. A 50-ton press in which the work is held stationary; the cylinder and ram which apply the pressure are arranged to traverse along the bed of the machine to apply the load at any required point. The machine is provided with a hand-operated pump with automatic release, and the up and down movement of the ram is controlled by air pressure. The ram has a stroke of 8 inches and the maximum distance between centers is 72 inches.

Manufacturing Lathe: William B. Mershon & Co., Saginaw, Mich. A lathe designed to meet the requirements of manufacturing plants in which the use of heavy speeds and feeds is the rule. The swing over the bed is 22 inches, and over the carriage 14 inches; the distance between centers for an 8-foot bed is 3 feet, 8 inches. A silent chain drive is ordinarily provided for transmitting motion to the feed, but a belt may be substituted if desired. The weight of the machine with an 8-foot bed is approximately 4000 pounds.

Single-purpose Lathe: Duplex Printing Press Co., Battle Creek, Mich. A machine developed to meet the requirements of shell turning. The design follows conventional lines, the chief aim of the designer having been to produce a rigid machine capable of meeting the severe service conditions which exist in ammunition factories. Two quick changes of speed are provided by the gear-box, and there are four changes of feed. The swing over the bed is 19 inches and the swing over the carriage 11½ inches. The capacity between centers is 34 inches.

Bench Milling Machine: Bickett Machine & Mfg. Co., 1110-1112 Richmond St., Cincinnati, Ohio. A tool designed for splining and milling small parts at high speed. Such products as parts of rifles, revolvers, automatic machines, typewriters and sewing machines may be very satisfactorily handled on this bench miller. The spindle is made of high carbon steel, ground all over, and mounted in ball bearings which are provided with dust-proof covers. Both the table and knee are provided with adjustable stops and the cross-feed knob is graduated to read to 0.001 inch.

Friction Clutch: Bicknell-Thomas Co., Greenfield, Mass. A combination friction clutch and pulley which has been designed with a view to avoiding unnecessary weight and to secure easy operation. Other features of the design are the provision of means for making adjustment for wear and the development of a construction of extreme simplicity. The body is keyed to the shaft and held in position by hollow set-screws; it carries two friction shoes which work on the inner surface of the rim. Clutches of this type are made in capacities ranging from 4 to 12 horsepower at 100 R. P. M.

Electric Cylinder-seam Welding Machine: Toledo Electric Welder Co., Langland & Knowlton Sts., Cincinnati, Ohio. A motor-driven seam welding machine designed for the purpose of rapidly welding the seams of cylinders made of sheet steel or lead coated stock. It has a capacity for welding a 12-inch seam in five seconds, and working at this rate of production the machine leaves a perfectly smooth surface which is ready to be enameled or finished in any other way. The joint is water- and gas-tight. To obtain the required accuracy when producing duplicate parts, gages are furnished to enable the operator to turn out product of the required dimensions.

Band Turning Machine: Traylor Engineering & Mfg. Co., Allentown, Pa. A machine for forming the copper rifling bands on shrapnel and high-explosive shells. The work is held by a positive opening and closing chuck operated by compressed air. Control is afforded by a lever placed in front of the machine. The forming of the copper band is done with two tools which work successively. The capacity is for shells ranging from 2 to 6 inches in diameter and an idea of the rate of production will be gathered from the fact that the band on two 18-pound high-explosive shells has been completed in 50 seconds. Production can be maintained at the rate of 100 shells per hour.

ACCIDENTS AND HEALTH

Protection of the worker against ill health as well as accidents is a new extension of the safety movement that is being promoted by the American Association for Labor Legislation, whose headquarters are at 131 E. 23rd St., New York City. This extension, according to the association, can be brought about most effectively through a comprehensive health insurance measure. Instead of placing all the burden upon the employer, as the workmen's compensation laws have done, the bill for health insurance drafted by the association proposes to distribute the cost between the employer and workmen and to obtain a subsidy of one-fourth the total from the state. When the bill becomes a law, all manual workmen and others earning less than $100 a month will receive medical care and sick benefits for not more than twenty-six weeks of sickness in a year. The wife will receive special attention at childbirth and the family will be sssured of medical care and a small funeral benefit upon the death of the wage earner. It is believed that such a measure will not only protect the workers when ill, but it will also call attention to the possibility of preventing sickness, just as fire and accident insurance have stimulated preventive measures in these fields. Employers and others interested in the proposed legislation should obtain from the association a copy of *Health Insurance*.

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CARPENTER THREADING DIE-HOLDERS

The holders shown in Figs. 1 and 2, which are for use on threading dies and mills or other tools made in the form known as prong, spring or acorn dies, are a recent product of the J. M. Carpenter Tap & Die Co., Pawtucket, R. I. Tools

Fig. 1. J. M. Carpenter Threading Die-holder which supports Outer Ends of Prongs

made in this form have been defective to a certain extent from a lack of support near the outer ends of the prongs where the work is being done. The illustration of the two dies

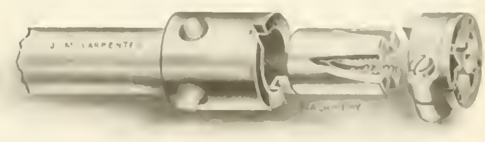


Fig. 2. A Simpler Form of the J. M. Carpenter Threading Die-holder

shown in Fig. 3 is proof of this statement, as this illustration was made from dies that were twisted in the condition shown here from actual use, showing a lack of support on each land or prong. These die-holders, which were patented September 28 and November 9, 1915, give this much needed support by placing dogs or stops on the adjustable rings which are locked firmly to the holders. These stops engage with the prongs near the outer end on the back side of same, thus holding the prongs firmly in place while they are under the strain of cutting. The acorn die was first brought out by J. M. Carpenter many years ago and was patented May 12, 1896.

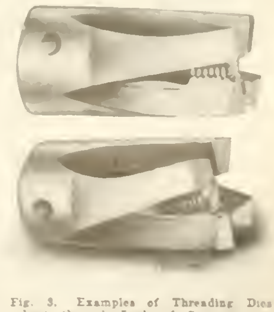


Fig. 3. Examples of Threading Dies bent through Lack of Support at Outer Ends of Prongs

DEPOSITED COPPER PARTS

There are many parts that are generally made from sheet copper in which the presence of a seam of any kind is undesirable, but in methods of manufacture that have been commonly employed—particularly in the case of tapered parts or pieces where one tube surrounds another—the presence of a seam in the work is a practical necessity. In attempting to develop a method of manufacture that would avoid the necessity of having a seam in the work, it became evident that the development of some method of depositing the copper electrolytically would constitute an ideal means of overcoming the difficulty.

The method employed by pioneers in this work consisted of making a wax core of the shape and size of the interior of the part that it was desired to make. This core was then made one of the terminals of an electrolytic cell containing a solution from which copper would be deposited on the core. A film of any desired thickness could be obtained by continuing the operation for a sufficient length of time. Although the method just described afforded a means of producing seamless parts, the use of the wax core had two serious drawbacks. First, it was found difficult to deposit the copper uniformly on the core; in many cases the metal was found to vary considerably in thickness, and in extreme cases there were small holes extending right through the metal. Second, it was found that the copper deposited on the wax core possessed a relatively low tensile strength.

These limitations of the process suggested the possibility of further improvement and the Cobal Co., Inc., 29 Thirteenth St., Long Island City, N. Y., has developed a method by which the objectionable features of depositing the copper on a wax core have been eliminated. It consists of employing a die-cast white metal core in place of wax, as the results of experiments have shown that copper deposited on the metal core will be of uniform thickness and that the strength of the metal will be materially greater than in cases where the deposit is made on wax.

The illustrations show examples of parts made by the Cobal Co., and will give an idea of the scope of the process. This is particularly true in the case of the manifold for an automobile engine, illustrated in Fig. 2, which shows what com-

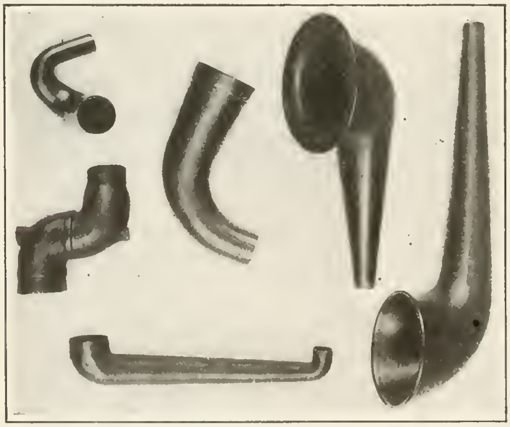


Fig. 1. A Few of the Parts which the Cobal Co. is making by Electrolytic Deposition of Copper

plicated parts can be made. The cross-sectional view in this illustration shows an example of a compound tubular structure. In producing such a part, a core is first made for the inner tube and the copper shell is deposited on this core in the usual way. Then a second core is cast around the inner tube to provide for depositing copper to form the outer tube. On parts of the general type shown in Fig. 2, the flanges are made separately and electrically welded to the ends of the tubes. In all cases, after the copper has been deposited, the work is put in a heating furnace where its temperature is raised sufficiently to melt the white metal core so that it may be poured out of the copper tube. As the melting point of white metal is approximately 600 degrees F. while that of copper is 1981 degrees F., it will be evident that it is an easy matter to melt the white metal without bringing the copper anywhere near the melting temperature.

Among the parts of the products which the Cobal Co. is making by this method, the following may be mentioned: water jackets for gas engines, water-jacketed gas intakes for

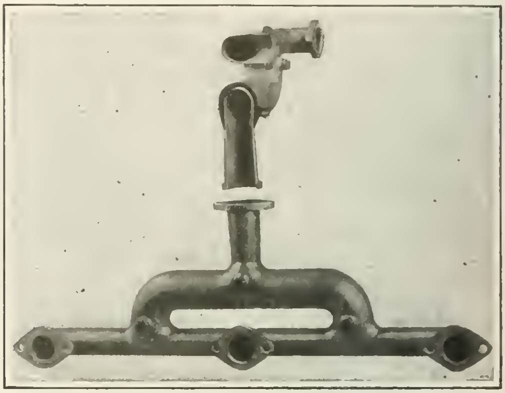


Fig. 2. Case in which Double Tubular Structure is produced by Electrolytic Deposition of Copper

gas engines, tapered fittings, elbows, copper-coated steel wire and rollers, announcer horns, fittings and tubing for phonographs, incubator parts, etc.

* * *

NEW YORK ANNUAL AUTOMOBILE SHOW

The fifteenth annual automobile show held at the Grand Central Palace, New York City, from December 31 to January 8, inclusive, brought together a notable exhibit of products of the leading manufacturers of motor cars and accessories throughout the country. This annual motor show is an event of national importance. It places before the buying public the new products of an industry that in a few years has become third in importance in the manufacturing of the United States, steel and cotton being first and second.

Four floors of the Grand Central Palace were required to provide space for the cars and accessories. On the ground and mezzanine floors, the space was given over to complete cars and chassis. In many cases the chassis and engine parts were cut out in such a manner as to show the operation of the engine, transmission and other parts to advantage. On the third and fourth floors were shown motor car accessories. These, from the mechanic's point of view, were probably the most interesting, as many novelties were included, and the construction of the devices shown were in many cases made clear by sectional cuts or disassembled parts. A noteworthy feature of the exhibit was the large number of attractive two- and five-passenger cars, ranging in price from about $650 to $900.

During the past year there has been much discussion of eight, and twelve-cylinder automobile engines. Although a multiplicity of cylinders has advantages, it also has disadvantages, and while a number of cars shown were of the eight- and twelve-cylinder types, most of the leading models were of the six-cylinder type. It is apparent from the exhibition of cars that the standard by which the automobile engineers measure an engine is its power, cost of production and cost of operation rather than by the number of cylinders. According to this standard, the six-cylinder engine is probably equal if not superior to all others. The eight- and twelve-cylinder cars in use apparently give satisfactory service, but if the 1916 show is a criterion, the six-cylinder car is here to stay. The high-priced car of four or five years ago, having an engine of twenty-five to thirty horsepower, has been developed into a car that averages fifty horsepower and costs considerably less than $2000 fully equipped. In fact, the equipment

is more complete than that furnished a few years ago with cars of double the price, and much of the special equipment formerly found only on high-priced cars is now a feature of the less expensive makes.

Another prominent feature was the limousine or all-year-round body. This type has, in the past, been obtainable only in the most costly cars, but now there are several cars with limousine bodies sold for less than $1000. The motor car has proved its usefulness as an all-year car rather than a summer luxury. Several companies have been formed during the past year for the purpose of making limousine bodies for all makes of cars and have apparently found a ready market for their product. A large part of the motor car builders now provide either permanent or detached limousine bodies, and this development is likely to make motor cars even more popular with those who use them for business purposes in winter.

The most prominent features apparent to the casual observer at the show were the increased power of the engines, simplification and reliability in power equipment, improved appearance of the bodies and the large reduction in cost of well known makes. As to engine design, it may be said that the best makes with few exceptions have standardized the six-cylinder small-bore, long-stroke engine having a power capacity of about fifty horsepower. The weight of the cars has been greatly decreased by the use of alloy steels and aluminum alloys in cylinders, crank casings, pistons, etc. In most respects the present $2000 cars are superior to cars built four or five years ago at any price.

* * *

NATIONAL-ACME MFG. CO. PURCHASES WINDSOR MACHINE CO.

The National-Acme Mfg. Co. has acquired the plant of the Windsor Machine Co., Windsor, Vt., and the present intention is to continue the Cleveland, Montreal and Windsor plants of the National-Acme Mfg. Co. along the lines heretofore followed with a view to expanding them as rapidly as conditions seem to warrant. It was voted at a special stockholders' meeting held in Cleveland, January 20, to increase the capital stock from $2,500,000 to $9,000,000 ($7,500,000 common and $1,500,000 preferred) for the purpose of providing funds for an extension at Cleveland which is about complete, for contemplated improvements at Montreal, and to provide in part for the purchase of the Windsor property. The price paid for the stock of the Windsor Machine Co. was $3,575,000 or $1100 per share.

* * *

CENSUS OF MANUFACTURERS

An organization is contemplated consisting of representatives of the American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society of Civil Engineers, American Institute of Mining Engineers, and American Chemical Society, to collect data of the machine shops and factories of the United States that might be available for the manufacture of munitions of war in case of an emergency. President Woodrow Wilson, in a communication to W. L. Saunders, president of the American Institute of Mining Engineers, expressed hearty sympathy with the idea, regarding it as a patriotic service. The board of engineers suggested by the president will comprise a representative member of each of the five societies in each of the forty-eight states of the Union, which means a national board of 240 engineers. Behind these men will be the combined membership of the societies which totals more than 38,000 mechanical, electrical, civil, mining, and chemical engineers.

Mr. Saunders states that a preliminary census of the industries of New Jersey was made, including every factory and plant, large and small, which, after elimination, was found to include about 800 factories that produce things which would be needed in the event of war. The plan, if carried out for the entire nation, would give the government complete data as to the resources of each and every factory, the nature of its activities and what materials it would be best prepared to furnish. The value of such a national mobilization of manufacturing resources in a great emergency could hardly be overestimated.

JOHN A. HILL

John A. Hill, president of the Hill Publishing Co. and principal owner of the *American Machinist*, who died suddenly of heart disease on January 24, was a fine example of the typical American who from modest beginnings has risen by inherent ability and energy to a commanding position of honor and wealth. Mr. Hill was born in Vermont, February 22, 1858, and taken West by his parents when a small boy, first to Wisconsin, later moving in a "prairie schooner" to the plains. He returned to Wisconsin when a lad and worked for six years in a printing office. Later he took up the study of mechanics, working as a machinist in Colorado, and at the age of twenty was a locomotive engineer on the Denver & Rio Grande Railway, engaged in the work of extending the line through the Rocky Mountains. In 1885 he turned to newspaper work, and for about a year was editor and one of the owners of the *Pueblo Press*, which he left to return to railroading, where he remained until 1887. During those years some of his spare time was given to writing for the *American Machinist*, and his articles were so highly regarded that in 1887 he was offered a position as editor of the *Locomotive Engineer*, publication of which was begun by the *American Machinist* in that year, and which he and Angus Sinclair bought in 1891, changing the name to *Locomotive Engineering*. In 1896 the two partners also bought control of the *American Machinist*, and on the dissolution of their partnership a year later, Mr. Sinclair took *Locomotive Engineering* and Mr. Hill the *American Machinist*. He rapidly increased the income and value of his journal, and in 1902 was able to buy *Power*, which was the leading periodical in its field. Three years later he acquired the *Engineering and Mining Journal* and in 1912 the *Engineering News*. Then he began the publication of the *Coal Age* and recently bought the *Colliery Engineer* and consolidated the two. In 1902 Mr. Hill merged all his publishing interests in the Hill Publishing Co., capitalized at $1,000,000. One of Mr. Hill's cherished ambitions was realized in 1914 by the erection of a modern twelve-story fireproof printing building to house his publications, at Tenth Ave. and Thirty-sixth St., New York City, which included many original ideas for a structure devoted to that business. Mr Hill was a man of strong and attractive personality and unbounded energy, generous, warm-hearted and a good friend. He leaves a widow and one daughter, Miss Jean C Hill.

* * *

PERSONALS

Victor Brook, tool designer for the Arrow Electric Co., Hartford, Conn., has joined the editorial staff of MACHINERY.

R W. Johnson, superintendent of the Emil Grossmann Mfg. Co., Inc., Brooklyn, N Y., has resigned to take the position of factory manager with the Weiner-Barnet Co., Newark, N. J.

William H. Carpenter, formerly superintendent of the East

Bristol brass mill of the Bristol Brass Co., Bristol, Conn., has been appointed manager of the Mayo Radiator Co. of New Haven, Conn.

Norman B. Chase, for many years superintendent of the Cincinnati Shaper Co., Cincinnati, Ohio, has resigned the position to become vice-president and general manager of the Fosdick Machine Tool Co. of Cincinnati.

Charles F. Scribner, formerly production engineer with the Colt's Patent Fire Arms Mfg. Co., Hartford, Conn., has joined the Cleveland Twist Drill Co., Cleveland, Ohio, to fill the position of assistant superintendent.

C. H. Handerson has succeeded A. E. Coburn as advertising manager of the Cleveland Twist Drill Co., Cleveland, Ohio. Mr. Coburn resigned to take the position of advertising manager of the Maxwell Motor Co., Detroit, Mich.

Martin G. Sperzel has resigned his position as sales engineer for the Standard Roller Bearing Co., Philadelphia, Pa., and has taken a similar position with the Royersford Foundry & Machine Co., 54 N. 5th St., Philadelphia, Pa.

L. W. Coppack has been made sales manager for the Plank Flexible Shaft Machine Co. of Grand Rapids, Mich. Mr. Coppack will travel extensively in the interests of the company, selling flexible shafts and universal joints.

Paul R. Ketzer, formerly connected with the Watson-Stillman Co., New York, has been appointed eastern manager in charge of sales of the Metalwood Mfg. Co., Detroit, Mich., with an office in the exhibition department of the Philadelphia Bourse.

Leslie B. Stauffer was elected secretary of the Warner & Swasey Co., Cleveland, Ohio, at the recent annual meeting of the stockholders. Mr. Stauffer, who has been with the company seventeen years, started as a clerk in the factory. He succeeds Frank A. Scott who has been made vice-president.

Alfred P. Mello, formerly of the Westinghouse Co., Springfield, Mass., has been appointed chief engineer and superintendent of the Davis Arms Co., Boston, Mass. This company is equipping a large plant for the manufacture of military rifles and expects by June to be turning out 1000 Spanish-Mauser rifles a day.

E. C. Waldvogel, who has been connected with the Yale & Towne Mfg. Co., New York City, for the past eleven years, and has successively filled the positions of traveling salesman, sales manager, and assistant general manager, has been appointed general manager. In addition to the regular duties which belong to his new office, Mr. Waldvogel will have general supervision of all domestic, Canadian and export sales.

A. S. Baldwin, works manager of the R. D. Nuttall Co. of Pittsburg, Pa., a large manufacturer of commercial cut gears, has resigned to take the position of manager of ordnance for the Poole Engineering & Machine Co. of Baltimore, Md. The Poole Engineering & Machine Co. has contracts approximating $19,000,000 with foreign governments for war munitions. Mr. Baldwin was for three years general manager of the Alberger Pump & Condenser Co., Newburg, N. Y.; four and a half years general superintendent of Driggs-Seabury Ordnance Corporation, Sharon, Pa.; and two years superintendent of the American-British Mfg. Co., at Bridgeport, Conn.

OBITUARIES

Asa S. Cook, president of the Asa S. Cook Co., Hartford, Conn., died January 13 of pneumonia. Mr. Cook left four children.

D. Lorenzo Stebbins, a large manufacturer of mowing machines, died at his home in Hinsdale, N. H., December 28, aged eighty-eight years.

Henry M. Geis, salesman for the Brown & Sharpe Mfg. Co.'s Chicago store, died at his home in Maywood, Ill., December 21, aged thirty-five. Mr. Geis left a widow and one son.

William B. Ruggles, head of the Ruggles-Coles Engineering Co., New York City, and for more than twenty years a prominent engineer, died at his home in Bergen Point, N. J., January 23, aged fifty-four years.

Benjamin M. Jones, president B. M. Jones & Co., Inc., Boston, Mass., died at his home in Boston, November 26, aged seventy-eight years. Mr. Jones, representing Samuel Osborn & Co., Sheffield, England, had the distinction of introducing to the metal-working industries of America, the well-known "Mushet" self-hardening steel in the early seventies, shortly after its discovery.

Prof. Ole N. Trooien, Brookings, South Dakota, died December 21, aged thirty-five. He graduated from the engineering department of the State College of Brookings and spent a year at the University of Wisconsin. His illness began with an attack of the bends in 1908 while employed as engineer in the construction of the Pennsylvania R. R. tunnels under the Hudson river. His thesis on steam engine design, written at the University of Wisconsin in 1907, is now largely incorporated in some of the mechanical engineering handbooks.

Robert H. Grant, a well-known expert in the manufacture of balls and design of ball-making machinery, died at his home in Ann Arbor, Mich., January 11. He was a graduate of the Fitchburg High School, Fitchburg, Mass., and the Fairchild Institute of Flushing, N. Y. His mechanical training was obtained with the Pratt & Whitney Co. of Hartford and the Simonds Rolling Machine Co., Fitchburg, where his father, John J. Grant, who built and equipped the first ball-bearing factory, was superintendent. With his father, Mr. Grant organized the Grant Anti-Friction Ball Co., which was later consolidated with the Cleveland Machine Screw Co. of Cleveland, Ohio. When the Cleveland Machine Screw Co. was sold to a French syndicate, Mr. Grant organized the Grant Ball Co. of Cleveland, which manufactured balls and screw machine products. Selling his interest in this company, Mr. Grant became superintendent of the Standard Roller Bearing Co. of Philadelphia, Pa., which at that time had only a small factory, employing fifteen men. Within three years the company acquired control of ninety per cent of the ball trade of this country and had built and equipped a plant covering several acres. After having been with the company eight years, Mr. Grant resigned and spent some years designing machinery and equipping plants for the manufacture of balls and ball and roller bearings. Mr. Grant was a valued contributor to MACHINERY. In the February, 1912, number he began a series of articles on the manufacture of steel balls and ball and roller bearings, which made public for the first time much valuable information on the theory and practice of ball making.

COMING EVENTS

February 21-26.—"Safety First" exhibit, under government auspices to promote safety in mining. A conference of state mine inspectors will be held at the office of the Bureau of Mines, February 24.

Sept. 11-16.—Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Yale University, New Haven, Conn. Catalogue of the Sheffield Scientific School for the college year 1915-1916.

Society of Automobile Engineers, 29 W. 39th St., New York City, at its annual mid-winter meeting, held in New York in January, elected the following officers: Russell Huff, president; Eugene E. Foljambe and Robert H. Combs, vice-presidents; Herbert Chase, treasurer; Edwin R. Hall, David Beecroft, John G. Utz and George W. Dunham, members of the council.

Motor and Accessory Manufacturers, 33 W. 42nd St., New York City, held its twelfth annual meeting in New York in January. F. Hallett Lovell, Jr., was elected president; C. W. Stiger, C. E. Thompson and T. J. Wetzel, vice-presidents; L. M. Wainwright, treasurer; and Alfred P. Sloan, Jr., secretary and assistant treasurer. William M. Sweet was continued as manager of the organization.

Association of Engineering Societies, St. Louis, Mo., organized in 1881, has been disbanded and the publication of the "Journal of the Association of Engineering Societies" has been discontinued. The Engineers' Club of St. Louis, the largest society in the association, has begun the publication of a bi-monthly journal, known as the "Journal of the Engineers' Club of St. Louis." The subscription price is $2 a year.

American Association for Labor Legislation, 131 E. 23rd St., New York City. Booklet entitled "Health Insurance," containing standards and tentative draft of a proposed health insurance act to be brought before the New York legislature at the present session. The Act will provide for the insurance of workers against ill health and will provide medical care and sick benefits for all workers receiving less than $100 a month for not more than twenty-six weeks sickness in a year. The cost will be distributed between employer and workman and the state.

American Electrochemical Society, 239 W. 39th St., New York City. The New York section of the American Electrochemical Society has arranged a symposium on "Electrochemical War Supplies" which it will hold jointly with the New York sections of the American Chemical Society and the Society of Chemical Industry at the Chemist Club, 52 E. 41st St., New York City, Friday evening, February 11. Lawrence Addicks will speak on "Electrochemical War Supplies;" W. S. Landis on "Air Saltpeter;" E. D. Ardery (U. S. Army) on "Hydrogen for Military Purposes;" Albert H. Hooker on "New War Products;" William M. Grosvenor on "Magnesium;" G. Ornstein on "Liquid Chlorine;" and George W. Sargent on "Electric Steel."

NEW BOOKS AND PAMPHLETS

Mechanical World Pocket Diary and Year Book for 1916. 429 pages, 4 by 6 inches. Illustrated. Published by Emmott & Co., Ltd., Manchester, England; distributed in the United States by the Norman-Remington Co., Baltimore, Md. Price, 30 cents.

This collection of useful engineering notes, rules, tables and data, has been published by the "Mechanical World" for twenty-nine years, and is well known to the engineers of Great Britain and, to a lesser degree, in the United States. The section on steam boilers has been largely rewritten in this twenty-ninth edition and much additional information introduced on boiler mountings, etc. Some notes on brazing and soldering have been included and new tables regarding the Lancashire and Cornish boilers, dimensions of locomotive boilers, steel plates, friction clutches, circle spacing, etc. The little work is one that every engineer, designer, draftsman and mechanic should often find of use.

Mechanical Engineer's Pocketbook. By William Kent. 1526 pages, 4 by 6¾ inches. Published by John Wiley & Sons, Inc., New York City. Price, bound in leather, $5, net.

This well-known reference book of rules, tables, data and formulas was first published in 1895, and it now appears in the ninth edition, revised. The revision was accomplished with the assistance of Robert T. Kent. A review of the work as a whole would be superfluous, and it will be desirable only to state the changes that have been made since the eighth edition was published in 1910. Many engineering standards have been changed in this period which made a thorough revision of many sections of the work necessary. These changes involved over 400 pages and required the addition of over 150 pages of new matter. Chapters on many subjects in the earlier editions have been condensed in order to permit the insertion of new matter without increasing the size of the book to unwieldy proportions. The chapter on machine shop practice has been rewritten and doubled in size, and now covers many subjects omitted in earlier editions, including data on planing, milling, drilling and grinding, machine tool driving, etc. Among the new tables included are tables of square roots of fifth powers, four-place logarithms, standard sizes of welded steel pipe, standard pipe flanges, properties of wire rope, firebrick, properties of structural sections and columns, chemical stand-

Speaking of Spindle Power and Rigidity Consider this Operation

It consists in milling gas engine connecting rods, eight at a time. Rods are held in vertical position in a swinging jig, four on each side, and are milled on both ends. Four rods present the big end and four the small end to the six cutters at the same time. The milled surface across the big end is 2½″ diameter; small end 1¼″ diameter; ¼″ stock. There is also an oil wick extension on the large end which is milled with two cutters 4½″ x ⅝″. Four cutters are 10″ x 2″. They rotate 21 R. P. M., or 55.3 feet per minute; feed is 4¾″ per minute. Production is 32 rods per hour, *monthly average.*

The Cincinnati No. 2 Plain Miller

The above work is done by the Rutenber Motor Company, Marion, Indiana, on a Cincinnati No. 2 Plain Miller. The special feature in this operation which shows up "Cincinnati" rigidity is the height at which the cutters work from the clamped fixture and the entire absence of chatter marks from the finished work.

Give us the opportunity to show what "Cincinnati" Millers can do for you.

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO, U. S. A.

ards for iron castings, flow of air, water and steam, power required for driving machine tools, both singly and in groups. The index has been amplified and is so arranged as to make quick finding of subjects easy. The general popularity of "Kent" is attested by the fact that the total issue is 108,000.

NEW CATALOGUES AND CIRCULARS

International Engineering Co., Cleveland, Ohio. Catalogue of tapping, countersinking and deep-hole drilling machinery.

G. M. Yost Mfg. Co., Meadville, Pa. Catalogue 7, giving dimensions and prices of universal machinists', blacksmiths' and wood-workers' vises.

W. J. Savage Co., Inc., Knoxville, Tenn. Circular of Gray's sheet metal cutter No. 1 for cutting sheets or plates up to and including 3/16 inch in thickness, with a reciprocating tool.

U. S. Machine Tool Co., Cincinnati, Ohio. Circular of No. 1 manufacturers' hand milling machine. The U. S. Machine Tool Co. is the machine tool department of the U. S. Electrical Tool Co.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet descriptive of Dixon graphite products, for lubricating cylinders, valves, bearings, slides, gears, chains, and all kinds of mechanisms.

General Electric Co., Schenectady, N. Y. Bulletin 43253, treating of series luminous arc lamps of the pendant type, showing the illumination obtained by these lamps on streets in various cities.

Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn. Circular of the Armstrong ratchet nipple threader for threading pipe in close places where ordinary die-stocks cannot be used.

Steel-Art Tool Co., Machinery Hall, Chicago, Ill. Catalogue 6 on "Satco" safety drill-holders, safety tool-holders, safety sleeve ratchets, live pipe center for lathes, boring-bars and bar holders, and safety lathe dogs.

Shepherd-Prince Co., Inc., 18 E. 41st St., New York City. Circular of the "Master" wrench, consisting of an alligator type wrench with one sliding jaw that adapts the wrench for all sizes of square and hexagonal nuts, pipe, etc., within its capacity.

Bickett Machine & Mfg. Co., Cincinnati, Ohio. Circular of "National" No. 0 hand miller for splining and milling small parts at high speed. Parts of rifles, revolvers, automatic machines, typewriters and sewing machines can be machined with great rapidity.

Joseph T. Ryerson & Son, Chicago, Ill. Circular of a pneumatic spring banding press, especially designed for railroad and commercial spring manufacturing and repair shops. The press exerts a pressure of sixty tons on the two rams with an air pressure of 100 pounds per square inch.

High-Speed Hammer Co., Rochester, N. Y. Catalogue of riveting hammers of the pedestal vibrating arm type, made in several styles and sizes. The machine delivers an elastic blow; the smallest machine has capacity for 3/16 inch rivets, and the largest is designed for 1/4 inch to 5/8 inch rivets.

General Ordnance Co., Denver, Colo. Bulletin of 22-inch heavy-duty single-purpose projectile lathe, having a swing of 22 inches over the shears and 13 3/4 inches over the carriage. This lathe is built with only two speeds; the ratios of the driving pulley to the spindle are, respectively, 1 to 5 and 1 to 3.

Newman Mfg. Co., 717-721 Sycamore St., Cincinnati, Ohio. Circular of Newman multiple rotary chuck for converting engine lathes into turret lathes at small cost; and "Spotlight" brackets with special guards, reflectors and shades for holding incandescent electric lamps in any desired position without danger of breakage.

Toledo Electric Welder Co., Langland and Knowlton Sts., Cincinnati, Ohio. Bulletin 17 containing information on heavy-duty spot welders. The various styles of welding machines for handling material of different gages are illustrated. Butt welding attachments for spot welding machines, seam welders and butt welding machines are also illustrated.

Simonds Mfg. Co., Fitchburg, Mass. Collection of twelve advertisements, entitled "Hacksaw-ology," giving a bit of history and touching on cutting-off methods, hacksaw teeth, set of hacksaw blades, steel and temper, cutting off stock by hand, cutting off stock with the power saw, lubricating hacksaw blades, cutting thin stock with hacksaws, why hacksaw lathes break, cutting tubing and rods and hacksaw blade economy.

Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Catalogue on Beaudry belt- and motor-driven hammers which are built in two types, namely the "Champion" for light and heavy railroad, machine, and general forging, and the "Peerless" for plating, drawing, swaging, collaring, spindle making and general manufacturing. The "Champion" hammer is built in sizes from 50 to 500 pounds weight of ram, and the "Peerless" hammer is built in sizes from 25 to 200 pounds weight of ram.

Landis Machine Co., Waynesboro, Pa. Catalogue 22 illustrating Landis threading machinery and describing in detail the construction of the Landis die. Since issuing its last catalogue the company has perfected a line of pipe threading and cutting machines and has developed a grinder suitable for grinding Landis chasers. These machines are shown in the new 1916 catalogue. Those who have thread cutting to do will find the tables of U. S. S., V, and Whitworth threads, lag screws and cutting speeds for various diameters of bolts, of value.

Winter Bros. Co., Wrentham, Mass. Catalogue 11 of carbon steel taps and dies, and high-speed steel taps and dies, "Thistle" brand, containing lists of hand taps, nut taps, machine screw taps, tapper taps, pulley taps, hob taps, stove bolt taps, patch bolt taps, Beaman & Smith taps, hand screw chasers, staybolt taps, tap wrenches, boiler taps, pipe taps, adjustable round dies, die-stocks, square dies, spring screw threading dies, screw plates and tables of information. The catalogue is provided with a thumb index at the side which makes reference to any section quick and easy—a feature that should be much appreciated by those who have to consult it frequently.

Norma Co. of America, 1790 Broadway, New York City, has recently issued a particularly comprehensive catalogue—No. 105—on Norma precision ball and roller bearings. The first fifteen pages contain a general description of the construction of these bearings, and the next twenty pages go more into detail, stating the reasons for the specific points of design, and analyzing the principles of anti-friction efficiency with particular reference to Norma bearings. Sixty pages of tabular matter containing dimensions and prices of all the types of Norma bearings give an idea of the extent of the line. Following the tabular matter are several pages of drawings illustrating applications of these bearings that will be found of suggestive value by draftsmen and designers. The last section of the book treats of the selection of anti-friction bearings, and the suggestions contained therein should go far toward avoiding bearing troubles.

TRADE NOTES

Kearney & Trecker Co., Milwaukee, Wis., has changed the location of its Cleveland office from 313 Garfield Bldg. to 515 Garfield Bldg.

International Oxygen Co., 115 Broadway, New York, inaugurated the eight-hour day at its works in Newark, N. J., beginning January 1.

Welborne & Co., South Ferry Bldg., 44 Whitehall St., New York City, is a concern recently formed by W. E. Welborne for transacting business as purchasing agent, export and import agent and manufacturers' representative.

H. W. Caldwell & Son Co., 17th St. and Western Ave., Chicago, Ill., builder of conveying, elevating and power transmitting machinery, has opened a sales and engineering office at 711 Main St., Dallas, Tex., in charge of J. C. Van Arsdell.

Plank Flexible Shaft Machine Co., Grand Rapids, Mich., manufacturer of flexible shafts and universal joints, was burned out the last of December, sustaining considerable loss. The plant has been re-equipped and is now operating as usual.

Allied Machinery Co. of America, 55 Wall St., New York City, announces a change of address for its Paris office. The Paris office and show-rooms are now located at 19 Rue de Rocroy, in the vicinity of the Gare du Nord and in the center of the machinery district.

H. P. Townsend Mfg. Co., Hartford, Conn., maker of high-speed riveting machines, automatic screw machines, drilling machines and lathe taper attachments, has added several thousand feet of floor space to its plant to provide greater facilities for the manufacture of its machines.

U. S. Machine Tool Co., Cincinnati, Ohio, has been organized for the manufacture of machine tools. The officers are: J. A. Smith, president; William A. McCallum, vice-president; and G. H. Felter, secretary and treasurer. The new concern is an offshoot of the U. S. Electrical Tool Co., and has the same officers.

Royersford Foundry & Machine Co., 54 N. 5th St., Philadelphia, Pa., has built an additional warehouse and added two floors to its factory, which provide about 12,000 square feet, to be used for the assembling of 10-inch, 14-inch and 20-inch drilling machines, and emery grinders. This part of the company's business is growing very rapidly.

L. H. Gilmer Co., Philadelphia, Pa., has completed the first unit of its new factory in Tacony and has moved the office and manufacturing departments from 52 N. 7th St. to the new plant. Ground will be broken immediately for the second building unit, 50 by 200 feet. The company's business is rapidly improving and the prospects for future business are bright.

Doehler Die-Casting Co., Brooklyn, N. Y., and Toledo, Ohio, has placed contracts for its Toledo factory buildings to provide an area of 70,000 square feet of floor space, consisting of foundry, machine shops and offices. With these buildings completed, which are to be ready for occupancy May 1, the company will be in a better position than ever to give its Western patrons prompt and efficient service.

Keuffel & Esser Co., 127 Fulton St., New York City, has purchased the entire stock, furniture and fixtures, good will, trademarks, etc., of E. G. Soltmann, New York, who recently went into bankruptcy. The stock purchased was inventoried at more than $100,000. It included many of Soltmann's specialties that architects have been using for years and which Keuffel & Esser Co. will continue to market.

Worcester Lathe Co., 68 Prescott St., Worcester, Mass. A. W. Whitcomb, formerly of the Whitcomb-Blaisdell Machine Tool Co. and Charles E. Thwing, who for the past two years has been marketing the "Worcester" lathe, have joined under the name of the Worcester Lathe Co. for the purpose of continuing the manufacture of 11-inch and 13-inch "Worcester" lathes and to manufacture larger lathes and other machine tools.

Metalwood Mfg. Co., Detroit, Mich., has opened an office in the exhibition department of the Philadelphia Bourse, in charge of Paul R. Ketzer, eastern manager. Mr. Ketzer was formerly connected with the Watson-Stillman Co. and is well qualified to assume the duties of his new position by reason of his thorough knowledge of hydraulic engineering as well as through his wide acquaintance gained from extended sales experience in his territory.

Richardson-Phenix Co., Milwaukee, Wis., manufacturer of lubricators and oil distributing apparatus, has opened a branch office in Boston at 141 Milk St., in charge of Charles E. Blake. The New York office of the Richardson-Phenix Co. has been removed to 30 E. 42nd St. E. M. May, manager of the New York office, has associated with him J. J. May, who will devote his energies to the Richardson-Phenix "Nokut" valve department.

C. G. Buchanan Chemical Co., Cincinnati, Ohio, manufacturer of "Ferro-Case" hardening compound, has been obliged to secure larger quarters and has removed to 118 E. Pearl St., Cincinnati. The company will occupy all four floors of the building, and new apparatus has been installed, increasing the capacity about four times. It is hoped that the increased facilities will enable the company to keep abreast of the demands for its product.

Fosdick Machine Tool Co., Cincinnati, Ohio, builder of radial drills and horizontal boring machines, has been sold to a group of Cincinnati men. Norman B. Chase, for many years superintendent of the Cincinnati Shaper Co., is vice-president and general manager. There will be no change in the line of tools built or in the selling agencies. William Herman, who has been president and general manager of the concern, will retire from business on account of ill health.

R. E. Ellis Engineering Co., Chicago, Ill., has moved into offices at 202 Machinery Hall. The company is the local agent for the Hannifin Mfg. Co., Chicago, Ill., Kelly Reamer Co., Cleveland, Ohio, Murchey Machine & Tool Co., Detroit, Mich., and the Standard Electric Tool Co., Cincinnati, Ohio; and is selling agent for single-purpose lathes for turning large shells, etc. Mr. Ellis was formerly with the Chicago branch of Manning, Maxwell & Moore, Inc. and later with the Steinle Turret Machine Co., Madison, Wis.

Standard Pressed Steel Co., Philadelphia, Pa., manufacturer of steel shaft hangers and other pressed steel specialties, had a portion of its plant and its office destroyed by fire January 8. Concerns making machinery and supplies used by the company are invited to send copies of their latest catalogues and circulars to replace those destroyed. The company reports that rapid progress is being made toward resuming operations in full, and that it is able to continue making shipments in spite of the fire.

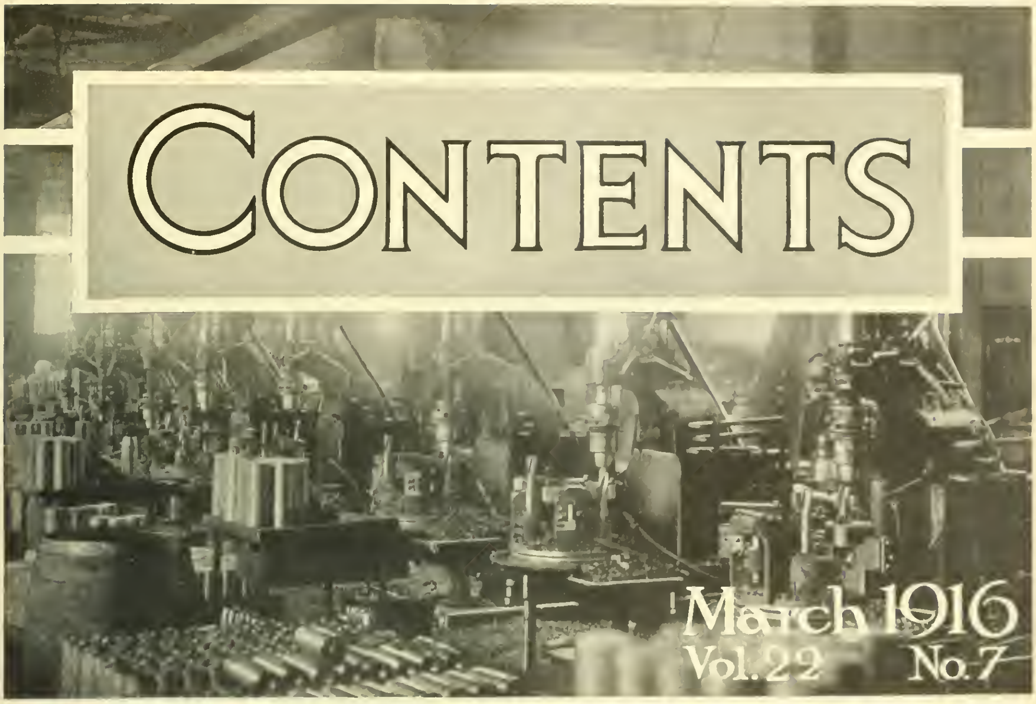
Bullard Machine Tool Co., Bridgeport, Conn., has placed a contract with the Turner Construction Co. for the erection of a reinforced concrete building, 268 by 50 feet, four stories high. The first story will be of "two-floor" height, and will be served by cranes operating in the two sections which run the entire length. The second and third floors will be utilized as machine rooms, while the fourth floor will be occupied by the management, shop executives and drafting department. The new building is to be ready for occupancy May 1.

Hoover Steel Ball Co., Ann Arbor, Mich., has let contracts for two additional manufacturing buildings and one office building to be erected immediately. These additions will increase the capacity of the forge and tempering department and the grinding department. They will be built of concrete and brick. These three buildings make a total of six additional buildings that have been added to the company's plant within about eighteen months. They afford a total manufacturing floor space of about 60,000 square feet.

American Metal Products Co., 3009-3021 Lisbon Ave., Milwaukee, Wis. At the annual meeting of the stockholders the old board of directors was re-elected, same being constituted as follows: Peter J. Weber, president; Henry C. Brelie, vice-president; William J. Eberle, secretary and treasurer; Richard Gaertner, general manager; and Charles E. Helm and August Littmann. The officers reported that although the present plant is being worked to full capacity it is impossible to keep up with the demand and many large orders are pending which absolutely necessitate the immediate installation of additional facilities, which the board voted should be provided.

Joseph T. Ryerson & Son, Chicago, Ill., tendered an annual Christmas dinner to the Ryerson salesmen and office executives of the Chicago plant at the Hotel La Salle, Wednesday evening, December 29. E. L. Ryerson, chairman of the board, and Clyde M. Carr, president of Joseph T. Ryerson & Son, were hosts. A story telling and musical program by talent within the house made the event very entertaining. During the Christmas holidays, Joseph T. Ryerson, treasurer, and W. H. Eulass, New York manager, acted as hosts for the house at a dinner of the sales and office organizations in New York City at the Hotel Astor. A. M. Moeller, St. Louis manager, was host at the dinner given his salesmen and office executives.

L. S. Starrett Co., Athol, Mass., issued a circular letter to its employes at Christmas time, stating that during the first seven months of 1915, with the exception of one month, its sales were slightly more than the sales of the corresponding months of last year. Beginning with August, the increase in business was greater, and on the whole, business during the year was very satisfactory. The company confined its activities to the production of mechanical tools and made no shells or other munitions of war. During the year, piece-work was instituted in various departments with success. The quality of work has been kept up, and those who are doing piece-work have averaged more than 25 per cent more pay than they would have received at day wages.



THE INDUSTRIAL PRESS, Publishers
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Seeing the Market Whole—2

Is the machinery sales manager sure that he sees his market whole and that every group of prospects receives attention? Most of us find it easier to cultivate the big people from whom we receive the bulk of our business. Yet very often it is the neglected smaller units, of considerable value in the aggregate, which give the new competitor a free field, and in time a solid foundation upon which to build a business able to battle for the biggest customers in the market.

An analysis of MACHINERY'S circulation shows in a very interesting way the great diversity of businesses in which machine shop equipment is used. The cards comprising the analysis, returned by readers, specify the lines of business they are engaged in. All the regular lines are, of course, adequately represented—machinery manufacturers, automobile manufacturers, the big steel and textile mills, mines, railroad shops, shoe factories, chemical works, engine builders, etc. It is the great diversity of special lines represented which makes the list as interesting as it is varied in character. We have room here for only a very small percentage of the manufacturing enterprises shown, omitting the well-known lines which every energetic sales manager works hard all the time:

Windmills
Haying Tools
Washing Machines
Excavators
Linograph Machines
Cement Works
Centrifugal Casting Machines
Gun Carriages
Well-drilling Machinery
Fire-fighting Apparatus
Grease Guns
Bookbinding Machinery
Art Bronze Works
Dental Apparatus
Shoe Machinery
Chain Makers
Adding Machines
Gas Works Apparatus
Steel Mouldings
Shipyards
Knife Works
Creosoting Timber
Windlasses
Cotton Machinery
Paper Pulp Works
Bottling Machinery
Rubber Factory
Wire Goods
Mill Architects and Systematizers
Munitions Shells and Cases
Cream Separators
Type-making Machinery
Can-making Machinery
Cigar-making Machinery
Magnetos
Wood-printing Machinery
Fence Machinery
Cement-mixing Machines
Furniture Factories
Cork Works
Box Works
Paper Carton Works
Brush-making Machinery
Silversmiths
Sidewalk Lights
Motor Trucks
Refrigerating Machinery
Carburetors
Flour Mills
Seeding Machinery
Cut Stone
Car Seals
Auto Jacks
Glass Works
Grist-mill Machinery
Oil Tanks and Pumps
Canning Machinery
Dredges
Steering Gears
Hardware Works
Wall-paper Machinery

Milling Buick Aluminum Crank-Cases

Edward K. Hammond

The enormous production of motor cars and the low prices at which they are now sold have been made possible by the use of machine tools of high efficiency and the provision of means for expediting the movement of the work from machine to machine. These conditions are exemplified in the Buick plant of the General Motors Co. in the machining of aluminum crank-cases. The cases are milled dry on special Ingersoll machines with cutter speeds ranging up to 600 feet per minute and feeds ranging up to 30 inches per minute. The highly developed milling machine practice and the automatic means provided for transporting the cases have greatly reduced the cost of production.

THERE is probably no industry in which more efficient equipments and methods are used for handling the work than in the manufacture of automobiles. The reason for this is that many automobile factories have been built and fully equipped for producing a large annual output of cars, according to designs worked out by experienced industrial engineers. In such cases, a higher rate of efficiency may naturally be expected than that attained in factories which have experienced a slow growth over a number of years, with the result that departments and equipment have been added from time to time, under conditions dictated by available floor space rather than by any preconceived idea of their relation to other departments in the factory.

It is the purpose of the present article to describe methods used in the Buick plant of the General Motors Co., at Flint, Mich., for milling aluminum crank-cases. The principal equipment consists of a battery of four planer type milling machines designed especially for this work by the Ingersoll Milling Machine Co., Rockford, Ill. These machines, together with the fixtures used on them, will be described in detail; and the information concerning the method of handling the work will also include a description of the machining operations performed on other types of machines, which come between the milling operations.

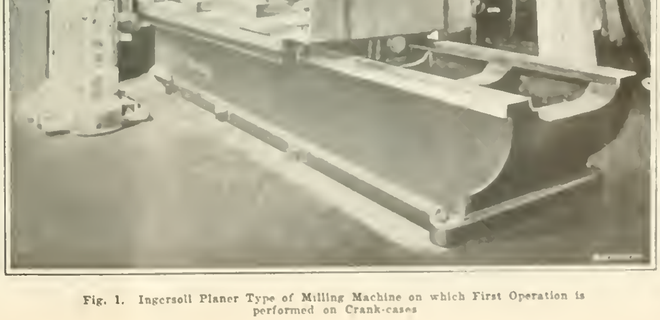

Fig. 1. Ingersoll Planer Type of Milling Machine on which First Operation is performed on Crank-cases

Ingersoll Milling Machines and Fixtures

Each of the Ingersoll milling machines is equipped with fixtures for holding five complete crank-cases, i. e., five upper and lower halves and, in this connection, it may be mentioned that all the fixtures used on these machines were also designed and built by the Ingersoll Milling Machine Co. The machines are of the fixed cross-rail

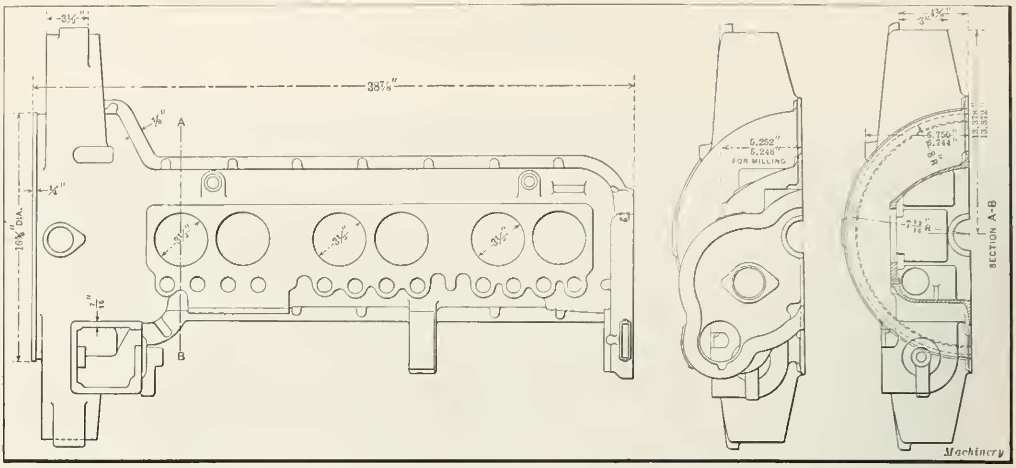

Fig. 2. Design of Upper Half of Crank-case for Buick Motor Car

type, the cross-rail being cast integral with the housings. The drive is provided by a 25-horsepower motor mounted on top of the housings, and the table is driven by a spiral rack and pinion. Continuous lubrication is provided for all bearings on the machine by means of oil-tubes which carry the lubricant by gravity from a reservoir located at the top of the housings. There is a similar reservoir on the side of the machine, from which tubes carry a continuous supply of oil to the feed change-gears. The table bearings on the bed are lubricated from oil-pockets cast at each end of the table. Provision for holding the work on the machine is made by means of six longitudinal T-slots which are supplemented by a liberal number of pin-holes.

Both hand and power feed of the work to the cutters are provided, the maximum power feed being at the rate of 30 inches per minute. There are twelve changes of feed for each change of cutter speed. The position of the vertical saddles on the rail may be adjusted by hand, and the horizontal saddles on the housings are also provided with vertical hand adjustment. The spindles are made of forged steel, and they are $4\frac{1}{2}$ inches in diameter; motion is transmitted to the outside vertical spindles by bevel gears which take power from a horizontal driving shaft on the rail, while the intermediate spindles are driven from the outer spindles by means of spur gears. The available spindle speeds range from $17\frac{1}{2}$ to 75 revolutions per minute, when the drive is provided by a 2 to 1 variable-speed motor. Two arbor supports are provided on each of the housings, and these supports have both vertical and lateral adjustment.

Arrangement of the Machines in the Factory

The machines are set up end to end and occupy one complete bay in the motor factory. The aluminum castings to be machined are brought to the milling department and the upper halves of the crank-cases are stacked at one side, while the lower halves are placed at the opposite side of the first milling machine, at a point just in front of the housings. Two operators are employed at each machine, and as the work passes out from under the cutters, one man stands at each side of the moving table, releases the work from the fixtures and

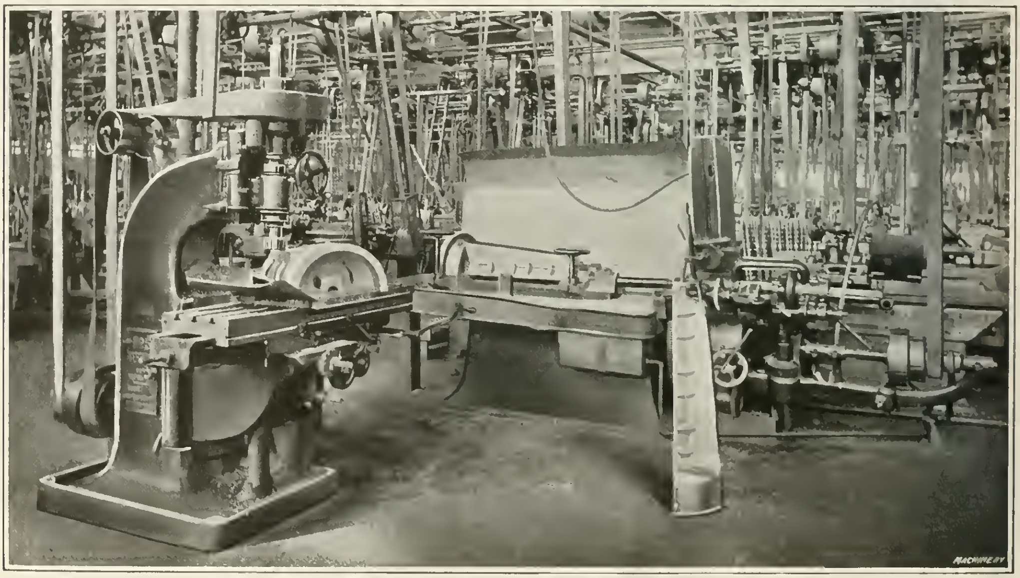

Fig. 3. Boring Shaft Bearing and facing off Oil Pump Pad

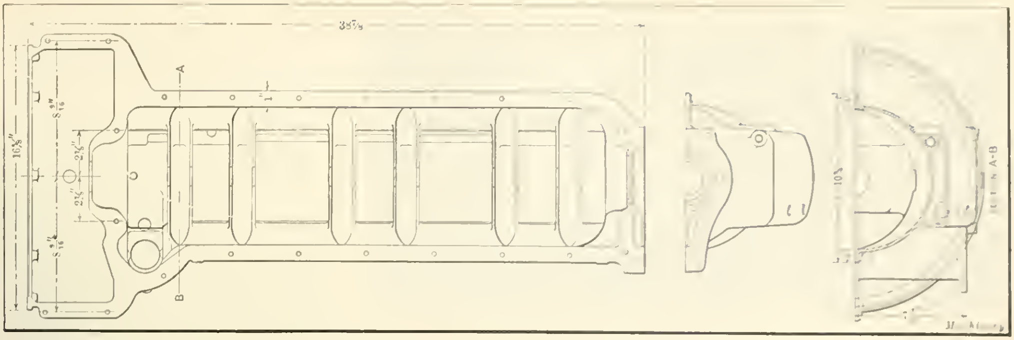

Fig. 4. Design of Lower Half of Crank-case for Buick Motor Car

removes it. After all the pieces have been taken out in this way and the table starts on its return motion, the operators go to the front of the housings where the accumulation of castings has been placed ready for them, and these castings are put in position in the fixtures as the table moves back. No attempt is made to clamp the work in the fixtures at this time, however; the clamping is done as the table moves forward to bring the work up to the milling cutters.

The arrangement will probably be better understood by referring to Figs. 1 and 6, which show general views of two complete milling machines. Fig. 1 shows the machine on which the first milling operation is performed, and in this illustration a number of castings will be noticed standing on the floor just in front of the housings. These castings will be set up in the fixture as the table comes back preparatory to taking the next cut. To facilitate handling, gravity conveyors are provided between the machines, and as the work is removed from the fixtures it is lifted directly onto these conveyors which take it to the machine on which the subsequent operation is performed. This makes it unnecessary for the operators to stoop in setting down the work, and saves them from excessive fatigue. As a result, there is no slowing down of the rate of production from this cause. A section of one of these conveyors is shown in Fig. 5, from which it will be seen to be of the gravity-roller type. The same system of conveyors is employed between all machines in the milling department, so that the amount of labor involved in transporting the work from machine to machine amounts to practically nothing.

Referring again to Fig. 1, which shows the machine on which the first milling operation is performed, it will be seen that the crank-case castings are set end to end on the table. On this machine, there are four vertical spindles on the rail, but no horizontal spindles carried by saddles on the housings; the work performed consists of rough-milling the connecting surfaces between the upper and lower halves of the crank-cases. The two cutters which work on the same casting rotate in opposite directions, the purpose being to neutralize all strains and reduce the possibility of the work being forced out of position. The milling cutters employed for this purpose are of the inserted-tooth type; formerly, high-speed steel cutters were used, but the excessively high cost of high-speed steel at the present time led to experiments being conducted with different brands of carbon steel, and it was found that by using cutters made of Jessop carbon tool steel, very satisfactory results could be obtained. The depth of cut is about 3/32

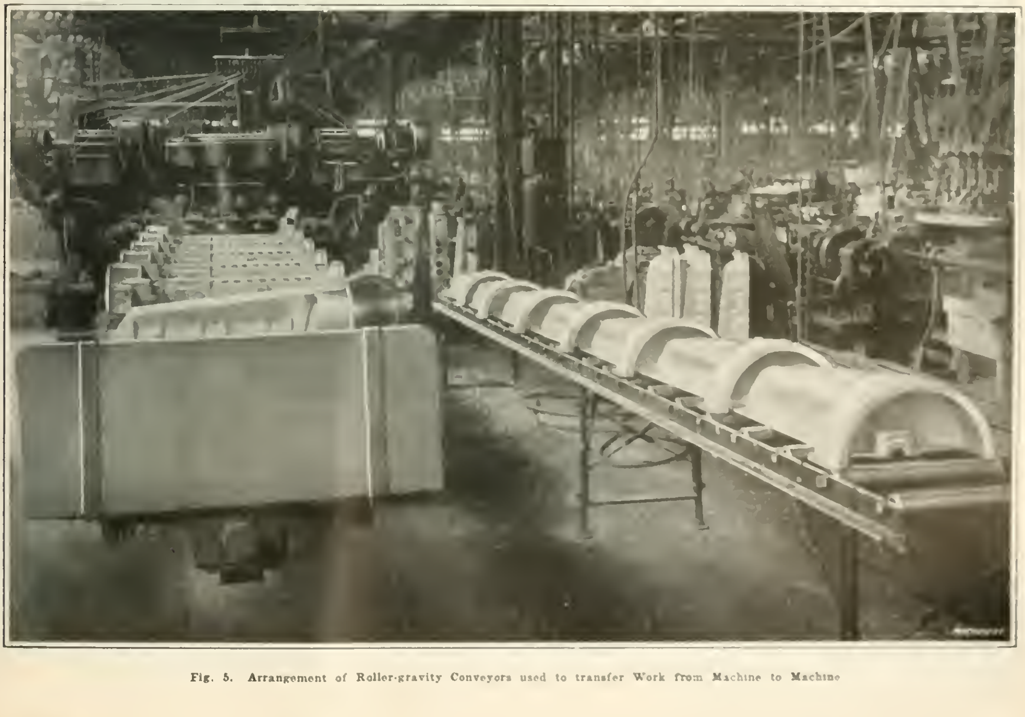

Fig. 5. Arrangement of Roller-gravity Conveyors used to transfer Work from Machine to Machine

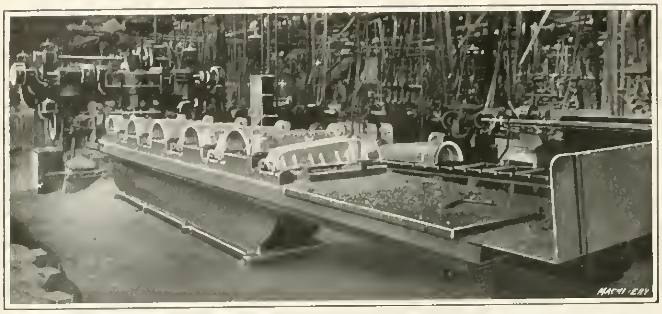

Fig. 6. Same Type of Machine as that shown in Fig. 1. but equipped with Fixtures set transversely across Table

inch and the work is fed to the cutters at a rate of 29 inches per minute. The peripheral speed of the cutters is 600 feet per minute.

It was formerly the practice of the General Motors Co. to use a cutting compound in milling these aluminum crank-cases, but trouble was experienced from water being thrown from the large cutters that are employed, and when the matter of obtaining new machines for the work was taken up with the Ingersoll Milling Machine Co. this firm recommended that the work be done dry. Milling without the use of any cutting compound was adopted at the time the new machines were put in operation, and the results obtained have been entirely satisfactory. The rate of production is twenty-two upper and twenty-two lower halves of the crank-cases per hour.

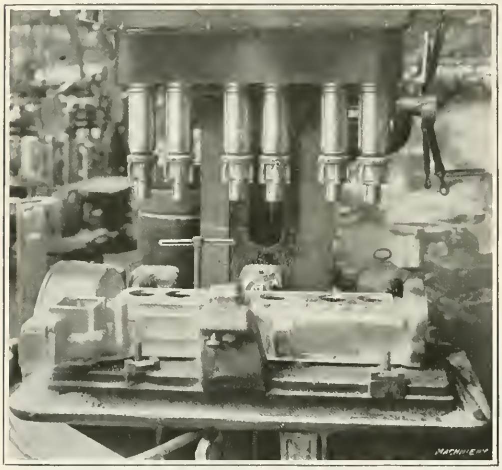

Fig. 7. Foote-Burt Boring Machine on which Cylinder Holes are machined in Upper Halves of Crank-cases

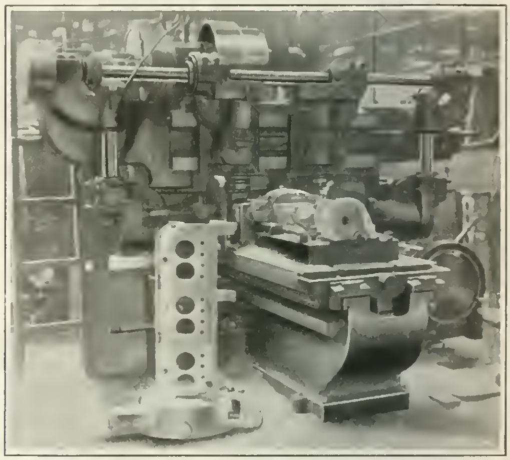

Fig. 8. Small Ingersoll Milling Machine used for facing Suspension Arms, Starter Box Seat and Accelerator Pad

A close view of two pairs of fixtures of the type used on the first machine is shown in Fig. 9, where it will be seen that the upper and lower halves of a crank-case are set up in one pair of fixtures, while the other pair is empty in order to show the construction more clearly. These fixtures are designed to provide a three-point suspension support for the work. The lower halves of the crank-cases, which are carried in the fixtures at the far side of the machine, are supported by two pivoted brackets *A*, which engage the under side of the flanges, and a third support which contacts with the bottom of the crank-case, this support being located inside the fixture at the opposite end from the brackets *A*. Additional support is provided by spring pins *B* which engage the casting along the under side of the flanges at each side. The work is secured in the fixture by clamp screws which grip each side of the casting and are supplemented by hold-down straps on each fixture, one of which is shown at *C*.

The upper halves of the crank-cases are held in the fixtures at the near side of the machine. Here, again, the three-point suspension principle is employed for locating the work in the fixtures; at the flywheel housing end, the casting is engaged by the stop *D*, while the third suspension point *E* contacts with the bottom of the casting at the gear-case end. Further support is furnished by spring pins *F* which adjust themselves to engage the flange at each side of the casting. The work is clamped in the fixture by means of binding screws which are tightened at *G*, and held down by studs projecting up through the cylinder holes.. Slotted plates (one of which is shown at *H*) are provided for use on these studs so that the time required to tighten them is reduced as far as possible.

The second operation is performed on the upper halves of the crank-cases, which are transferred from the first milling machine to a six-spindle Foote-Burt boring machine that bores out all the cylinder holes at a single setting. The machine used for this purpose is shown in Fig. 7; pads are provided on the fixture which support the work from the finished face of the flange, and the longitudinal position is governed by means of a slot *A* which engages a small vee cast on the work for that purpose. Two bosses at each end of the casting engage pads on the fixture and govern the sidewise location of the work. The casting is clamped down by means of suitable straps which hold it by the flange. This machine is operated at a feed of approximately 0.020 inch per revolution, and a cutter speed of 350 feet per minute; the depth of cut is 3/32

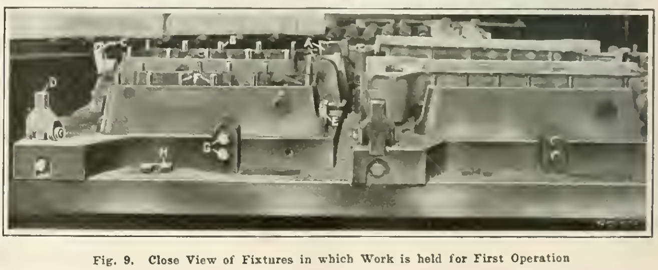

Fig. 9. Close View of Fixtures in which Work is held for First Operation

inch. The machine is more than able to keep up with the rate of production obtained on the preceding milling operation.

The lower halves of the crank-cases go direct from the first to the second Ingersoll milling machine, and the upper halves go onto the same machine from the Foote-Burt boring machine on which the second operation is performed. This machine is shown in Fig. 6 and is employed for the purpose of rough-milling the top surface of the upper half of each crank-case, and for taking a roughing cut on the end of the gear-case and on the end of the flywheel housing on both the upper and lower halves of the crank-case. It will be seen that the machine used for this purpose is provided with five spindles, there being three vertical spindles carried by saddles on the rail, and a horizontal spindle at each side of the machine carried by saddles on the housings. The three vertical spindles perform the facing operation on the top of the crank-case, and the horizontal spindles face the end of the gear-case and the end of the flywheel housing.

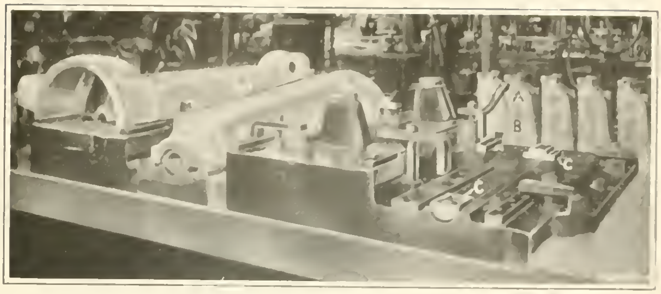

Fig. 12. Milling Machine and Fixtures used for taking Finishing Cut over End of Gear-case and Top of Crank-case

A close view of the fixtures provided on the machine is shown in Fig. 11, where it will be seen that pads *A* are provided to support the work from the finished faces of the flanges that were milled during the first operation. The upper halves of the crank-cases are located from the cylinder holes by means of plugs *B* on the fixtures, while the lower halves of the cases are located by means of the vee cast on the work, which fits into notches *C* on the fixtures, and by bosses cast at the opposite side of the work which are engaged by stops *D*. The method by which the work is strapped down on the fixture will be readily seen by referring to the illustration, but attention is called to the fact that each pair of straps holds two castings, so that the time required to clamp the work is reduced to a minimum. The cutters are set up on the machine by means of positive locating blocks, and fine adjustment is obtained by a dial test indicator. The work is fed to the cutters at a rate of 23 inches per minute, and the peripheral cutting speed of the cutters is 600 feet per minute. The depth of cut is 3/32 inch.

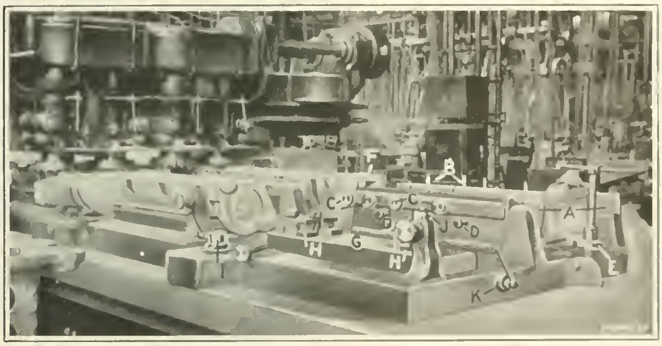

Fig. 10. Milling Machine and Fixtures used for taking Finishing Cut over Flanges

The fourth operation, which is performed on the third large Ingersoll milling machine, consists of taking a finishing cut on the faces of the flanges. The fixtures employed for this purpose are shown in Fig. 10, from which it will be seen that they are of the same design as those employed for the first operation, but in the present case, the operation of the fixtures is more sensitive. The lower halves of the cases are held by a three-point suspension (two points shown at *A*) and further supported by spring pins *B* which engage the flanges at each side. The arrangement is essentially the same as that explained for the corresponding fixture for the first operation, except that the spring pins *B* are adjusted by independent screws *C*, which gives a more uniform support to the work than is the case where all of the pins are controlled by a single screw. The work is held down in the fixture by four independent screws *D* which engage the sides of the crank-cases, and by two straps *E* and *F* which engage each end of the work.

The upper halves of the cases are located by pads *G* from the milled upper faces of the work, and by plugs *H* which enter the cylinder holes. Two spring pins *I* engage the work under the flywheel housing, and two pins *J* and *K* help to support the casting at the opposite end. The work is held down in the fixtures by means of straps on the plugs *H* which extend up through the cylinder holes. The depth of cut taken is about 0.025 inch and the cutting speed and feed are the same as for the first operation, i. e., the feed is 29 inches per minute and the peripheral cutter speed, 600 feet per minute. After the work is removed from the fixtures, it is transferred to a surface plate and tested with tissue-paper feelers 0.003 inch in thickness to insure an accurate fit between the upper and lower halves of the crank-cases when assembled.

The fifth and sixth operations are performed on the lower halves of the crank-cases. In the fifth operation, the work is set up on a Barnes horizontal drill press, shown in Fig. 3, where the crankshaft bearing is bored. The fixture provided on this machine locates the work by means of two pads which engage the same bosses on the castings that were used in the second and third operations, and the longitudinal position of the work in the fixture is determined by the vee on the casting which engages a notch on the fixture. The work is held down by means of two straps and a clamping screw. While the boring operation is being performed on one case, the case in which the bearing has just been bored is set up on a No. 5 Becker vertical milling machine, which is also shown in Fig. 3, and the pad for the oil pump is faced off. The fixture used on this machine is very simple, consisting merely of a flat plate to

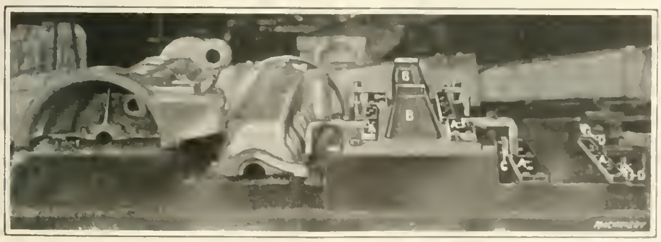

Fig. 11. Fixtures used to hold Work while milling Top Face of Crank-case and Ends of Flywheel Housing and Gear-case

which the work is strapped down. The machine is equipped with an automatic trip to disengage the feed after the milling operation has been completed. One operator is able to attend to these two machines and secure a rate of production equal to the rate at which the crank-cases are turned out by the milling machine on which the preceding operation was performed. On both the Barnes and Becker machines, the work is lubricated with water.

In the seventh operation, the lower halves of the crank-cases are finish-milled on the gear-case end, and the upper halves of the cases are finish-milled on the top to a limit of accuracy of 0.002 inch, and also finish-milled on the gear-case end. The equipment used for this purpose is shown in Fig. 12, where it will be seen that the fixtures for holding the upper halves of the crank-cases are essentially the same as those employed for the third operation, except that a support A is provided to support the gear-case end of the work and eliminate chatter. The fixtures used for holding the lower halves of the crank-cases are of a different design from any that have formerly been employed. In this case, the work is located by stops B engaging the end of the flywheel housing which was rough-milled in the third operation, and by plugs C which enter the bored bearing in the crank-case. After being milled on this machine, the top surface of the upper halves of the crank-cases are tested for accuracy with a straightedge, and the surface of the flange is tested with tissue-paper feelers 0.002 inch in thickness. The distance between the finished surfaces on opposite sides of the upper halves of the cases is measured with a micrometer and must be accurate within a limit of 0.004 inch.

After being subjected to this inspection, the work is taken to a four-spindle Ingersoll milling machine, of smaller size than the ones previously used, on which the arms are faced off for the three-point suspension mounting of the crank-case on the frame; this machine also mills the face of the seat for the starter gear-box and the accelerator pad. It is shown in operation in Fig. 8. The work is done dry and the rate of feed is 20 inches per minute, with a peripheral cutter speed of 500 feet per minute. The depth of the cut is about 3/16 inch, and the work is located by two plugs on the fixture which enter the cylinder holes. The final milling operations are performed by a battery of five No. 3 millers shown in the heading illustration, equipped with fixtures which locate the work from the cylinder holes in all cases. These machines perform a collection of miscellaneous operations; the operation of milling and the fixtures are quite simple, so that a detailed description would be of little interest.

This article is not intended to be a complete exposition of the machining operations involved in the manufacture of Buick crank-cases. The idea has been threefold: first, to present a brief description of machines and fixtures employed for this work which embody principles that are applicable for many other milling operations; second, to point out the labor-saving methods used for handling the work; and third, to show the exceptionally high rates of speed and feed which are obtainable in milling aluminum, and to point out the fact that this high rate of production is obtained without the use of any cutting compound. In an article of this kind, the value to the general reader is the possibility of employing similar methods in his own work; and if readers of MACHINERY find other applications for some of the principles of fixture design and methods of handling the work that have been described, the present article will have attained its object.

* * *

A German concern has brought out a new bearing metal known as "war bronze." The composition of this alloy, however, is not published. The war bronze is the result of experiments undertaken to produce a bearing metal which can be used as a substitute for alloys containing a high percentage of copper, on which metal the German government has placed an embargo during the war. It is claimed that this war bronze can be used in all cases where brass, ordinary bronze, or phosphor-bronze would ordinarily be employed, and that it has been used with good results for bearings and worm-wheels for some time.

FORMULAS FOR COMBINED BENDING AND TORSION STRESSES

In an article in the *Sibley Journal of Engineering*, December, 1915, G. B. Upton deals in a very complete and concise manner with the different formulas that have been developed for the stresses in metals subjected to combined tensional, compressional and shearing stresses—that is, combined bending and torsion. The principle now accepted as true for beams or machine parts loaded so as to produce combined bending and torsion is known as "Guest's law," which states that in any case of single or combined loading the point where the elastic limit and the yield point is exceeded, is dependent upon the maximum shear stress exceeding a certain critical shear stress value. This critical shear stress value is only half the tension stress intensity at the tension yield point of the metal.

Guest's law was tested out experimentally only for a limited number of ductile metals. It is fairly obvious that it cannot apply at all to the brittle metals. As a hypothesis, Guest's law has to compete with two other hypotheses. The three hypotheses concerning the conditions at failure may be stated as follows:

1. Guest's. Failure occurs when the maximum shear stress in the piece of metal reaches a certain critical value.

2. Rankine's. Failure occurs when the maximum tension stress in the piece ("principal stress") reaches a certain critical value.

3. St. Venant's. Failure occurs when the maximum unit deformation in the piece reaches a certain critical value.

The comparison of the different criteria of failure may perhaps be made more evident by comparison of the resulting formulas for combined bending and torsion of a solid circular shaft.

1. Guest's:

$$q = \frac{16}{\pi D^3}\sqrt{M_b^2 + M_t^2}$$

2. Rankine's:

$$p = \frac{16}{\pi D^3}\left(M_b + \sqrt{M_b^2 + M_t^2}\right)$$

3. St. Venant's:

$$p = \frac{16}{\pi D^3}\left(0.7M_b + 1.3\sqrt{M_b^2 + M_t^2}\right)$$

In the above formulas,

q = shear stress intensity;

p = tension stress intensity;

D = outside diameter of shaft;

M_b and M_t are, respectively, the bending and torsion moments.

It is obvious that the three formulas will not give the same solution for D. Rankine's and St. Venant's formulas are fairly similar; Guest's differs radically from the other two.

The opinion of the writer of the article abstracted, as to the applicability of the three criteria of failure, has been formed partly from the results of the experimental work noted above, and partly from recent work in the Sibley College laboratories. For the fully ductile metals, which have a yield point in tension testing, and break with a cup and cone break under tension, Guest's law is probably true not only at the yield points in the various loadings, or in combined loadings, but also at the break. For the semi-ductile metals, which have a tension yield point, but finish in tension testing with the square break of pure tension, Guest's law determines yield points and Rankine's law determines breaks (if tension break is possible under the system of loading applied). For the brittle metals there are usually no yield points (certainly not in tension), and Rankine's law determines tension breaks. In the compression of brittle metals, Guest's law determines yield points, if there are any, and also determines breaks, if they are due to shear. St. Venant's law does not apply anywhere. The determinant of failure is always a stress, not a deformation. All yield points are determined by a shear stress; and all breaks are determined either by a shear or by a tension stress.

LATHE CHUCKS—1

A REVIEW OF FACEPLATE AND COLLET WORK-HOLDERS

BY JOSEPH HORNER*

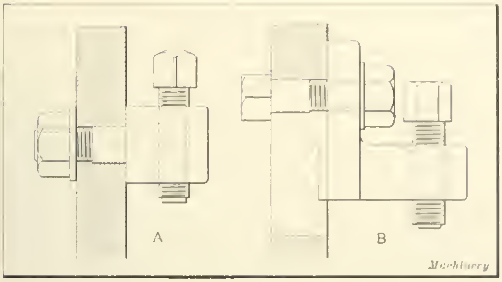

Fig. 1. Simple Screw Dogs on Faceplate

THE potter's wheel is obviously the clue to the origin of lathe chucks, and its simple form is still representative of the great group of face chucks. The only essential difference is that in the latter a precise means of obtaining a frictional hold upon the work is provided in the form of jaws or other devices, necessitated by the nature of turning. The fact that a large proportion of turned work has to be steadied or supported upon an extraneous center does not alter the principle, since the chuck is always the driving agent. The earliest types of lathes comprised nothing more than a couple of centers held in uprights driven in the ground, and the work was rotated with a cord. At this time no kind of chuck was used, but the abandonment of the cord drive brought about the necessity for a driver or chuck, and upon the advent of the handwheel, footwheel and power agency for driving the lathe, regular chucks were developed. At the present day it is bewildering to attempt to grasp the immense variety of chucks in use. Even during the last five years or so their ranks have received great accretions on account of the increasing

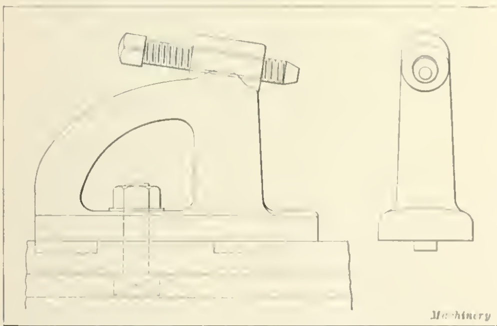

Fig. 2. Dog for Use on Boring Mill Table

practice of using special chucks for gripping repetition work, particularly in automobile manufacture. In addition to specialized shapes of jaws, the chucks often include seatings or abutments for the purpose of support or precise location of the object, and holes for the reception of pilots on tools.

Apart from this growing specialization in chuck design, the chief point which differentiates modern types from those of, say, a decade since is that of enhanced strength. In the majority of cases standard designs have been made heavier. In other cases new designs have been evolved to meet the greater strains produced in dealing with high-speed work. Chucks with steel instead of cast-iron bodies are now largely used. The use of auxiliary screw dogs or serrated jaws is noticeable in many instances as a help to the frictional drive of the standard jaws. There is difficulty in dealing with classes of work which are liable to distortion through pressure wrongly applied. In such cases it may be impracticable to exercise any great force in clamping, because the work will assume a distorted form, and will spring back to its original outline upon being released from the chuck. This, of course, would give detrimental and uncertain results. The employment of driving pins or flanges solves the difficulty in some shapes, these drivers rotating the piece against the stress of cutting. When it is not feasible to introduce driving pins or flanges, a considerable amount of thought and care may have to be exercised in designing the chuck or its jaws. Sometimes, even, the selection of a safe mode of chucking alters the determination of the precise type of machine which the piece shall be machined upon.

Another question that must never be disregarded is whether the work will run in proper balance, and for this reason a good many objects are tooled while held in a fixed position

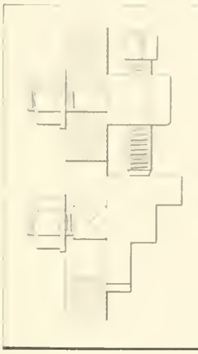

Fig. 3. Simple Dogs and Thrust Screw on Faceplate

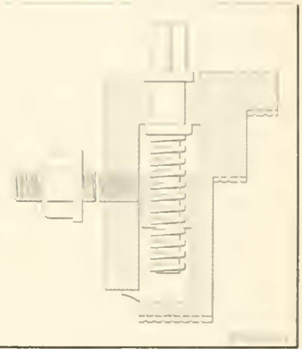

Fig. 4. Self-contained Faceplate Jaw

in preference to rotating them in a lathe. If work is repetitive the expense and time occupied in securing a proper balance by the use of a counterweight on the chuck is repaid, and if there are a number of operations that follow in succession and can be best done with tools from a turret, it is better to revolve the work and machine it in this fashion. A piece might be more easily gripped on a boring type of machine, without the need of balancing, since the piece remains stationary, but the time of changing tools in the boring spindle would make this method prohibitive.

The question of the relative number of parts to be machined usually determines the form of chuck which shall be used unless the work is of the plainest description. In the latter instance, an ordinary type of chuck with standard jaws is perhaps perfectly suitable. However, as soon as any complication in outline affecting chucking arises, it is necessary to devise a chuck, or make special jaws, which will facilitate gripping, lessen the time and eliminate all risk of inaccuracies. In a shop doing the ordinary run of miscellaneous work, the chucks will be all more or less standard, that is, modifications

Fig. 5. Another Design of Self-contained Faceplate Jaw

* Address: 45 Sydney Bldg., Bath, England.

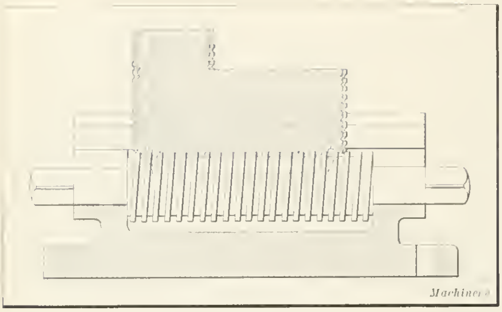

Fig. 6. Reversible Faceplate Jaw

of a special nature will not be very noticeable. But in a highly specialized shop the number of strange shapes encountered is remarkable, and any one of them picked out at random would probably be suitable only for the particular kind of work it is handling. Occasionally, however, a chuck is designed with a certain degree of adaptability to cover a range of holds, thereby saving expense and storage room. The addition of one or more fitments, or an adjustment obtained by placing screws or bolts in another set of holes is usually sufficient to meet requirements. Balance-weights also may have adjustability to two or three locations, placed accurately to suit the altered position of the same work or another piece of different size. The matter of whether a chuck shall be designed for one purpose only or for various uses is entirely dependent upon the number of pieces to be produced by it. The number of similar pieces to be produced affects the kind of chuck employed in a radical fashion, more particularly if the work is of moderate or small dimensions. In the latter case, a spring type of chuck frequently suits better than one with sliding jaws, and is easier to operate and more convenient in some respects. Special collets are necessary to fit the work, and it is generally a simpler matter to arrange these in a spring chuck than in one with sliding jaws. But when the dimensions of the object exceed the capacity of spring chucks, the matter is one for choice between a special chuck made to suit, and false jaws fitted to a chuck of standard design.

Faceplate, Dogs and Holding Devices

For the purpose of these articles, we shall take up the chucks where they begin, by the attachment of screw dogs to an ordinary faceplate, forming the primitive principle of gripping at the side of the work. At one time, turners had no other assistance than that of the faceplate with dogs of a more or less makeshift type, and such things as proper sliding jaws accurately fitted were unknown. The work was held by the ends of screws, but as cuts were light, and time was of little importance, there was not the same need for rapid and powerful means of holding that present-day requirements demand. Neither was there any self-centering principle available, and all work had to be adjusted tentatively. Even standard round shapes as drills and rods were held in bored chucks and clamped with screws—a method only met with now in the bell chucks. Though the method of using simple screws in dogs attached to a faceplate, as shown in Fig. 1, is still utilized largely among amateurs and to a lesser degree in the small shops, it is open to the objection of insecurity. The point or end of a screw affords only a small area, on which work is liable to swivel or skid. The surface, moreover, becomes impressed quickly, resulting in slackness while the turning or boring is in progress. With a jaw having three or more times the surface contact, these difficulties are greatly diminished, and it is practicable to hold with continuity of pressure from beginning to end with little or no risk of slipping out of position, unless the object is exceptionally shaped, tapered, or has excessive overhang. The only merits of the screw dog device are its cheapness, since an ordinary faceplate may be employed. Practically the only instance where the screws possess any advantage over proper jaws is their adaptability to reach into angles and recessed parts where space is limited. In a few cases it may be necessary to have unusually long screws, but generally quite short ones are employed, as in Fig. 1, since adjustments of more than a very short distance can be made by shifting the dog in its slot, or to another hole. The amount to which a screw is set out from the surface of the plate depends on the class of work being handled; it is usual to have a double set of dogs, one set with the screw laid closely in, as at *A*, Fig. 1, and the other with the dog lengthened to bring it further away, or made in the form of a miniature angle-plate *B*. It is not usual to set the screws at other than right angles to the axis of the dog, because the work is more likely to slip, but in the case of the horizontal tables of boring and turning mills, gravity helps to keep the object down, and it is then practicable to set the screws at a slight angle, pointing downward. The dog is either plain, like that shown at *A* or *B*, Fig. 1, or elaborated into a higher casting, Fig. 2, to reach some way up the work and resist tilting. Should the work be shallow, it can be packed up to make it come up to the range of the screws. Either three or four such dogs are utilized. Frequently they supplement the grip of the standard chuck jaws, the piece being first centered and gripped with these, and the screw dogs brought up afterward.

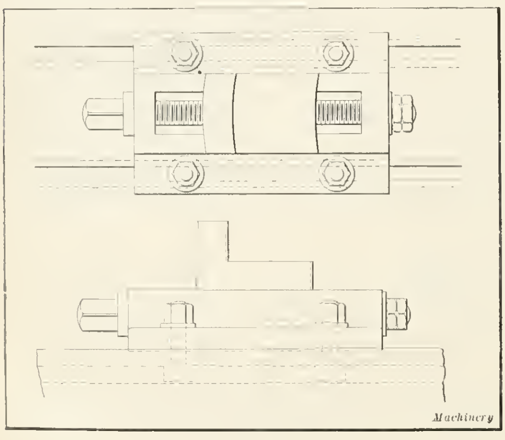

Fig. 7. Large Faceplate Jaw

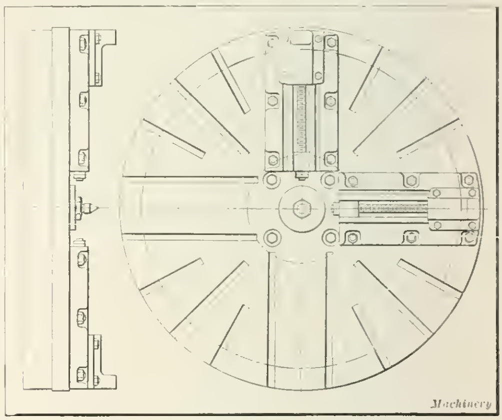

Fig. 8. Heavy Faceplate provided with Reversible Jaws

A makeshift compromise between the screw dog and the regular jaw is to push the one along with the other, as shown in Fig. 3. It is a clumsy device, however, and not easy to manipulate, while for diameters approaching that of the faceplate it cannot be employed. The neatest device is the self-contained jaw, Fig. 4, comprising a base bolted to the faceplate, a jaw sliding in vees on the base, and a screw passing

through the nut which is let into the jaw. Stronger designs are illustrated in Figs. 5 and 6, the first with a screw of medium diameter retained by thrust collars, the other with a screw of more generous diameter, and a jaw which can be run out at either end for reversal. As large faceplates and boring-mill tables have double T-slots, it is necessary to modify the bases of the jaws accordingly, as in Fig. 7. The largest plates are fitted with bases of sufficient length, Fig. 8, to give the full range of travel to the jaws, thus obviating the necessity for adjusting the bases. They are only touched when removal is required, to leave the plate plain. In any type of jaw-fitting there is the disadvantage that the necessity for having a base makes the jaw stick out from the plate farther than when fitted direct to slots in the plate. A great many classes of objects, however, are secured with the help of bolts and clamps, supplementary to the grip of the jaws, so that the objection is not so important as it may seem.

A variety of special hooks or clamps is also used for certain work which is difficult to hold firmly, either on account of the small area available for gripping or because of a slight taper which tends to eject the piece when the vibration induced by cutting is set up. Fig. 9 shows a clamp combined with a jaw (for use in a tire-boring mill) especially to secure the tire firmly. The clamp is hinged to throw down out of the way. Another way in which part of the severe duty is taken from a set of jaws is that of adding one or more driver pins, set either directly in the faceplate, or into massive castings bolted thereto. These pins engage with arms or other projections, and afford a positive drive. Sometimes, also, when an extremely heavy cut has to be taken from a bar or shaft, the hold of ordinary jaws is supplemented by the application of three or four massive screw dogs, of the type shown at *A*, Fig. 1, which are very heavy and held with two or three bolts.

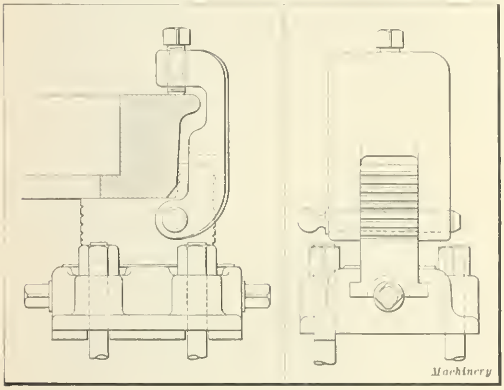

Fig. 9. Jaws with Pivoted Clamp

Independent-jaw Chuck

The standard independent-jaw chuck is directly related to the faceplate fitted with a set of loose jaws, the only difference being that the jaws are fitted directly into the plate and the screws are built in, as shown in Fig. 11. There is a good deal of variation in detail, especially in regard to methods of taking the thrust of the screws. In the first example shown, the screws are laid in from the front, which necessitates an open slot; but a more workmanlike way is to take the thrust a little way inside the hole by means of a loose collar *A*, Fig. 10, slipped in after the screw has been inserted endwise, and secured with a couple of pins fitting half way in the chuck and half way in the collar. Or the screw collar is brought further in, resting against a shoulder, and the loose collar is laid in as at *B*, Fig. 10; this is an alternative to using the tail of the screw to receive the thrust in one direction. Instead of a plain collar, however, a threaded one may be used which can be tightened to make an exact working fit without backlash and which is locked with a lateral screw; this device permits of later adjustments to eliminate backlash due to wear, as shown at *C*, Fig. 10. It will be noticed that the essential difference between this class of chuck and the various types of modern chucks now on the market is the way in which the jaws are fitted into the body. The chucks thus far described take a bearing by the squared tail, but in the modern types the chuck bodies are grooved to receive the tongued bases of the jaws, resulting in a much better fit and greater resistance against lateral pressures. It is now the practice in making old-fashioned independent-jaw chucks to recess the jaws slightly in the body, which tends to keep them in line and to relieve the pressure from the screw stud end, as illustrated in Fig. 12. But this does not overcome the tendency to tip over; hence the necessity for the screwed tail and nut at the back.

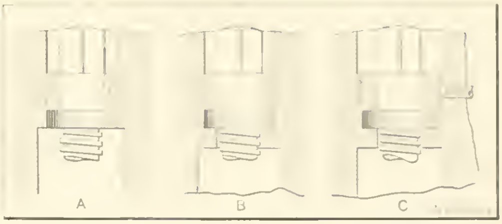

Fig. 10. Screws retained by Collars of Various Types

Reversible jaws on the independent-jaw chucks of the class just illustrated are arranged upon a kind of stud, corresponding to the shank of an ordinary jaw, but with a circular portion upon which the jaw may be rotated. The driving screw is given a slight amount of play, as shown in Fig. 13, so that when the nut at the back is slackened the jaw and shank may be pulled out sufficiently to clear the tongue on the under side of the jaw, making it possible to reverse the jaw.

The design of independent-jaw chucks with tongued jaws, Fig. 14, is employed now to a far greater extent than the other class previously described. The screws are of large diameter, and the tendency of modern practice has been to increase thicknesses of metal in the body, width of jaws, and to use steel bodies, or cast-iron bodies reinforced with steel. Modern practice is rapidly tending also to continue the threaded portion of the screw at the outer end, Fig. 14, to the outside periphery of the chuck. This necessitates modifying the method of taking the end thrust of the screw, that is, transferring the location of the thrust bearing to a position about half way down the screw. A thrust pad or plug is generally inserted from the back and secured with a screw or screws set at its side, or centrally. The use of a thrust pad is advantageous from the point of view of durability, since it can be hardened

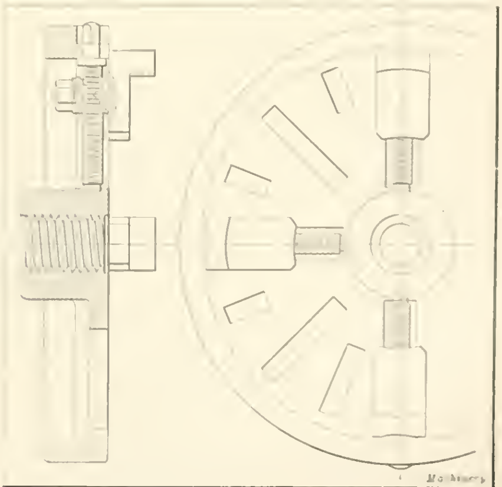

Fig. 11. Independent-jaw Chuck

and so form a medium that is greatly superior to any portion of the chuck itself for resisting wear. The Cushman thrust pads are split and expanded into their seatings with a taper-headed screw. The Horton chucks employ a tapered block *A*, Fig. 15. A peculiar arrangement is seen in the design of the Oneida National Chuck Co.; here, as shown at *B*, Fig. 15, a steel ring is laid in the mold and incorporated in the casting when pouring, thus forming a powerful reinforcement to resist the outward strain imposed when the work is gripped. Where the thrust shoulders of the screws come they lap over this ring, so that the thrust is received by it.

Holes and slots of through or T-slot type are variously made in independent-jaw chucks for the reception of bolts, the precise arrangement often depending on the size of the chuck.

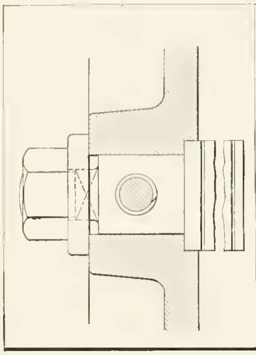

Fig. 12. Jaw recessed slightly into Plate

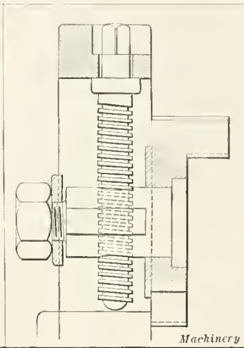

Fig. 13. Reversible Jaw swiveling on Stud

In the larger chucks for heavy lathes and for boring mills the number of T-slots is increased, and frequently the jaws do but a fraction of the work of holding, the major part being undertaken by bolts, clamps, and driver pins. A ring of teeth for driving a heavy plate is either bolted upon the back, or is cut solidly as in Fig. 16. Increased stability and wearing capacity of jaws is obtained by widening and deepening them, thus enlarging the wearing areas and affording better resistance against tipping. The Horton widened jaw with flanged base, Fig. 17, offers a radical departure from the ordinary grooved jaw, and is well adapted to severe service. The effect of the increased width of base on the size of the screw is that it can be greatly increased in diameter. The Union Mfg. Co. has a system of double ribs in its heavy type chucks, shown

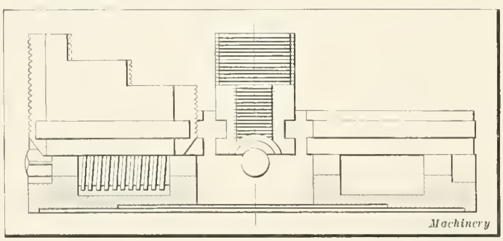

Fig. 14. Heavy Independent-jaw Chuck with Tongued Jaws

in Fig. 18, the jaws, of course, entering more deeply from the chuck face than usual.

Concentric or Universal Chuck

Although independent-jaw chucks have a series of circles struck upon the face for centering the various jaws approximately, this method lacks accuracy and speed when there are many of the same pieces to be chucked. The simultaneous operation of the jaws is highly essential for this class of work, and this is provided by the concentric or universal chucks. Two methods are in use for effecting the movement of the jaws in unison. One is to connect each screw with a bevel gear meshing with its pinion, and the other is to abolish the screws and move the jaws directly by a scroll plate engag-

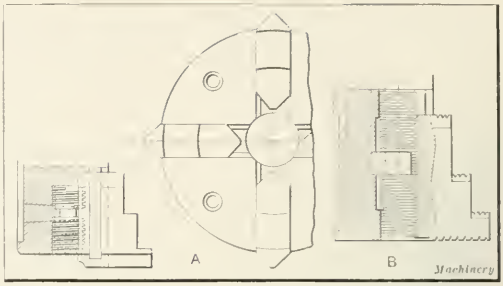

Fig. 15. A. Horton Chuck Jaw with Tapered Block; B. Oneida Chuck with Thrust Ring

ing with teeth on the back of the jaws. Rotation of the scroll plate is effected either by direct hand or lever pressure, or through the medium of gears. The objection to the screw method is the tendency to wear in the threads, which introduces backlash, rendering exact concentric action unlikely after a little use. The strain on the circular rack and the pinions is also very severe, and for this reason it is advisable to only lightly tighten one pinion to set the jaws upon the work, and then go round and set up each screw hard with its own square, pursuing the reverse method when loosening the work. Fig. 19 will serve to show the principle of the geared screw design of universal chuck, this being a type of car wheel chuck made by the E. Horton & Son Co.

What are termed lever scroll chucks are the weakest from the point of view of tightening; the scroll ring is rotated either by the grip of the fingers on a knurled rim, or by means of a tommy rod inserted in a hole in the rim. These

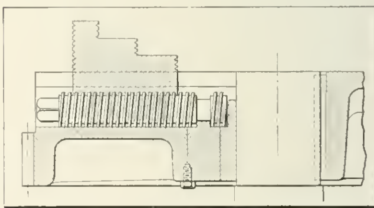

Fig. 16. Heavy Independent-jaw Chuck with Spur Gear Drive

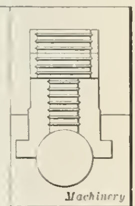

Fig. 17. Jaw with Wide Base

chucks, Fig. 20, are used by amateurs and light lathe workers, and are very handy for work within their power because of the ease with which tightening and releasing is done. But there is a definite limit to the gripping power, and a gear drive to the scroll becomes essential. In most instances bevel gears are utilized. There is one exception—where worm-gears are employed—and another, the Westcott, where spur gears are fitted, both designs being intended to increase the power. The ends of a bevel pinion usually run in parallel bearings, but an exception may be observed in Fig. 21. Here it will be noticed that the outer bearing is of coned form so that the backward thrust of the pinion always makes the tapered bearing fit without shake. Another variation is met with in the Whiton practice; here the key is formed to act as a part bearing, Fig. 22. The latest pattern of Horton chuck offers a

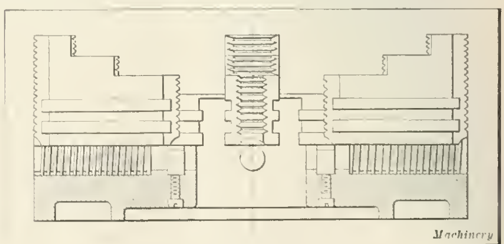

Fig. 18. Union Double Tongued Jaws

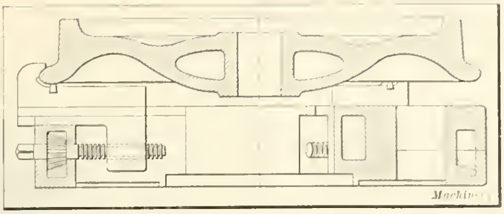

Fig. 19. Universal Car-wheel Chuck

modified arrangement of pinion bearing, seen in Fig. 23, the outer end of the pinion being nearly as large as the outer diameter of the teeth, so as to allow of a very large hole for the powerful wrench which is employed. A thrust ring is placed as shown to afford sufficient bearing for the backward pressure. It may be mentioned that the teeth used are of the Brown & Sharpe stub form, and this strong shape in conjunction with the fact that the pinion is of heat-treated steel, oil-hardened, makes for great durability.

Messrs. Alfred Herbert, Ltd., of Coventry (England) manufacture a concentric chuck *A*, Fig. 24, which differs radically from all others by the fact that a spiral is not used, but three eccentric grooves are formed in a ring. In these grooves three sliding blocks are confined, which, in turn, are attached to three T-slides. These T-slides have serrated faces which fit into numerous serrations on the jaws and are held in place by two screws. As the sliding blocks fit the short eccentric grooves exactly at all positions, they do not suffer from the

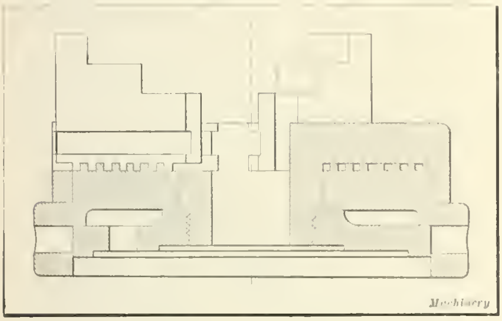

Fig. 20. Lever Scroll Chuck

disabilities incurred in trying to make a jaw of constant curvature match the varying radii of a spiral comprising many circles, as is the case in a scroll chuck. The jaws, which are reversible on the slides, may be adjusted to and from the center by slacking the two holding screws half a turn and resetting by matching the accurately cut serrations. With this device it is also possible to hold eccentric or irregular work as well as concentric work. The standard jaws furnished cover the range of all diameters of the chuck with two steps only. Heat-treated chrome-nickel alloy steel is employed for the pinions, which have eight teeth of the shape shown at *B*, Fig. 24. and the ring carrying the teeth and eccentric grooves is of heat-treated steel, ground in the hole. Three sector plates, doweled and screwed on, constitute the face of the chuck, and they carry the numbered circles by which the jaws are set concentrically. Although this design of chuck does not provide for running the jaws in or out any distance (as an ordinary scroll chuck does) it is claimed that modifications in diameters are more quickly and easily made by the slackening of the screws already mentioned than by tedious running in or out. The chuck is not intended to compete with light cheap kinds, of course, but is for the heaviest service, built in capacities from 12 to 25 inches.

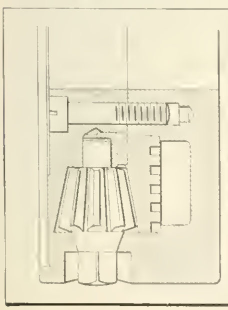

Fig. 21. Pinion with Tapered Journal

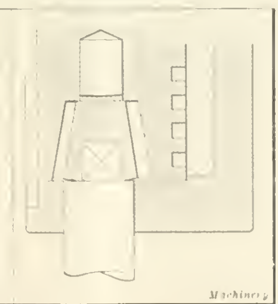

Fig. 22. Pinion Wrench turning in Chuck Hole

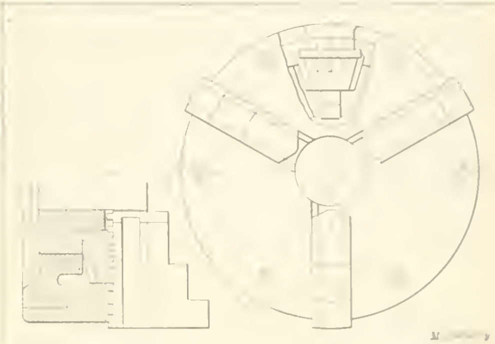

Fig. 23. Horton Universal Chuck with Large Wrench Socket in Pinions

Another distinct departure from ordinary design is the Taylor "spiral" chuck which, instead of having the scroll teeth cut upon a plane face, has them made in a hollow cone, Fig. 26, and of V-section. They present a backing to the teeth of the jaws directly in line with the pressure, and more than half the pressure is taken by solid metal. It is possible to use a much finer pitch of spiral than in the ordinary design, and the threads can be hardened and ground, both in ring and jaw The jaws necessarily slide down inclined grooves, and this, incidentally, has the beneficial effect of partly masking them within the chuck cone so that there is less liability for them to catch in workmen's clothes or hands

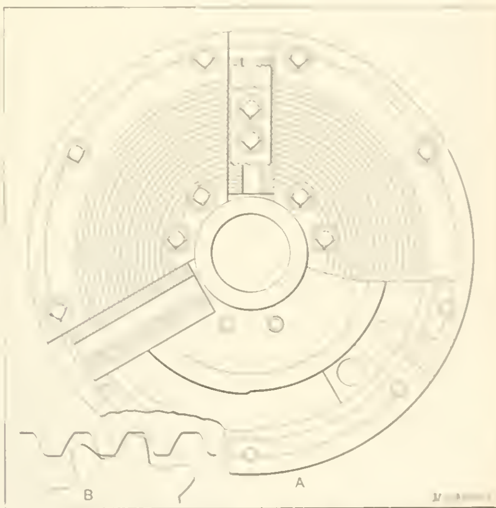

Fig. 24. Concentric Chuck with Cam Ring [illegible]

Chucks with two jaws only are not so frequently operated with a scroll as with a screw. When using the screw there is no need to have a complete round body, and the sides can be flat, constituting a box body, which saves weight and is

more convenient for holding certain classes of work. An independent-jaw box-body chuck has the jaws moved by separate screws, but a universal-jaw type has a single screw with right- and left-hand ends. The location of the screw determines whether the work may pass by the jaws into the chuck body or not. If the screw is set centrally *A*, Fig. 25, it obstructs the passage, but if at the side, *B*, there is nothing to prevent the work from extending into the body.

Combination Chucks

In a universal chuck of the scroll type the radial movement of the jaws is produced solely by the rotation of the scroll, and the labor, wear, and time incurred by this procedure in large chucks is highly objectionable. This has brought about the practice (in chucks for boring and turning mills) of mounting the jaws with interlocking serrations on the faces of separate slides which mesh with the scroll. This gives provision for rapid loosening of the jaws and their transition to or from the center, in the same manner as in the Herbert chuck previously illustrated.

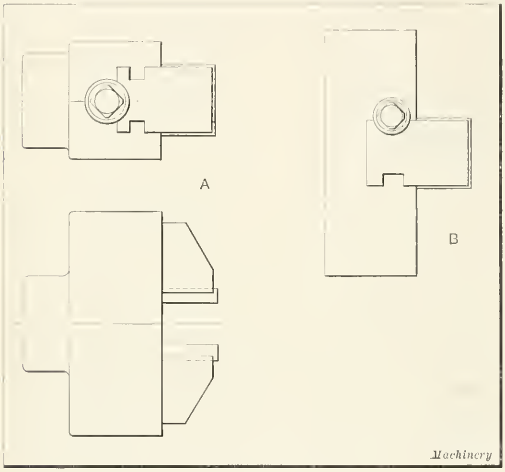

Fig. 25. Brass Finisher's Chuck

Having seen the principles of operation of both independent and universal chucks, we will now consider a type which affords a useful blending of the two kinds, the combination chuck. This, as its name implies, provides either independent or universal movements of the jaws as desired. Two devices are in common use for attaining this end, one being to employ geared screws and arrange the rack so that it may be dropped out of mesh, and each screw turned independently, and the other to use a scroll but give each jaw a separate movement by an independent screw. When the rack device is utilized it is generally lowered by removing a ring from the back of it, or by turning a ring with raised nibs which enter into recesses in the rack and allow the latter to drop sufficiently. In a Pratt & Whitney design, Fig. 27, the ring is grooved so that when partly revolved it lowers the rack out of engagement. The Westcott chucks have a ring provided with concave places underneath to fit over lugs standing up in the back of the chuck, and provision is made to partly rotate the ring and bring the straight back onto these lugs, thus raising the rack into gear with the pinions. Several chucks are designed on this general principle. The scroll and screw design also finds much favor, an example being seen in Fig. 28 (Horton), with very large screws. Another chuck, with screws having a central thrust collar and a worm-gear for turning the scroll, is shown in Fig. 29.

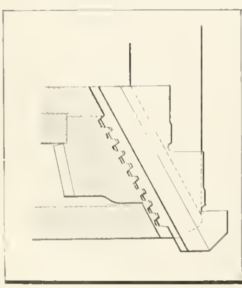

Fig. 26. Taylor Spiral Chuck with Jaws Inclinably Mounted

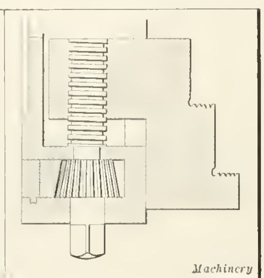

Fig. 27. Combination Chuck with Revolving Ring behind Back

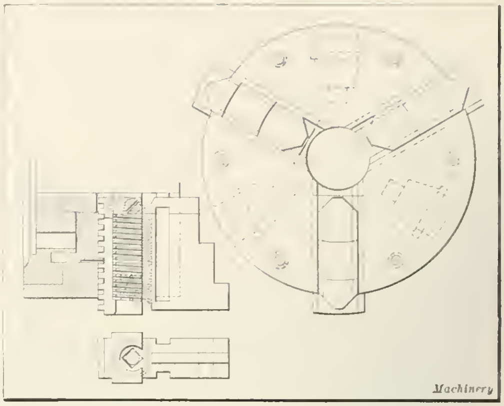

Fig. 28. Combination Scroll and Screw Chuck

The combination chuck is disparaged by some, but it nevertheless fills a useful sphere, particularly in cases where the expense of two separate chucks is objected to, or the trouble of changing one for another frequently arises. Some general runs of work require frequent changes from a universal to an independent chuck and *vice versa*. When dealing with eccentric work it is a great convenience to be able to adjust the jaws independently to suit the contour and then move them simultaneously in or out for repeated pieces. Some kinds of chucks, moreover, as those used on heavy lathes, turning or boring mills, are never changed, and the combination principle has to be embodied if the most useful style of chuck is desired.

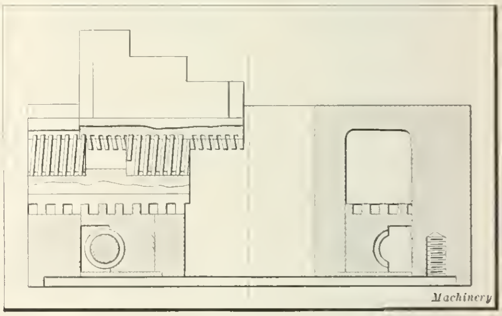

Fig. 29. Combination Chuck with Worm-gear

* * *

Aluminum alloys which are claimed to be extremely tough and strong and highly malleable when cast in chilled molds are composed of 91 per cent aluminum, 8 per cent zinc, 1 per cent cadmium, or 88 per cent aluminum, 10 per cent zinc and 2 per cent cadmium. When cast in sand molds, castings made from this alloy have a fine smooth surface and can be readily machined. When cast in chilled molds, the alloys can also be rolled into wires or flat bands. The method of manufacturing the alloy consists in adding zinc and cadmium with or without the addition of a suitable flux to the molten aluminum. The mass is maintained in a molten condition until the zinc and cadmium have been evenly absorbed and is then poured.

MACHINING OPERATIONS ON THE GEAR SHAPER

JIGS AND FIXTURES EMPLOYED FOR FINISHING THE SADDLE AND CABINET

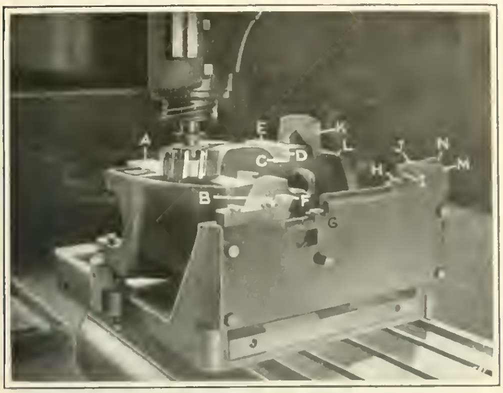

Fig. 1. Work set up on Milling Machine for roughing out Saddle Bearing

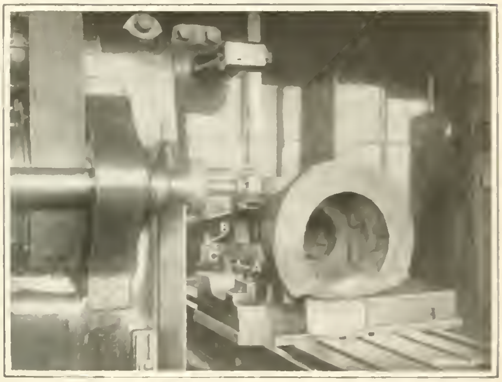

Fig. 2. Milling Bearings for Gib and Plate that hold Cutter-slide in Place

THE first step taken by a tool designer who is confronted with the problem of developing jigs and fixtures for machining some unusual piece is usually to refer back to the drawings of any tools which he may have designed for holding similar parts. There are men who have been fortunate enough to have had a wide experience in designing jigs and fixtures for machining a great variety of products, and such men will seldom find much difficulty in devising a satisfactory method of handling the most intricate work, but the experience of the average tool designer is likely to have been confined to some specific line, and consequently the development of tools for exceptionally difficult machining operations is purely a matter of ingenuity and likely to consume an unnecessary amount of time.

But the tool designer who is engaged in a given line of work always has the opportunity of gaining the equivalent of experience in handling other lines by reading descriptions of jigs and fixtures developed by designers engaged in such work; and he will frequently find it possible to apply ideas acquired in this way in the development of tools for use in the factory in which he is employed. Were it not for the possibility of applying ideas in this way, there would be little point in the publication of detailed descriptions of jigs and fixtures employed for specific machining operations.

It is the purpose of the present article to describe the milling, boring, planing, drilling and reaming operations performed on the saddles and cabinets of gear shapers built by the Fellows Gear Shaper Co., Springfield, Vt. In machining the saddles, it is necessary to make use of the milling machine, horizontal boring machine, horizontal drilling machine and planer, and the first part of the article will be given over to a description of the tools and methods of procedure employed in performing machining operations on each of these machine tools. The cabinets of the machines are first planed on their upper and lower surfaces, after which they are set up in a jig that is used in conjunction with two radial drill presses which drill and ream all of the holes; and a description of this work will be presented in the latter half of the article.

Milling Chucking Spots and Rough-milling Saddle Bearing

The fixtures used for performing the second and third operations on the saddle castings are provided with three hardened steel pads which locate the work from three chucking spots. These spots are provided by milling the faces of three bosses which are cast on the saddles for that purpose, and the first operation consists of performing this work. For this purpose the saddles are blocked up in approximately a horizontal position on the milling machine table, a No. 4 Cincinnati vertical milling machine being employed for the purpose.

The second operation consists in rough-milling the bearing by which the saddle is supported on the machine. As previously mentioned, there are three pads on the fixture in which the work is held, which locate the casting from spots that were milled by the preceding operation; and in addition, there are five hardened gage spots on the fixture, which are brought into contact with the cutter before each milling cut is taken, in order to provide for locating the table in the desired positions. The five surfaces to be milled are shown at *A*, *B*, *C*, *D*, and *E*, Fig. 1, and the hardened gage spots provided on the fixture for locating the milling machine table in the proper positions for taking a cut over each of these surfaces are shown at *F*, *G*, *H*, *I*, and *J*, respectively. The cutter shown in Fig. 1 is employed for milling surfaces *A* and *E*, after which a smaller cutter is substituted for reaching surfaces *B*, *C*, and *D*. The work is done on the same machine as was used for milling the chucking spots on the castings.

Planing the Saddle Bearing

The third operation consists in finish-planing the surfaces that were rough-milled during the previous operation, and for this purpose the work is held in the fixtures in which the roughing operation was performed on the milling machine, but in planing, three of the saddles are set up at a time on a G. A. Gray planer, the arrangement being clearly

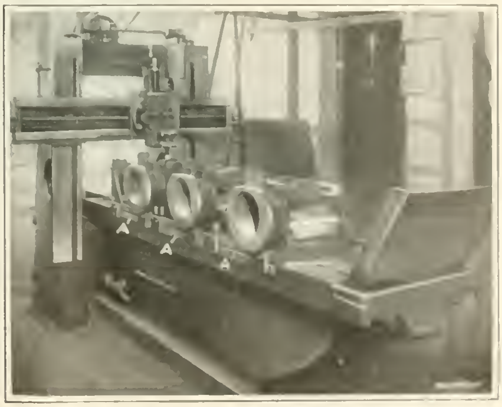

Fig. 3. Finishing Saddle Bearing on Planer

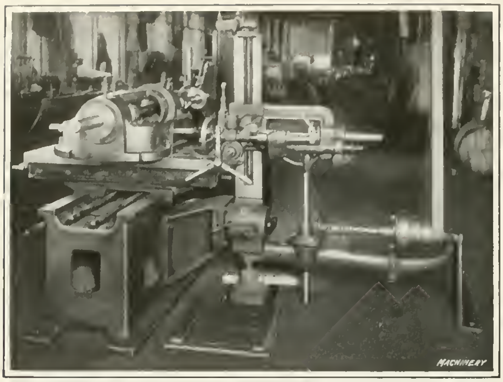

Fig. 4. Arrangement of Lucas Boring Machine and Barnes Drill for machining Holes in Saddle

shown in Fig. 3. A tapered gib is provided in the cross-rail bearing in the saddle to afford means of compensating for any wear that may develop in this member of the gear shaper, and it is the necessity of machining the bearing to receive the gib which led to the employment of three separate fixtures instead of constructing a single planer fixture for holding three saddles at a time. The use of the individual fixtures makes it possible to employ taper strips *A* between the fixture and the edge of the planer table, to locate the work at the proper angle for planing the gib bearing. In other respects the finishing of the five surfaces *A*, *B*, *C*, *D* and *E* of Fig. 1 by planing is essentially the same as that followed in the rough-milling operation, so that further description is unnecessary. In addition the surfaces *K* and *L* to which the worm-box is attached are finished while the work is set up on the planer, and the hardened gage spots *M* and *N* are planed on the fixture to provide for setting the tool to take the required depth of cut.

Milling Bearing Surfaces for Gib and Side Plate that Hold Cutter-slide in Saddle

The cutter-slide or ram runs in the cylindrical bearing in the saddle, which is open at one side as shown in Fig. 2; and the slide is held in its bearing by a flat plate and a taper gib at opposite sides of the opening. It will be recalled that the bearing by which the saddle is supported on the cross-rail of the machine has already been finished, and the fixture employed in performing the fourth operation holds the casting in exactly the same way that the finished part will be supported on the gear shaper. This method of holding the work will also be employed on all subsequent machining operations on the saddle. There are six surfaces to be milled, and the work is done on a No. 4 Cincinnati horizontal milling machine, the arrangement being shown in Fig. 2. The end of the cross-rail on the fixture, which supports the work, is shown at *A*; and two of six hardened gage spots that locate the cutter for the performance of successive milling operations are shown at *B* and *C*. Location of the work for milling the bearing for the taper gib is obtained by a strip placed between the fixture and the edge of the milling machine table, the arrangement being essentially the same as that explained in connection with the description of the planing operation.

Boring and Drilling Operations on the Saddle

The fifth operation consists in boring and reaming the holes for the cutter-slide, the index wheel, the driving shaft, and the lead-screw. Two of these holes are located at right angles to the other two, and to provide for machining all four holes at a single setting of the work, the equipment used consists of a No. 6 Lucas boring machine which has the head of a No. 2 W. F. & John Barnes horizontal drill press bolted to the side of its bed, the arrangement being clearly shown in Fig. 4. The fixture which holds the work is of the same design as the one employed for the preceding operation, *i. e.*, the casting is supported from the cross-rail bearing. It will be evident from the illustration that the bearing for the slide and the housing for the index wheel are machined by cutters carried on the spindle of the Lucas boring mill, while the holes for the lead-screw and driving shaft are drilled by the Barnes horizontal drilling machine.

In boring the holes for the cutter-slide and index wheel, three cuts are taken over the work. The roughing cut leaves 1/16 inch of surplus metal and the intermediate cut leaves 0.010 inch to be removed during the finishing operation. In drilling the two holes for the lead-screw and driving shaft, two operations are required. A roughing cut is taken with a core drill which leaves 1/32 inch of surplus metal that is removed during the finish-boring operation.

Facing Off Index Wheel Flange and Turning Edge of Flange

The final operations consist of facing off the flange on which the index wheel rests, turning the edge of this flange, and cutting the scraping groove. For performing these operations, the work is set up on a Lucas horizontal boring mill, which is equipped with a star head.

Machining Operations on Cabinets of the Gear Shaper

The planing of the flat surfaces on the cabinet of the Fellows gear shaper are commonplace operations which require no description. There are three parts that comprise the work to be machined. They are the cabinet, the swinging apron, and the apron lever. The holes to be machined are the hole which carries the work-spindle quill, two holes which support pivots for the swinging apron, two holes which carry the plungers that operate the apron lever, and the hole which carries the lever stop. The plunger holes and the lever stop hole are cored out at the time the casting is made; and in addition to the drilling and boring operations referred to, it is required to face the top and bottom of the hole in which the work-spindle quill is carried.

The cabinet *A*, the swinging apron *B*, and the apron lever *C*, are assembled as shown in Fig. 5; and suitable means are employed for holding these three component parts in the required positions relative to each other. The machining is done on two radial drill presses, which are set up at right angles, as shown in Fig. 7, with the jig carried on the bed of one of the machines. The advantage of this form of equip-

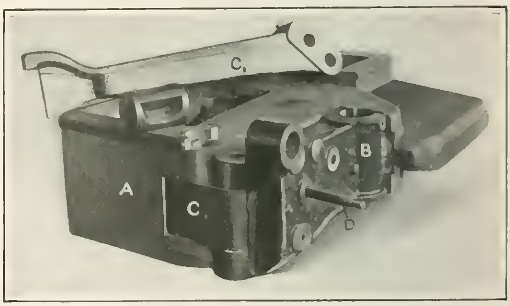

Fig. 5. Parts of Fellows Gear Shaper Cabinet assembled ready for Drilling Operations

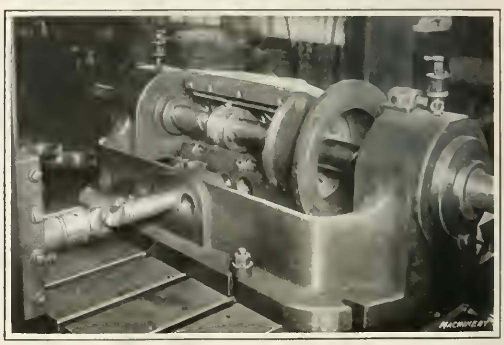

Fig 6. Close View of Work and Tools on Machines shown in Fig. 4

ment over a special boring machine is that the two radial drills are always available for standard classes of work, and they do not need to be changed in any way when it is desired to employ them for general drilling.

Construction of the Drill Jig

A close view of the drill jig with one of the castings in place is shown in Fig. 8. In locating the work in the jig, the casting is pushed back so that bolt *D*, Fig. 5, extends through a hole at the back of the jig; and the nut is screwed up on this bolt so that the finished faces on the apron *B*, Fig. 5, are drawn back against locating pads in the jig. Sidewise location of the work is secured by means of plunger *A*, Fig. 8, the work being moved the required amount to bring the index mark on this plunger into coincidence with a mark on the plunger housing before the bolt *D*, Fig. 5, is tightened to secure the casting in place in the jig.

After the work has been set up in the jig, the proper tools are used successively for drilling, boring and reaming the holes. A collection of the tools employed for this purpose is shown on the bases of the drilling machines in Fig. 7. Referring to the close view shown in Fig. 8, it will be evident that bushings are provided in the jig at *B*, *C* and *D* for locating the hole for the spindle quill and for the two holes which carry the pivots for the swinging apron. Hardened slip bushings fit into holes in the jig for grinding the different tools. The hole for the spindle quill is roughed out by means of a fly cutter, after which an intermediate cut is taken with the same type of tool. The bosses at the top and bottom of this hole are next faced off by tools carried in the fly cutter bar; and the hole is then reamed with a Pratt & Whitney inserted-tooth reamer. The holes for the pivots which carry the swinging apron are roughed out with a Morse shell drill and finished with a Kelly reamer.

For locating the hole which carries the lever stop, there is a bushing on the jig, which is carried by the swinging bracket *E*. After the lever stop hole has been drilled, this hole is used as a point of reference in locating the two holes for the plungers which operate the apron lever. The bushings through which these holes are drilled are carried by brackets which

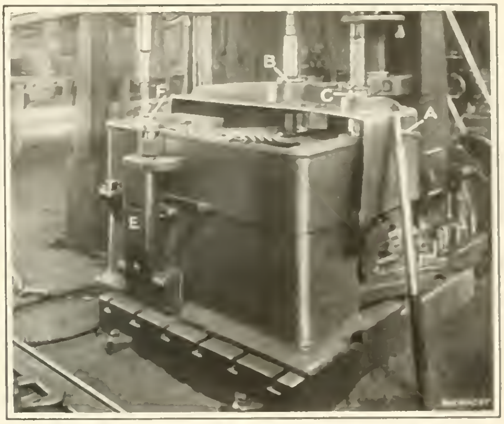

Fig. 8. Close View of Drill Jig used on Machines shown in Fig. 7

have stems that fit into the hole drilled for the lever stop; the distance between the holes is naturally determined by the length of the bracket, while the angular position of the bracket and bushing carried by it is determined by a spline on the stem that enters a keyway in the jig. These three holes are cored out in the casting; and in each case the roughing cut is taken with a twist drill, after which a Kelly reamer is employed for the finishing operation. The use of one of these bushings is shown at *F* in Fig. 8. In addition to the six main holes in the work, which have been referred to, there are a number of other small holes to be drilled; and it is interesting to note that all of these holes can be machined without requiring a second setting of the work. As regards both accuracy and rate of production, the results obtained from this method of machining are highly satisfactory.

E. K. H.

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STRENGTH OF DROP-FORGINGS

Several years ago we published in MACHINERY a paper read before the Franklin Institute, relating to the heat-treatment of alloy steels. In this paper the statement was made that drop-forging was very injurious to steel. We are informed by J. H. Williams & Co., Brooklyn, that this statement is erroneous, and that instead of the strength of drop-forged steels being less than that of steels not so treated, drop-forgings show a material increase of strength. With the ordinary run of mild steels from which the majority of drop-forgings are made, and which have, in the bar, a strength of from about 55,000 to 58,000 pounds per square inch, drop-forging will increase the strength to 62,000 pounds per square inch without any other treatment. With the higher carbon steels, having a tensile strength of about 80,000 pounds per square inch, there is no difficulty in increasing the tensile strength by means of drop-forging to 95,000 pounds per square inch. Where different results have been obtained it is no doubt due to the fact that drop-forging has been done under improper conditions. This, however, is no indictment of the drop-forging process, because any process conducted under poorly adapted conditions is likely to spoil the material being handled. When drop-forging is done by experienced men provided with the proper facilities, and working under suitable conditions, the process improves the strength of the steel.

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The British Parliament has passed an act suspending for the duration of the war and until six months thereafter the operation of Section 27 known as the working section of the British patent act. During this period of suspension, no attack on British patents on the ground of non-working can be brought until six months after the close of the war and the period of suspension in Section 27 will not be reckoned against a patentee who has not worked his patent in Great Britain. The Act applies both to existing patents and to future patents which may be issued during the period of the war.

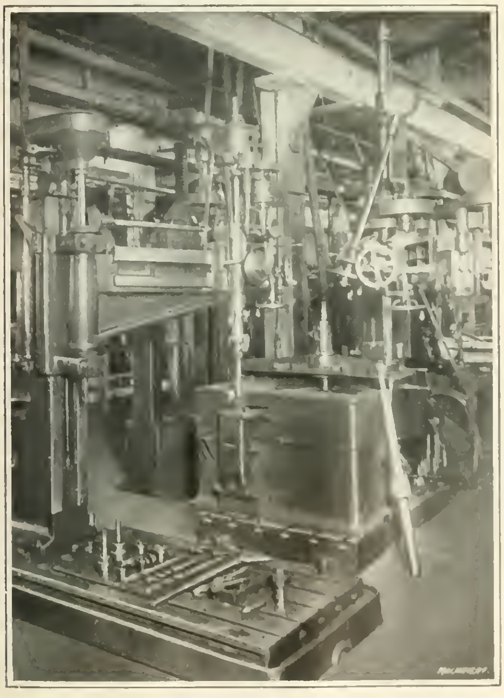

Fig. 7. Arrangement of Two Radial Drills for Operation on Gear Shaper Cabinets

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MACHINERY

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Alexander Luchars, President
Matthew J. O'Neill, General Manager
Robert B. Luchars, Secretary
Fred E. Rogers, Editor
Erik Oberg, Franklin D. Jones, Douglas T. Hamilton,
Chester L. Lucas, Edward K. Hammond,
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Associate Editors

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MARCH, 1916

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MANUFACTURING TO GOVERNMENT SPECIFICATIONS

The manufacture of shrapnel, high-explosive shells, rifles, bayonets, cartridges and other munitions of war on contracts, undoubtedly will result in some American concerns acquiring wholesome experience in the meaning of government specifications. We Americans are impatient of restriction and our manufacturers are no exceptions to the rule. When building machinery or manufacturing a product, they sometimes change dimensions or modify forms to suit their own peculiar ideas, and the result may be a product highly satisfactory to them but one that does not conform to the designer's original plan. The making of shell fuses and other material of that nature was practically an unknown art to most American manufacturers eighteen months ago, and they had a very limited conception of the technicalities of the business, so that when some of them undertook to fill contracts for foreign governments they got into trouble.

Specifications for foreign military supplies are rigidly drawn, and inspectors have a disagreeable way of holding closely to them; in fact their orders leave them very little discretion. Slight variations, which to the American manufacturers may appear unimportant or even seem to actually improve the product, are usually rejected. In some cases, it may appear that the requirements are unnecessary. A thousandth inch more or less on a part "fitting the atmosphere," would seem to make no difference whatever in the functioning or integrity of the piece, but the inspector holds that it must conform exactly or be rejected.

The manufacturer who undertakes to fill orders for war munitions must organize his plant on rigid lines, holding every man to the exact performance of his work. Variations in measurements must not be allowed even if the work produced is interchangeable, for interchangeability alone is not sufficient. Not only must the parts be interchangeable but they must exactly conform in shape to those prescribed. The material must conform to physical specifications; not only must the weight of the bare metal agree with the specifications, but the amount of protective coating, whether paint, lacquer or other material, must be just the prescribed number of drams or ounces.

New and unsuspected problems in machine shop practice have been forced on some who expected to become rich quickly. For instance, the firing hole of a certain fuse is drilled with a No. 69 drill. The hole is 5/8 inch deep in steel; great difficulty has been experienced in finding drilling machines and drills that would stand up to the work. The reason was that the ordinary drilling machine could not be operated at the high rate required to give a No. 69 drill the proper cutting speed. The rotating parts are not in perfect dynamic balance, and the resulting spindle vibrations break the drills.

The contractors, confronted with this and similar problems, have criticised the design of the shell parts, saying, for example, that the wall thickness is too great or the diameter of the firing hole is needlessly small. The probability is that neither the wall thickness is too great nor the diameter of the hole too small. The dimensions have been carefully worked out by ordnance experts, and have been confirmed by hundreds of tests conducted at great cost. The factors of time, velocity, inertia, impact and explosive action are all interrelated, and slight variations might utterly upset the ordnance experts' calculations.

Although we excel as manufacturers in certain lines, much can be learned from this war business that should be so applied as to improve the products. The solution of problems continues with the production of war material like those of automobile manufacture; it means a step forward in the development of the machine tool industry, and our manufacturers will apply the knowledge so acquired to improve their methods and product. In the competition for the world's markets, we must learn to be particular about the apparent nonessentials and remember that there may be very good reasons for seemingly absurd specifications. Moreover, it is the customer's privilege to demand what he wants.

* * *

OUR CONSULAR SERVICE

The United States government maintains a consular service in foreign lands at heavy expense, and from it gains inadequate service compared with that rendered to their respective governments by the consular representatives of the great European powers. The trouble with our consular service is that it has been regarded as part of the legitimate patronage of the political party in power. Consequently many consuls have been appointed who had little or no knowledge of the business of representing their government abroad. They were unfitted by nature, temperament and experience for the exacting and arduous duties of the service.

Many of the items published in the daily *Consular Reports* are puerile, inaccurate and misleading. The consular service could be a great aid in developing American trade abroad if it were composed of men trained for such service, appointed without regard to politics, and assured that they would be retained in the service as long as they attended to business satisfactorily.

An example of the inaccurate reports is the item that appeared in the December 6 number, stating that the United Kingdom would prohibit, after December 21, the importation of all machine tools and parts thereof except small tools. Mention was made of a board of trade license, but the natural inference drawn was that machine tools would be practically barred from Great Britain after the date mentioned. The fact was that the importation of machine tools was simply restricted to established concerns, and that the profits of the business were limited.

The machine tool business is only one of many whose prosperity may be promoted or hindered by the consular service. It should be placed on a plane above the influence of patronage and party politics. Trained men of experience and good judgment are needed to represent the United States abroad as perhaps never before, to promote the vast foreign trade that will surely be ours if wisely fostered.

* * *

Statistics show that in the past twenty-five years, 113,570 persons were killed and 123,611 persons were injured while walking on railway tracks and jumping on cars in the United States. Practically all of these accidents could have been avoided if the public had been excluded from the tracks.

TAKING ONES OWN MEDICINE

BY A. PURCHASER

It is universally acknowledged that the cobbler's children are proverbially out at the heel. When, however, the cobbler has risen to the height of a leading manufacturer one naturally expects him to discard this slovenly policy, and to adopt one of progressiveness in the use of his own product in manufacturing that product. In other words, we expect him to take his own medicine. Does he? From the experience of a number of years spent in purchasing activities for a large factory I am convinced that in many instances he does not. A few actual occurrences that remain in my memory may serve to illustrate the point. One of my early assignments was to visit a factory building grinding machinery, to judge if the shop equipment would warrant placing an order with the company for a number of special grinders. In his effort to convince me of the high quality of their work, the superintendent conducted me through their shops, pointing out here and there the refinements of their processes.

"As you will note," he remarked, stopping before a fine automatic shaft grinder, "all of our shafts, spindles, etc. are ground to exceedingly fine limits."

"Very good," I replied, "but why do you use a Gash & Snaggum grinder instead of your own?"

Stammering explanations followed, how they happened to have the machine before they built grinders, how it was a very good machine and they were too busy to replace it, etc., etc. We bought our grinders of Gash & Snaggum.

As our plant increased in size and the coal handling problem became more important, I was delegated to look into the matter of handling it in a manner that would be cheaper than by the use of manual labor as we were then doing. One company sent us such glowing literature regarding its grab-bucket system for the purpose, that we decided to give its proposition consideration. By appointment, I met a salesman in the city and with him traveled to the suburban town in which the factory was located. All the way out he entertained me with figures, illustrations and a fine line of talk which, by the end of our half-hour's run, had nearly convinced me that the one and only way in which coal could be handled efficiently in any factory was by the use of the Hoistem Co.'s grab bucket.

As we approached the factory I noticed several coal cars on the siding of the plant and was much pleased at the thought that I should have an opportunity to see one of these buckets in actual operation. When we drew nearer, however, I was surprised to find that each car had a crew of laborers who were industriously shoveling the contents by hand into the factory yard, whence it was transported in wheelbarrows to the engine room. I didn't have to say anything to that salesman. He explained, as best he could, how the great volume of orders had so taxed the factory's capacity that they had never found time to build themselves any coal handling apparatus, but he knew as well as I did that the bluff was worthless. I spent a very pleasant morning with him and could appreciate the difficulty confronting him in not having the proper backing of his company—but we bought another kind of coaling equipment for our factory.

The same thing occurred when we decided to take out our long lines of shafting and replace them with individual motor drives in our machine shop. I called on three motor builders, and in each case found plenty of enthusiasm until I requested an opportunity to visit their shops. Then the enthusiasm suddenly died out and, very reluctantly, I was shown through a belt-driven factory. At best, in a few cases, the tools were grouped and the groups motor-driven, and in not every case was one of their own motors employed for driving the group. Naturally my reports to the management regarding individual drives were somewhat lukewarm. It all looked fine on paper, but I wanted to see the actual operation before becoming convinced that the possibilities in any degree approximated the claims.

Finally I visited a fourth factory whose owners had furnished us with the usual collection of impressive literature. As soon as I started to talk with the salesman, in whose charge I was placed, I sensed a difference. His claims were made with the conviction of one who is able to back up all his statements. In the matter of looking over the factory he anticipated me.

"But, Mr. P——, there is no use of our talking this thing over a batch of blueprints and photographs. Come right out into the machine shop and we can discuss each kind of drive as we go along, with the working illustrations before us."

There were no explanations nor apologies here. Into the shop we went. There was no lineshafting to be seen. Each machine was equipped with its individual motor and they were all of this company's make. As we came to each machine my conductor explained the different types of applications that they had worked out; he told me how we could arrange with the tool builders for the equipment of new tools with this particular make of motor, and showed how old belt-driven tools could be most readily altered to employ motor drive. He also explained how his company was ready to supply us with detailed drawings of the auxiliary brackets and gearing needed to secure the best results from the application, and even offered the use of their bracket patterns in cases where we planned to equip tools that were the same as those they had altered.

When the question of results arose, he showed me the different types of tools in actual operation under the improved conditions and explained the savings they were making over the old methods. When we stood beside a lathe and saw the lathe hand, who was facing a casting, "notch up" his controller six times as the cut ran in toward the center, it was very clear that he was getting all the cutting speed that the tool would stand. I knew well that if the same work was being done with a belt-driven tool, the belt would not have been shifted once through the entire cut. This one demonstration was enough to satisfy me that there was something in this salesman's claims; and by the time the work of each tool in succession had been thus graphically analyzed, I was fully convinced. Furthermore, the salesman seemed to take it for granted that I would be. Possibly some of the other makers had shown me just as good motors—motors that were capable of just as efficient application and of making just as great a saving. But they had failed to produce the demonstration necessary to carry conviction. It will not be difficult for the reader to guess which one of the motor builders, visited in my investigation, secured our order for motor equipment.

* * *

In a recent consular report, a letter from A. H. Baldwin, commercial attaché of the Bureau of Foreign and Domestic Commerce of London to the London *Telegraph* was reproduced. Mr. Baldwin pointed out the great difficulties confronting the British Ministry of Munitions in providing an adequate supply of machine tools, especially for the new national factories. All the machine tool factories of the country have been placed under government control, but their output is not nearly sufficient to meet the huge demand. The government realizes the need for getting into its hands every available machine tool, and one of the results is the recent proclamation prohibiting the importation of machine tools into Great Britain. Mr. Baldwin says that it may be the intention of the government to prevent firms from securing new machine tools necessary for carrying on their business so that these tools can be used for national purposes instead, and it is further thought that the government will acquire machine tools from those few existing factories that have not every such tool engaged on munition work, although they might be needed for maintaining ordinary trade connections. He says that of course the nation's interests may compel such sacrifices, but they will entail immense industrial loss which could perhaps be avoided if the government would set up its own machine tool factories. This could be done by setting apart one or more of the new national arms factories simply for the purpose of supplying machine tools to the other national factories. Already certain controlled works have concentrated on the production of the jigs and gages needed in shell production. It would therefore be only a further step in the same direction to establish a national machine tool factory.

PLANING HELICAL SURFACES

BY EDWARD W. MILLER*

The cutter path of the Fellows helical gear shaper is controlled by a helical guide corresponding in lead to that of the cutter. A taper hole in the guide insures a good fit on the cutter-spindle, to which it is rigidly clamped so that the two may act as one piece. The guide has a bearing in a sleeve fitted and held to the upper index wheel. The helical surfaces of the guide bear against similar surfaces of a shoe fast in the

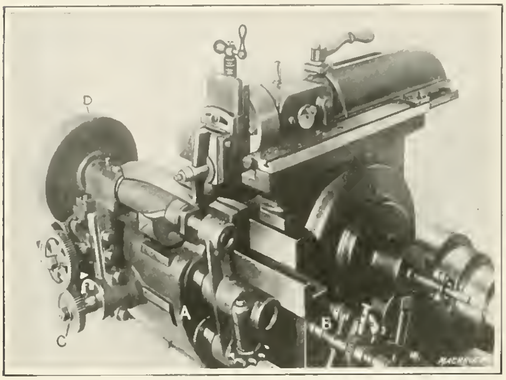

Fig. 1. Shaper Attachment for planing Helical Surfaces

sleeve and a gib which may be moved endwise in the sleeve. This rather unique gib affords an easy and correct adjustment for wear. As the cutter-spindle travels up and down, the guide bearing against the shoe and gib imparts the necessary twisting movement to pass the cutter through the work in the proper path. The machining of this helical surface presented a problem which was solved by a planing fixture adapted to a crank shaper.

Slide *A*, Fig. 1, is fitted to the shaper cross-rail, being operated by a special shaft *B*. This shaft, threaded far enough to allow ample slide travel, engages a square threaded adjustable nut. Extending farther as a plain shaft, it passes through a bevel gear integral with a sleeve which bears in the slide. A long spline in the shaft fits a key in the gear, causing it to rotate as the slide is fed along. Through a mating bevel gear,

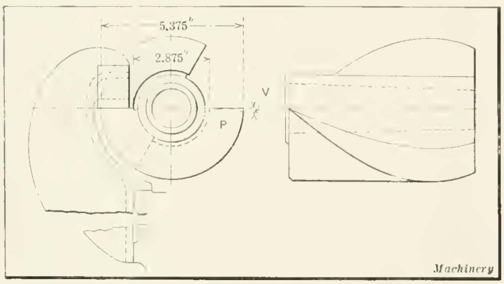

Fig. 2. End and Side Elevation of a Guide for machining Helical Surfaces

motion is imparted to shaft *C* and then through the change-gears and worm to a self-locking worm-wheel *D*.

The worm-wheel is keyed to the work-spindle and causes its rotation. It is thus possible to plane a guide of any desired lead by using the proper change-gears. It will be noticed that the outer end of the work-spindle is controlled by a support. The guide is clamped with the square nut and positively driven by a pin in the spindle flange.

All the elements of a true helix are straight radial lines. Investigation demonstrates that a tool operating at right angles to the axis of the work will not produce a theoretically correct guide unless reduced to a point. Proof of the above statement may be demanded, and as the study and solution of the problem is interesting, reference may be made to Fig. 2. Here is shown the end and side elevation of a guide. The helix advance in one turn is 20 inches. A development of this helix presents a right triangle (Fig. 3) with the long leg 20 inches, corresponding to the lead of the guide. The lengths 16.885 and 9.032 are obtained by multiplying 5.375 and 2.875 by 3.1416. Solving triangles *OAB* and *OAD*, we obtain 24 degrees 18 minutes and 40 degrees 10 minutes. It is thus evident that the helix angle varies according to the radial distance from the center.

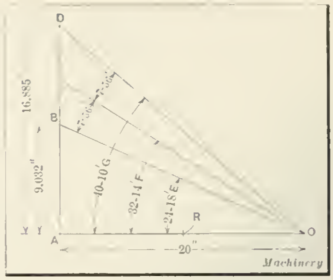

Fig. 3. Graphical Illustration of Helix Angles

In Fig. 4 let X–X represent the axis of the helical guide. Through any point *I* draw line *J*, making an angle equal to *F*, Fig. 3, with X–X. Draw *IK* perpendicular to *J*, and at any point *L* describe a circle passing through *I*. Draw *M* and *N* tangent to *H* at angles corresponding to *G* and *E*, Fig. 3. Let circle *H* represent a reciprocating tool traveling at right angles to the axis X–X. Angles *G* and *E*, Fig. 3, correspond to the helix angle developed by diameters 5.375 and 2.875, Fig. 2, and it becomes evident from the difference *Z* that the finishing tool does not produce straight radial lines. Only at point *I*, which marks the intersection of the guide axis with the helical angle 32 degrees 14 minutes, does the tool finish properly.

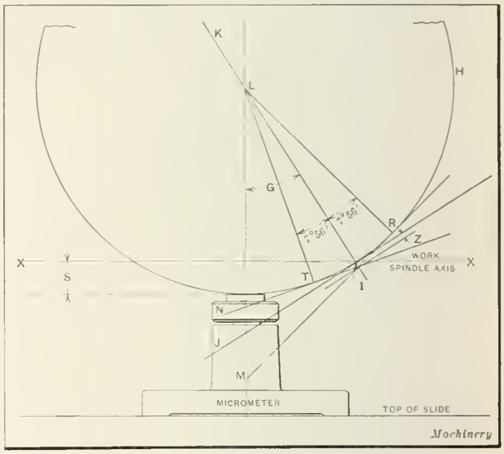

Fig. 4. Illustrating Method of determining Error

Evidently a tool consisting of a point only would produce correct results, but when of considerable diameter, as *H*,

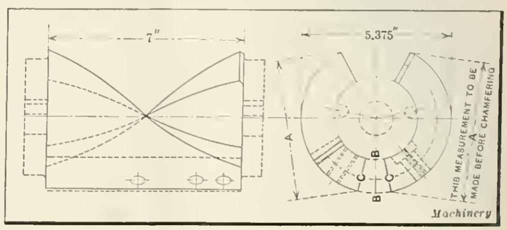

Fig. 5. Helix Shoe and Gib

* Address: Fellows Gear Shaper Co., Springfield, Vt.

there is contact at points R and T with lines M and N. The result is a curved surface P, Fig. 2, instead of a straight radial line. The height V of this curve is identical with distance Z, Fig. 4. The shorter the lead the greater is this error, inasmuch as shortening increases the difference in angles G and E, Fig. 3. This last statement is true when dealing with the problem at hand, since twenty inches is the shortest lead used. It is of passing interest to note that at point R, Fig. 3, the increase ceases and the angular difference decreases as point A is approached.

The guides are roughed with a round nosed tool of about 3/16 inch radius. The finishing is done with a piece of 1/8 drill rod gripped in a holder. Then with LR, Fig. 4, equal to 0.0625, error Z (or V as shown in Fig. 2) is obtained as follows:

$$\frac{0.0625}{\cos.\ 7\ \text{deg.}\ 56\ \text{min.}} = 0.0641$$

$$0.0641 - 0.0625 = 0.0016 = Z$$

This 0.0016 is easily removed with a scraper.

The exact position of the cutting tool is of course important, and settings are determined from angle F, Fig. 3, as this is the intermediate angle position on the helical surface. The tool is located with a special micrometer, as shown in Fig. 4. When the top surface of the micrometer anvil coincides with the work-spindle axis, the reading is zero. When setting the tool, the screw is turned a distance equal to S.

$$S = 0.0625 - (\cos G \times 0.0625)$$

The planing process has proved a rapid and satisfactory means of production . The practical impossibility of machining these helical guides with a mill or grinding wheel is apparent when one considers the necessity of keeping the tool diameter to 1/8 inch.

The gage shown in Fig. 2 is useful in keeping the two helical surfaces opposite. Fig. 5 shows the helical shoe and gib. They are machined as one piece, the metal indicated by dotted lines being removed when the different operations have been performed. The gib and shoe are parted on line BB. Surfaces C are then machined to dimension A. Dimension A varies with the lead, and the necessary shop instructions are furnished in a table which accompanies each guide order.

* * *

BROACHING TOOLS FOR MULTIPLE KEYWAYS

In one of the largest plants in the country devoted to the manufacture of automobile gears—that of the Brown-Lipe Gear Co. of Syracuse, N. Y.—there are some interesting spline or keyway broaching operations. The illustration shows two of the tools for this class of broaching, both of which are used on the Lapointe Machine Tool Co.'s broaching machines.

One of these broaches, that shown on the machine, is for broaching six semicircular keyways spaced equidistantly around a two-inch hole. The unusual feature of this tool is that the broach is built up of sections, each marking the width of a combined tooth and space of the complete broach. These rings are assembled on a bar of soft steel, being keyed so that they will always remain in proper alignment. Should one of the teeth break at any part of its cutting edge, it is only necessary to insert a new section. The sections are all held firmly together by drawing them into place with a nut on the end of the broach arbor. In broaching, trouble is often experienced from having the finish end of the broach, that does the final sizing, wear under size. With this type of broach, however, when the finish sections wear small, new teeth may be substituted, and the tool is then as good as new. While expensive to manufacture, this style of broach has a long life, the one shown having been in use for the past three years.

Another broaching tool for cutting multiple keyways is the one that the operator is shown supporting in an upright position. This is made with six separate broaches that work together in broaching the keyways in a gear having a large center hole. If the broach had been made solid, it would have required a heavy piece of steel, which, of course, would have been very costly. The method used was to construct a head-block of low-carbon steel, having slots in which the six narrow broach-strips are hinged. This head-block is pinned to the end of the pulling screw of the broaching machine. The broaches are guided by a slotted block that is seated in the faceplate of the machine. This block may be seen located about half way up on the tool. The broach strips are made tapering as regards thickness from the teeth to the back. The difference in thickness between the two ends of

Two Types of Broaches for cutting Multiple Keyways

the broach strip agrees with the depth of the keyway to be cut. When the broaches are started they barely graze the gear, but as they increase in thickness at the cutting point, the broaching takes place. The slotted guide block prevents the broaches from springing away from the cut. The gear is put in place for the operation by slightly springing the tips of the broach strips together and passing the blank on and up to the faceplate of the machine.

Both of these broaching operations are handled very rapidly, the average time for broaching a gear 7/8 inch thick, with six keyways, being but two minutes. C. L. L.

* * *

AUTOMOBILE MANUFACTURERS IN THE UNITED STATES

The latest statistics of motor car manufacturers in the United States show that thirty-four states now have motor car factories, and the total number is 463. Michigan leads the list with eighty-six. Then follow in order New York with sixty; Ohio, fifty-two; Illinois, forty-seven; Indiana, forty-five; Pennsylvania, thirty-five; Massachusetts, seventeen; Missouri, sixteen; Minnesota, fifteen; Wisconsin, fourteen, California, thirteen; New Jersey, ten, Connecticut, seven; Washington, six, and the others with from one to four:

California	13	New Jersey	10
Colorado	3	New York	60
Connecticut	7	North Carolina	1
Delaware	2	Ohio	52
Georgia	1	Oklahoma	1
Illinois	47	Oregon	2
Indiana	45	Pennsylvania	35
Iowa	6	Rhode Island	1
Kansas	3	South Dakota	1
Kentucky	3	Tennessee	3
Louisiana	1	Texas	3
Maine	1	Utah	1
Maryland	4	Virginia	1
Massachusetts	17	Washington	6
Michigan	86	West Virginia	1
Minnesota	15	Wisconsin	14
Missouri	16		
Nebraska	1	Total	463

MULTI-PURPOSE AND ADJUSTABLE FIXTURES

EXAMPLES OF TOOLS FOR TURRET LATHE AND VERTICAL BORING MILL WORK

BY ALBERT A. DOWD*

WHEN pieces of the same type but of various sizes are to be machined on the turret lathe or vertical boring mill, it is sometimes desirable to design the tools and fixtures in such a way that they can be adapted to handle the different pieces, thus avoiding the necessity of providing a separate tool or fixture for each piece. Naturally, when the production is large, such a procedure as this would be unprofitable because the tools could only be used on one piece at a time, and a lot of pieces of one size might be held up for a considerable time waiting for a lot of another size to be machined. When, however, the work comes along in lots of 100 to 200 pieces, a great saving in tool cost can be effected by the use of adjustable tools and fixtures, providing the design of the parts is such that it will permit of following this practice. Much depends on the shape of the work to be held and its machining requirements.

There are instances when the desired results may be obtained by simple means, and there are other cases which require the application of considerable ingenuity in order to avoid complications in the design. Properly designed and carefully built tools and fixtures of the adjustable type are profitable investments on certain classes of work, and their advisability should be carefully considered when several pieces of the same general type are to be handled. The greatest forethought is necessary in designing fixtures of this kind, in order to make sure that every point for every piece has received proper consideration. There is probably no other type of fixture which requires so much care in its design, and for that reason the important points given herewith should be most carefully noted.

* Address: 7909 Ridge Blvd., Brooklyn, N. Y.

Important Points in Design

1. The number of pieces to be machined should be the first point considered, for this naturally has an effect on the design of the tools and fixtures.

2. The largest and smallest pieces in the group should now be selected, and the machine on which the work is to be done should be determined according to the sizes of these pieces. If the variation in size is considerable, it may be economical to do a part of the work on one machine and the remainder on another, in which case the fixture should be so made that it can be adapted for use on both machines. There may even be cases when the range of sizes is so great that two or more fixtures may be necessary, one of which can be used on one machine and the other on a different one; or they can be made interchangeable, providing the speeds on both machines give range enough to handle the work. These points should be carefully considered.

3. The accuracy required in the finished work must be noted and care taken to provide means of upkeep on surfaces or locating points that are subject to wear. There may be occasional instances, on work requiring extreme accuracy, when it may be necessary to provide means of adjustment for truing up the fixture so that it will always run perfectly concentric with the spindle of the machine.

4. Rigidity in work-holding devices and tools should receive careful attention; and overhang from the spindle, turret or cut-off slide should be kept down to a minimum, so that chatter will not result from lack of support. These points need more consideration when the tools and fixtures are to be used on the horizontal type of machine, than when a vertical machine is to be employed.

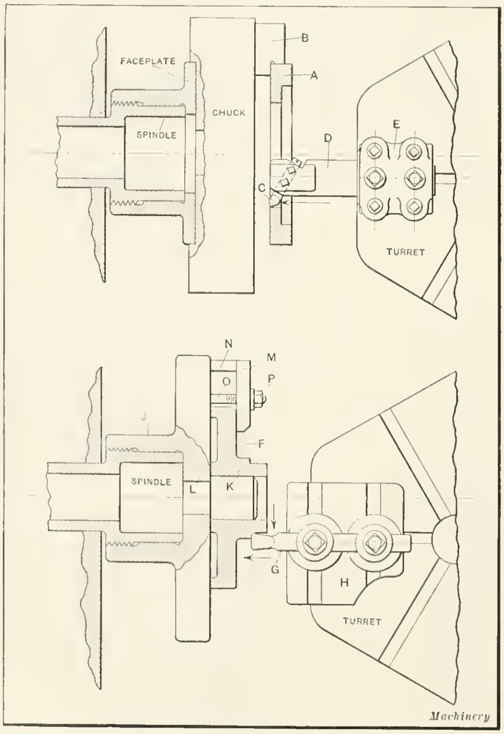

Fig. 1. Examples of Simple Work which can be held on Standard Three-jawed Chucks and Faceplates

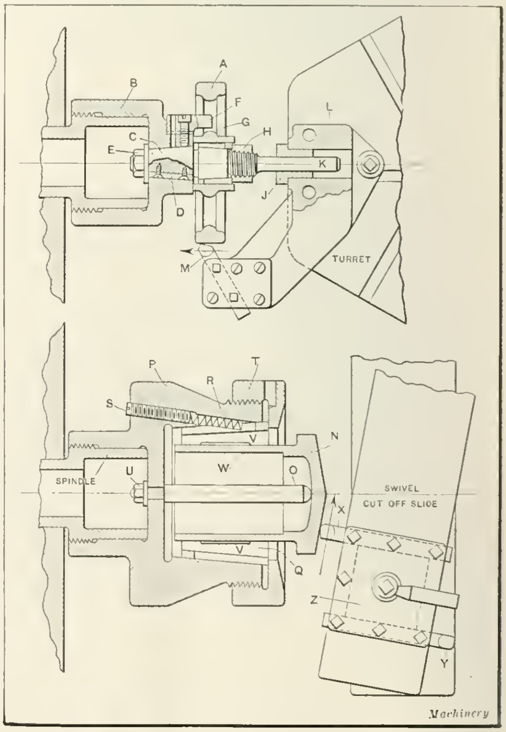

Fig. 2. Spoke Gear Blank held on an Expanding Bushing, and Pot Casting held in a Collet Chuck

5. Clamping devices for adjustable fixtures should be laid out (by means of a piece of tracing paper) for each piece to be handled, so that there will be no chance of clamps being too long, too short or improperly proportioned for some of the work. Errors are very likely to occur in this part of the design unless the greatest care is used; and there are also cases when the work varies in thickness as well as in diameter; so that this point must be carefully considered.

6. Provision for cleaning the fixture must be made, so that all locating points and surfaces will be readily accessible. If several sizes of studs or locating rings are to be used, they must be so arranged that chips and dirt will not interfere with the proper location of the work. They must also be placed so that they can be easily replaced or removed.

7. The adjustments which are necessary to provide for handling various sizes of work should be carefully studied, and suitable provision should be made so that the changes from one setting to another will always be uniform, so that variations in the work cannot occur on account of errors in adjustment. If necessary, setting gages can be made for the various pieces to be handled, or a separate set of screws or other adjustable locating members can be made for each piece and properly stamped to avoid mistakes. The nature of the work has a great deal to do with the method used to secure uniform adjustments, and specific cases will be noted as we proceed.

8. Convenience and rapidity of operation should be given consideration, and provision should be made for setting up the work in as short a time as possible. The fixture should be so arranged that the work can only be set up in the correct way, and it should be as nearly "fool-proof" as possible.

9. The cost of the fixture should be kept down to the lowest figure that is consistent with good design, because the number of pieces to be machined is comparatively small. If the work for which the fixture is made is of such a nature that it is not likely to be changed, a little more latitude is permissible; but as changes in design are always possible, it is advisable not to make an elaborate fixture.

10. The safety of the operator should always be considered, and projecting lugs, set-screws or other parts which might catch in his clothing should be eliminated from the design. Other points in design not mentioned in the foregoing will be specifically mentioned during the progress of this article; comments will be made, and faulty points criticised and discussed.

Adjustable Holding Devices in Common Use

The three- or four-jawed chuck is perhaps the most frequently used of all the holding devices which are adjustable to take various sizes of work. We have also collets of numerous kinds, which are adjustable within certain limits, and step chucks for work of a little larger size. For handling work in the rough state the three- or four-jawed chuck is adaptable to a great range of sizes, without any changes in the chuck jaws; but collets and step chucks require a change in jaws, or a re-setting if much variation is found in the diameters of different pieces of work. The step chuck is more frequently used for partly finished work, while collets are used for both rough and finished pieces, principally for bar work or something of a similar character. When a piece of work is to be made up in several sizes and is of a simple nature, such as the work *A* shown in the upper part of Fig. 1, it may often be handled to good advantage in a set of soft jaws *B* of a three-jawed universal chuck. These jaws are bored out on the machine to the exact diameter of the finished work, and when set up on the piece they present a good holding surface with sufficient accuracy for the ordinary run of commercial work. In the instance shown, the boring-bar *D* is held in the holder *E* mounted on a turret of the flat variety, which has a cross-feed motion to the turret in addition to the regular longitudinal movement. The tool *C* is adjustable both in the bar itself and in the turret movement, for boring the various diameters that are required.

It is well to note in passing that the soft jaws should be set up on a blank of some kind when boring them to size for a piece of finished work. This is necessary in order to make sure that all the back-lash has been taken out of the jaws.

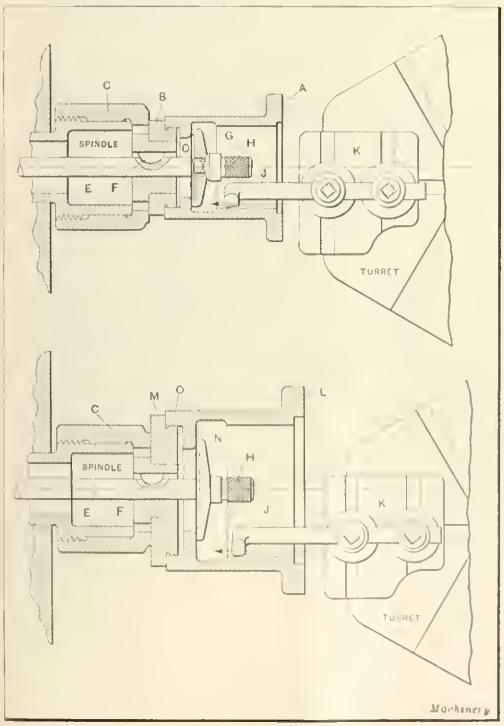

Fig. 3. Fixture for boring Pot Castings on Horizontal Turret Lathe; Different Clamping Collars are provided for Different Sizes of Work

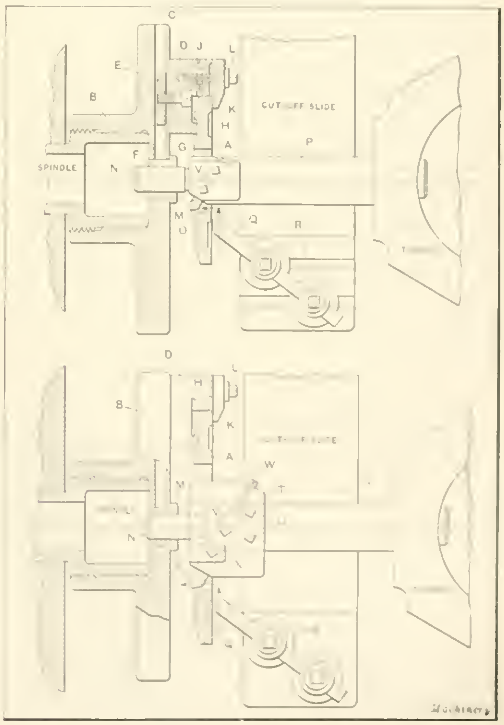

Fig. 4. Fixture for holding Bevel Gear Blanks of Various Sizes where Great Accuracy is required

It is obvious that the blank on which the jaws are set must be out of the way of the tool used for boring. Another point in connection with the use of soft jaws is that their accuracy is less to be depended upon when the work to be held is of large size, as the self-centering tendency is not so great in cases of this kind. The lower view in Fig. 1 shows a piece of work *F* previously bored and faced on one side, which is manufactured in three sizes, the largest of which is shown. In this case a standard faceplate *J* is screwed onto the spindle of the turret lathe and the work is located on the stud *K* which is turned to the diameter of the hole and finds a seat at *L* in the faceplate. The clamps *M* are tightened against the flange by nuts *P* acting on the T-bolts *O*, and supports *N* for the rear ends of the clamps are inserted between the clamps and the faceplate. A shovel nosed tool *G* is mounted in a holder *H* on the turret, and is used to cut the shoulder on the outside of the hub and face the end. Separate studs are provided for the various hole-diameters and the clamps may be readily adjusted in the T-slot. The two conditions shown in Fig. 1 are of a very simple nature and the method of handling requires little expenditure in tool or fixture cost.

Adjustable Arbor for Gear Blanks

The work *A* shown in the upper part of Fig. 2 is a spoke gear-blank that was made in two sizes, one of which was 8 and the other 6½ inches in diameter, with hub-holes 1¾ and 1½ inch in diameter, respectively. For holding these pieces, a special nose-piece *B* was fitted to the spindle, and the tapered portion *C* of the arbor was drawn back into it by the nut and washer at *E*, a key *D* being used to prevent turning. The expanding bushing *G* was split at six places, three from one end and three from the other, and it was crowded into the hub-hole by the washer *H* on the threaded portion of the arbor. In order to obtain additional rigidity the end of the arbor *K* was piloted into the bushing *J* in the special tool-holder *L* on the turret. The tool *M* turned the outside diameter of the gear and had sufficient adjustment to take care of the smaller diameter gear. As the frictional surface in the hub that was available for driving the gear against the cut was insufficient, a steel driver *F* was fastened to the hub on the nose-piece and furnished an excellent means of driving against one of the spokes of the gear blank.

Special Collet for a Bronze Pot

The piece *N* shown in the lower part of Fig. 2 is made in two sizes and the variation on the outside of the shell is only ¾ inch. The work was held in a previous setting by the heavy portion of the flange *X* while the inside surface *W* was rough-bored at a single cut, and the outside carefully finished to size. No other accurately finished portion being available for holding the work, the outside finished surface was naturally used for the second setting. A special collet chuck *P* of cast steel was screwed onto the end of the spindle and bored to a taper to receive the split bushing *Q*. One of the bushings being somewhat heavy, it was cut out in six places *V* along the length so that it would expand more readily. Three coil springs *R* were made adjustable by means of the screws *S*, and these assisted in releasing the work, while the threaded collar *T* was used to close the collet jaws. A machine equipped with a swivel cut-off slide and a revolving turret toolpost *Z* was used to cut the taper on the end of the work, the roughing and finishing tools *X* and *Y* being swung into position as needed. A steel stop-pin *O* was drawn back into the fixture by the nut *U*, and the rounded end of this pin provided for the proper location of the work.

Adjustable Fixture for Several Pieces of Electrical Work

Fig. 3 shows at *A* and *L* the smallest and largest sizes of some pieces of electrical work which were to be machined on a horizontal turret lathe; and there were two intermediate sizes which were also handled on the same fixtures. A special nose-piece *C* is screwed to the end of the spindle and has a hub at its forward end on which the locating ring *B* (upper view) is fixed. The finished portion of the work fits this ring at *D* and is drawn back against it by the collar *G*; the rod *E* passes through the spindle and is pulled back by means of a handwheel at the end, while the key *F* prevents it from turning. The forward end of the rod is threaded to receive the knurled finger-nut *H* which has a spherical bearing in the collar *G* to equalize the pressure. In setting up the work, the piece is placed on the locating ring, the collar *G* is slipped over the end of the rod *E* and the knurled nut *H* is rapidly screwed on with the fingers, after which the handwheel at the end of the spindle is used to tighten the collar. A long boring tool *J* is used to rough out the shouldered portion of the work and to bore the bearing, and it will be noted that although this tool has considerable overhang it is well set up in the tool-holder *K*, and given additional strength by the use of two toolposts. The larger piece *L*, shown in the lower part of the illustration, is set up on the ring *M* locating on the surface *O*, which has been previously bored. A larger collar *N* is used for clamping this piece.

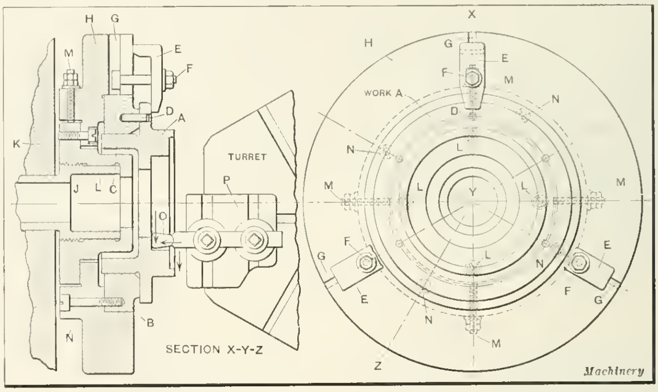

Fig. 5. Fixture in which Provision is made to compensate for Inaccuracy resulting from Misuse or Neglect

With the exception of the locating ring and collar, all of the other parts of the holding device are the same as in the preceding instance. Additional rings and collars for the intermediate sizes make the fixture complete. It will be noted that there are two holes in the front of the nose-piece, which are so placed that a rod may be used to drive off the locating rings when changing over the fixture for another size of work. This fixture is simple and comparatively inexpensive, yet it is adapted for use on four pieces of work of different sizes and the changes required are of such a nature that they may be performed quickly so that there is very little loss of time. It may further be noted that the boring tool is the same in each case and that the adjustment for different diameters is obtained by the cross sliding movement of the turret.

Adjustable Fixture for Special Bevel Gear Blanks

The work *A* shown in Fig. 4 is a special bevel gear blank, and these gears are used in a great number of sizes on textile machinery. The pieces were held in the first setting by the interior and were machined on the side having the beveled surface and on the periphery; they were also partially undercut along the edge of the rim in order to provide a clamping surface during the second setting. Extreme accuracy was required in the work, and yet there were so many sizes to be handled that the construction of separate fixtures was deemed inadvisable. A special faceplate *B* was therefore designed having three radial dovetail slots *C* (upper view) in its face; and a small portion *F* of each of these slots was left straight to assist in locating the movable jaws *D*. These

jaws were made of steel and were radially adjustable to various diameters, being clamped in any desired position by means of the screws *G* and the dovetail shoes *E*. A number of sets of soft steel supplementary jaws *H* were drawn back into a seat on the main jaws by the two screws *J* and were bored in place to the diameter of the outside of the gear, the main jaws being set in place to an approximation of the correct diameter in each instance.

The clamps *K* were drawn down onto the finished portion of the work by means of the screws *L* in the jaws. A bushing *M* was set in the center of the faceplate and used as a guide for the pilot *N* of the boring-bar *P* which was held in the turret. The tool *O* was used to bore the hole while the tool *Q* faced the unfinished portion of the gear blank, the latter tool being held in two toolposts *R* on the cut-off slide. In handling some of the larger gear blanks a supplementary head *T* (lower view) was placed on the end of the boring-bar and held in place by the screws *U* on the flatted portion of the bar. This head gave good support to the tool *S* which was used for boring the larger sizes of gear blanks. This tool was held in place by the screws *X* and *Y*, the latter passing through the hole provided for it in the bar. Fine adjustments were provided for in the backing-up screw *W* and the facing of the blank was accomplished by the same tool. This fixture took care of seven gear blanks of various sizes and gave very satisfactory results.

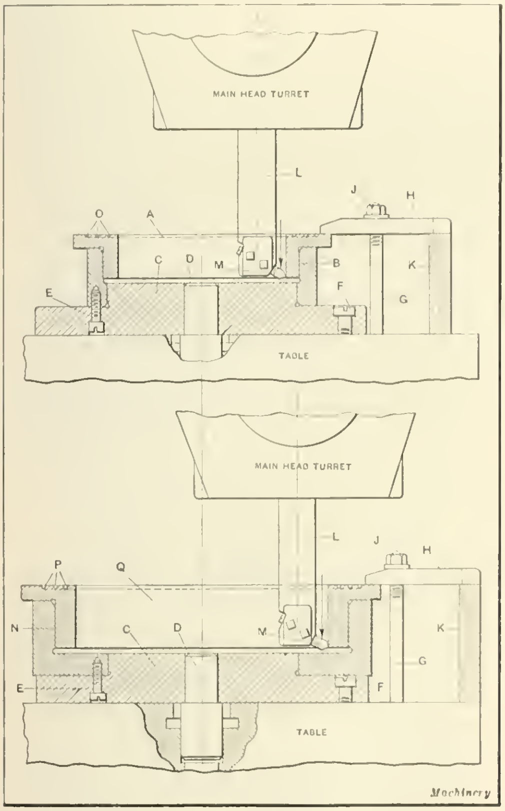

Fig. 6. Simple Fixture for holding Three Sizes of Steel Flanges, while boring, facing and cutting Packing Grooves

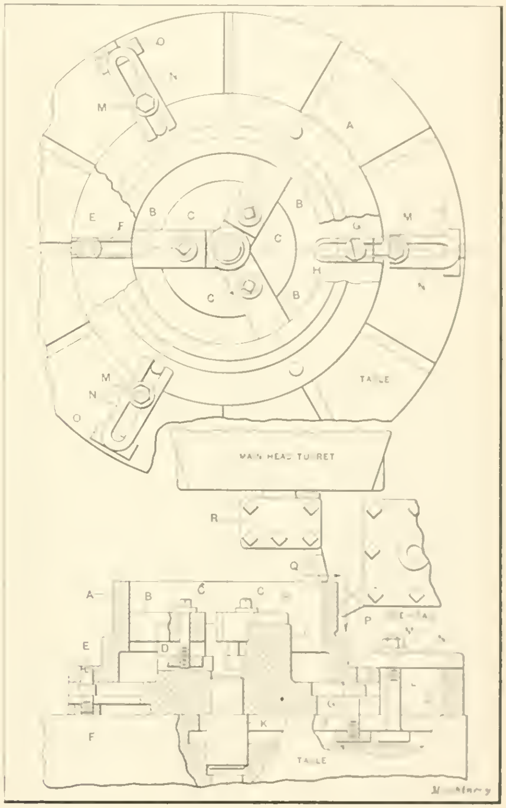

Fig. 7. Method of holding Three Sizes of Work which has been bored and faced and has had the Holes drilled in Flange

Adjustable Fixture with Means of Keeping in Truth

A fixture which is somewhat out of the ordinary and which may be adjusted to handle several sizes of work is shown in Fig. 5. As absolute concentricity is required in the finished surfaces of the work machined in this fixture, it is essential for the fixture to be arranged in such a way that it can be trued up if it becomes inaccurate through misuse or neglect. The cast-iron nose-piece *J* is screwed to the spindle in the usual manner and the supplementary casting *H* is bolted to it with the four bolts *L*. The holes in this piece are slightly larger than the bolts so that small adjustments may be made. The flanged portion of the supplementary casting carries four headless set-screws at *M*, by means of which the ring can be trued up, and check-nuts are provided to secure a permanent setting of the fixture. The locating rings *C* are made in several sizes to take the various pieces that are machined in this fixture, and each of these rings is furnished with a driving pin *D* which enters one of the bolt holes in the work.

The screws *N* are set into the ring from the rear and are located in different places for the various rings. The fixture has three T-slots *G* in order that the clamps *E* may be conveniently adjustable, by means of the T-bolts *F* which enter these slots. The boring and shoulder work performed on the piece is accomplished by the shovel-nosed tool *O* which is mounted in the tool-holder *P* on the turret. This is an example of a fixture designed for standard work of various sizes coming through in small lots, and which requires extreme accuracy in machining. Attention is particularly called to the compactness of the design and the way in which it is built close in to the spindle so that although the fixture itself is heavy, there is so little overhang that the weight is of small importance.

Adjustable Fixtures for the Vertical Boring Mill

The table of a vertical boring mill is so arranged that it may be used either as a faceplate or as a chuck with provision for clamping in the T-slots when necessary. This is a distinct advantage in many kinds of work and especially

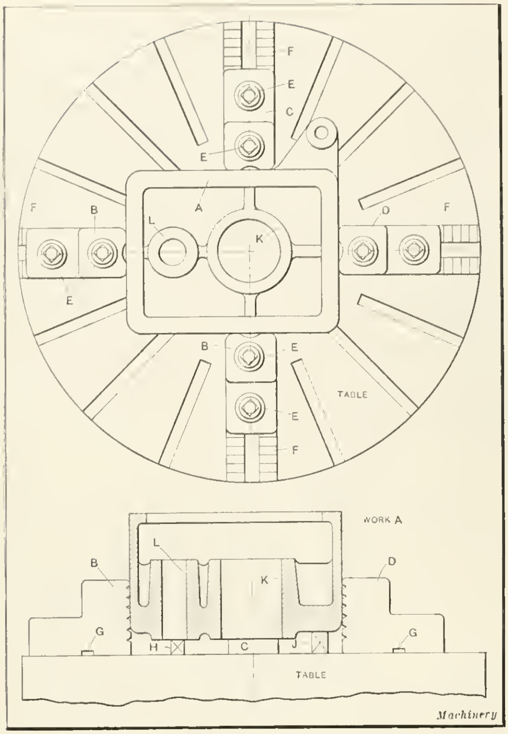

Fig. 8. Example of Use of Four-jawed Table for holding Rough Castings

so where a number of pieces of similar construction and different sizes are to be handled. Fig. 6 shows a simple fixture for handling three sizes of steel flanges A. The base C of the fixture is made of cast iron and is centered by a plug D in the table hole; and it is fastened down to the table by means of the screws F which enter shoes in the T-slots. In the upper illustration, the work A has been previously turned, faced and partially under-cut to provide for clamping, and it is held during the first setting by means of jaws on the inside of the flange.

On the second setting (shown in the upper illustration) the operations performed consist of boring the hole, facing the flange as far as the clamps, and cutting the packing grooves O. The locating ring B is slipped onto the finished portion of the base and is drawn down by the screws E. The clamps H are supported at the outer end by the wooden blocks K, and are drawn down onto the work by the nuts and washers J through the medium of the T-bolts G which are adjustable radially in the table slots. The boring-bar L is used for boring the interior of the flange with the tool M, while the side-head (not shown) faces the flange and cuts the packing groove. The lower illustration shows the fixture adapted for holding the largest piece Q which it handles. In this case the ring N is made of somewhat different shape so that it will locate properly on the finished portion of the base C. All other portions of the fixture are the same as in the preceding instance, the clamps H being moved outward in the T-slots a sufficient amount to take care of the work of larger diameter. The tools for boring, facing and cutting the packing grooves P are also the same.

Fixture with Adjustable Driver and Soft Internal Jaws

The work A shown in Fig. 7 is made in three sizes, the largest of which is illustrated. These pieces have been previously bored and faced, and the flange holes have been drilled in a jig. The base J of the fixture is made of cast iron and is centered on the table by means of the plug K. It is held down by three screws G which enter shoes H in the table T-slots, and it should be noticed that the slots in the fixture permit the T-bolts L to be moved inward to take care of work of smaller diameters. It is obvious that the screws G must either be moved inward when this is done, or else they can be placed at the extreme inner position and kept there at all times. The driving pin E is also arranged in a T-slot cut in the fixture, so that it can be moved radially to a position corresponding with the bolt holes; and the shoe F makes it secure in whatever position it may be placed.

Instead of using a locating ring, three soft jaws B are set in slots in the fixture base, and these may be clamped in place by means of the screws C which draw up on the shoes D in the T-slots. After clamping them in an approximately correct position, they are turned to the size of the interior of the casting. Attention is called to the fact that the outside portion of the hub in the base casting J is finished in order to facilitate calipering when turning the jaws. The clamps N are supported at their outer end by wooden blocks O and are drawn down on the flanged portion of the work by the nuts M. Radial adjustment of the clamps is obtained in the manner previously mentioned. The tools Q and P in the tool-holder R and the side-head, respectively, are used for facing and turning the outside diameter of the work. Adjustments for diameters are obviously obtained by setting the machine slide. This fixture may be made up at little cost, is easily adjustable and will take care of a great range of sizes. In addition to this, the accuracy obtained by its use leaves nothing to be desired.

Method of Using a Four-jawed Table as an Adjustable Fixture

When the nature of the work is such that a four-jawed table may be used, it is sometimes possible to obtain very satisfactory results on rough casting work without going to any expense whatever in the making of fixtures. An example of this sort is shown in the work A in Fig. 8. There were only twenty-five pieces of each size to be machined, and it

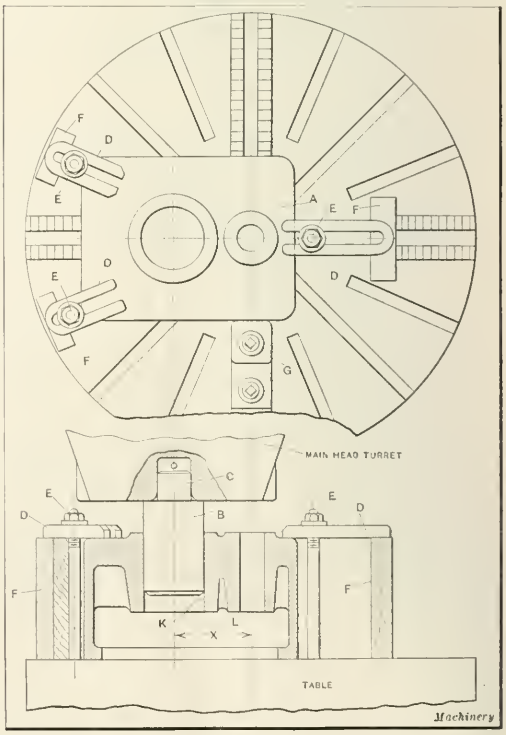

Fig. 9. Method of setting up Piece of Work shown in Fig. 8 ready for performing Second Series of Operations

was unlikely that others would be required for a considerable length of time, so that it was thought inadvisable to go to the expense of making even a simple fixture. Two operations were necessary on the piece, as the holes *L* and *K* had to be bored and both ends of the hubs faced, while the flange also required facing square with the hubs.

In the first setting the jaws *B* were set in such a position that they acted much as a vee would do in locating the casting; and after these jaws were set in the proper position, they were not moved until all of the pieces of one size had been machined. The work was set up on the steel parallels *H* and *J*, and the other two jaws *C* and *D* were brought up individually against the outside of the casting until it assumed the position shown in the plan view. The jaws were all set in the sub-jaws of the table, which were furnished with slots to receive the keys *G* on the under side of the jaws. They were held in place by the screws *E* which entered shoes in the slots of the sub-jaws. This method of handling may be adapted to a great variety of work. There is always a possibility, after the jaws *B* have been set in their correct position, that the operator may shift one or the other of these jaws unintentionally, thus destroying the setting. This may be obviated by marking the table at these points with a piece of chalk or in some other way which may suggest itself to the operator.

Second Setting of the Work

The method shown in Fig. 9 for setting up the piece for the second setting is quite out of the ordinary, but very good results may be obtained in this way when conditions will not warrant much expenditure for a fixture. The work *A* is placed on the table of the machine with the finished flange down and the unfinished hole *L* approximately central with the center hole of the table. The turret saddle is next traversed along the rail a distance *X* equal to the center-to-center distance between the two holes *L* and *K*. The dial clip on the handwheel is set to indicate this distance and the plug *B* having a shank *C* which fits the turret,

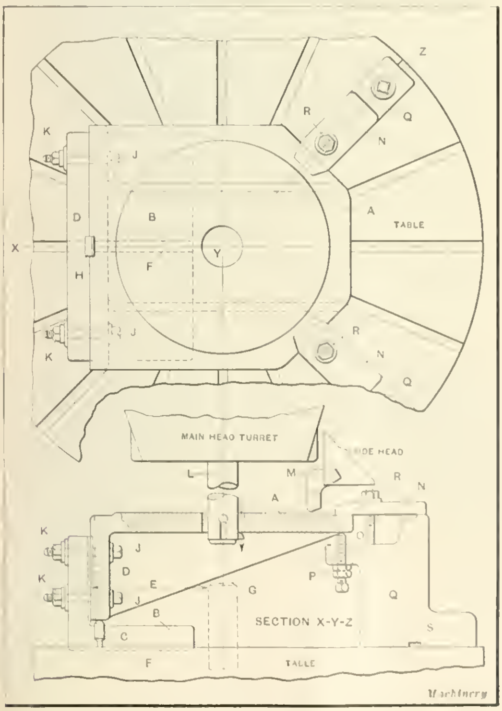

Fig. 10. Inexpensive Fixture for holding Two Sizes of Brackets while being bored and faced

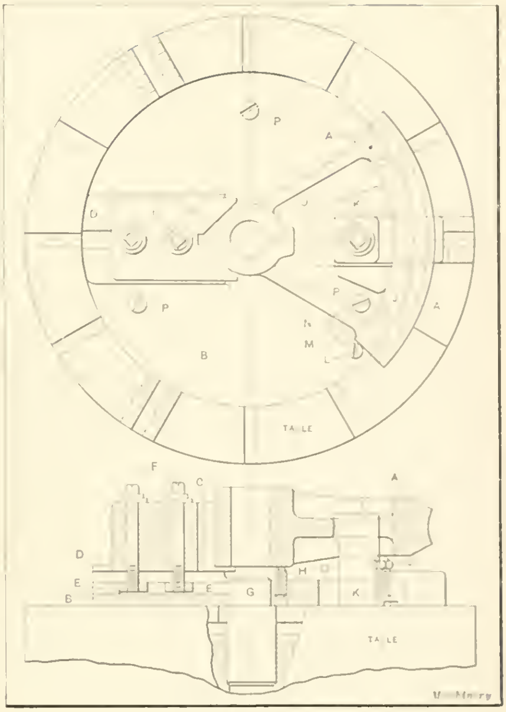

Fig. 11. Adjustable Fixture for holding Three Sizes of Bronze Worm-gear Sectors

is brought down until it enters the hole *K* of the work, thereby locating the piece correctly. The jaw *G* has been previously set to the correct distance and is not changed during this setting of the work. The piece is swung on the stud *B* as a pivot until the side of the casting brings up against the jaw *G*, and the three clamps *D* are then brought up into place and the work is clamped down on the table by means of the nuts *E* acting on T-bolts in the table slots. The ends of the clamps are supported by the wooden blocks *F*, as in the preceding instance. The turret plug is now withdrawn from the work which is then ready for machining. It will be noted that the jaw *G*, in addition to its function of locating the casting, also acts as a driver; and it will be seen that this method of handling requires no special fixture, nothing extra being needed except the locating stud *B*.

Adjustable Fixture for a Cast-iron Bracket

The work *A* shown in Fig. 10 is a cast-iron bracket which has previously been machined along the face *D* and has had the tongued portion cut approximately central with the cored hole at *Y*. Four holes have also been jig-drilled at *J*. Two sizes of these brackets were made several times each year in lots of ten or twelve, so that the expense of a complete fixture for machining each piece would have been excessive in view of the number of pieces produced. The following equipment proved satisfactory: An angle-plate *B* is tongued on the under side *F* to fit one of the table T-slots and is held down by screws (not shown). The distance *F* for the two sizes of brackets is easily determined by placing a stud *G* in the center hole of the table and locating the angle-plate *B* from it. The bracket is placed in position on the angle-plate so that the tongue *H* fits into the groove, and the bolts *J* are passed through the holes in the bracket and tightened by the nuts at *K*.

A little freedom is allowed in the bolt holes and the finished edge of the bracket rests on the pins *C*. Two special jaws *Q* are fixed in position on the table but may be adjusted radially when necessary to bring them into the correct posi-

tion for the other size of bracket. The jaws are provided with set-screws *O* which are adjusted to support the overhanging end of the bracket, after which they are locked by the check-nuts at *P*. The jaws are keyed at *S* to the sub-jaws of the table; and the clamps *N* are used on the unfinished portion of the bracket, being tightened by the nuts at *R* so that the surface to be machined is clear of interferences. The boring-bar *L* is used to bore the hole and the side-head tool *M* faces the pad. This is another example of a table being used with a faceplate having adjustable moving parts on it.

Adjustable Fixture for a Bronze Worm-gear Sector

The fixture shown in Fig. 11 was designed to handle three sizes of the bronze worm-gear sectors *A*. The base *B* of the fixture is centered on the table by means of the stud *G* in the center hole, and it is clamped securely by means of three screws *P* which enter shoes in the table T-slots. An adjustable V-block *C* is mounted on a finished pad and tongued on the under side to fit the slot *D*. All the jaws on the table chuck are removed and a special jaw *K* is substituted for one of them. This jaw is slightly under-cut on its face to assist in holding down the work, and at the same time it forces the hub of the casting up into the vee locating block. A slot *O* is cut in the base of the fixture in order to allow the necessary movement for this jaw. The hub rests on a headless set-screw *H* which is tapped into the base, and two other adjusting screws are provided at *J*. These are adjusted by means of a wrench after the jaw has been tightened. The set-screw *H*, however, remains set after it has been adjusted to suit the particular piece which is being machined. A driving screw at *L* takes the thrust of the cut and may be removed and placed in either of the holes *M* or *N* when used for the other pieces. In setting the V-block for another diameter of hub, it is only necessary to loosen the screws *F* and move the block radially to the desired position. The jaw *K* is readily set to size while the screws *J* and *L* are placed in holes provided for them.

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RECENT LEGAL DECISIONS INVOLVING MACHINERY

Baker Ice Machine Case Affirmed

(Supreme) The United States Supreme Court has sustained the United States Circuit Court of Appeals in Bailey v. Baker Ice Machine Co. The suit was an interesting one from the fact that the Supreme Court in its opinion has discussed to a considerable extent the subject of conditional sales of machinery.

By a contract in writing, made at Omaha, Neb., October 14, 1911, between the Baker Ice Machine Co. and Grant Bros., the former agreed to deliver and install upon the premises of the latter at Horton, Kan., an ice-making and refrigerating machine for the sum of $5940, to be paid partly in cash and partly in deferred installments evidenced by interest-bearing notes. It was specially stipulated that the title to the machine should be and remain in the Baker Ice Machine Co. until full payment of the purchase price; that the machine should not be deemed a fixture to the realty prior to full payment; that in the meantime Grant Bros. should keep the machine in good order and insured for the benefit of the Baker Ice Machine Co.; that if default was made in the payment of the purchase price, the Baker Ice Machine Co. should have the right to resume possession and take the machine away; and that, in the event this right was exercised, the company should be reimbursed for all expenses incurred under the contract, should be compensated for any damage done to the machine in the meantime, and should be allowed a rental for its use equal to six per cent per annum upon the purchase price from the date of the installation to that of the resumption of possession. And it was further stipulated that the Baker Ice Machine Co. should have the right to file a mechanics' lien for the materials and labor furnished under the contract, and that no notice of a purpose to file such a lien other than that afforded by this stipulation, would be required.

The machine was installed. Grant Bros. became insolvent, leaving a large balance due on the purchase price of the machine. The Baker Ice Machine Co. took legal proceedings to recover possession of the machine, but possession of the machine was turned over to the receiver and sold by him for $2000. The interesting question of the case was whether the sale was a conditional one and who really should have title to the machine.

Justice Van Devanter, who wrote the opinion of the court, said in part:

"The court below held the contract to be a conditional sale, that is, one making full payment of the purchase price a condition precedent to the passing of title...... We are of the opinion that the contract was rightly held to be one of conditional sale." The money recovered from the receiver's sale of the machine was awarded to the Baker Ice Machine Co. The court said it had never parted with the title of the machine. *(Bailey v. Baker Ice Machine Co., 36 Sup. Ct. 51.)*

Employer s Duty to Furnish Well Lighted Premises

(South Carolina) Where a room was not lighted, so the danger from a machine could not be seen, a servant who was acting under the direct orders of his superior, who was present, did not assume the risk of injury; for it was not his duty to look out for latent dangers. *(Brown v. Piedmont Mfg. Co., 86 S. E. 815.)*

Defective Machinery Causes Suit

(Ohio) Where, in an action for damages for breach of warranty, it is claimed by the purchaser that the defective machinery covered by the warranty delayed the operations of the factory of which it is a part, and it appears from the evidence offered by the purchaser that other causes contributed to the delay, the burden is upon the purchaser to show, by a preponderance of the evidence, what part of the delay was caused by the defect in the machinery warranted and what damages, if any, were sustained by reason of the delay so caused.

Where machinery covered by a contract of warranty is purchased for the purpose of being used as a separate unit in a factory, and the operation of the whole factory depends upon this unit properly performing its part, both in quantity and kind, with the other parts, the purchaser cannot retain this article in place in his factory for an unlimited time after discovering that it is defective and recover as damages the daily loss in the operation of the entire factory, but must within a reasonable time substitute a machine, in place of the defective one, that will do its part of the entire work without delaying the operation of the other parts.

If the purchaser elect to retain such defective machinery as a part of his factory, notwithstanding its failure to produce the quantity of the product manufactured by the factory that it is warranted to do, his recovery is limited by the provisions of division "a," paragraph 1, of section 8449, General Code, to a recoupment in diminution or extinction of the price paid therefor. *(Lewistown Foundry & Machine Co. v. Hartford Stone Co., 110 N. E. 517.)*

A Question of Trademarks

(Wisconsin) While any person may manufacture and sell unpatented articles and use his own name in so doing, yet, if another has previously and rightfully made that name valuable as a trademark descriptive of the same kind of goods, he has a property interest which the courts will protect, and they will also prevent the subsequent manufacturer of the same name from using it so as to deceive the public.

Where plaintiff and its predecessor for many years manufactured plows, beginning with the simple walking plow, then making sulky plows, gang plows, and later plows to be drawn by tractors or engines, plaintiff acquired a property right to the use of its name with respect to plows, which defendant cannot infringe under the claim that the engine-drawn plow outfit is a separate and distinct tool from the single plow, a plow being a plow, whether drawn by animal power or tractor; hence defendant, though its corporate name was practically the same as that of plaintiff, was not entitled to use it on plows in such a way as to deceive. *(J. I. Case Plow Works v. J. I. Case Threshing Machine Co., 155 N. W. 128.)*

DESIGN AND MANUFACTURE OF DIES*

POINTS ON STANDARDIZATION OF DIE PARTS AND EXAMPLES OF DIE DESIGN

BY GEORGE H. HAMILTON†

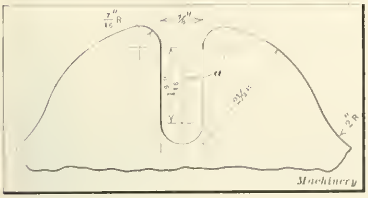


Fig. 1. Example of Standard Ear for Dies

Standardizing Patterns

A great deal of time and expense can be saved by standardizing die-shoe and punch-holder patterns, but this is not commonly done by manufacturers in the sheet metal or other lines of manufacturing. It is the usual custom to make the patterns as required without reference to what has been made previously; consequently, after the shop has been running for a few years a great many patterns have been made. If they are not standard and no record has been made of them, it will require perhaps several hours to look for a certain size shoe. Very often, after this time has been spent looking for the pattern none is found that will suit, so the foreman makes a sketch of the pattern required and has one made. It is entirely possible that there is one in stock that would suit if it could be found. There is no excuse for a condition of this kind although it exists in innumerable instances. This is the best argument for standard patterns and adequate records of same.

To standardize patterns, it is well to collect all the parts to be manufactured; this will give the designer or the master mechanic in charge of the work a good idea of the various sizes and shapes that will be required. If the product which is to be manufactured be of a great variety, it would be well to make an assortment of shoes starting from the smallest and increasing by about one inch in overall dimensions to the largest, making the slot not less than two inches in length as shown at *a* in Fig. 1. Very often there will be a number of special patterns to be made that are so different from the regular run of work that it would not be advisable to standardize them.

In order to keep a record of these special patterns, it would be advisable to make a sketch of each on the file cards, as shown in Fig. 2. In this way the designer or master mechanic can keep track of the patterns in stock without handling them Fig. 3 shows a useful record form of standard die shoes and punch-holders and their numbers, as all patterns should be numbered. It is more convenient, as shown in Figs. 2 and 3, to allot a certain group of numbers to standard die shoes and punch-holders, and another group to special die shoes and punch-holders, as the special die shoes will be more numerous than the others. By this method, the pattern required will be easily found. Fig. 3, which records the standard die shoes and punch-holders, is the simplest form. The length is the distance from lug to lug, whether it is the longest way of the pattern or not.

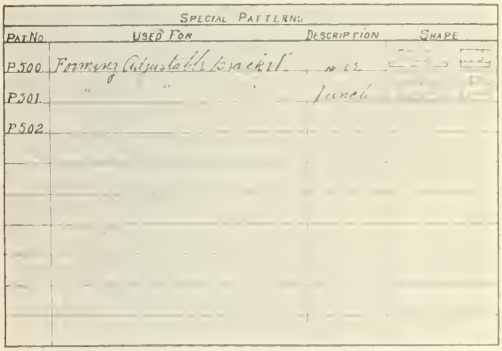


Fig. 2. Special Pattern File Card

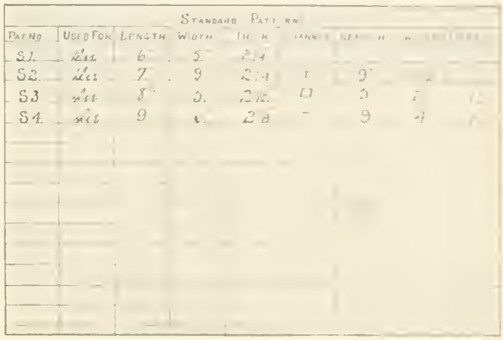


Fig. 3. Standard Pattern File Card

Standardizing Bolsters

It may appear to some managers that the standardizing of bolsters is of no value. Such is not the case, as it has been proved that if bolsters are not standard there is very often delay in waiting until one is made to suit certain dies. If the die shoes be made standard, then the bolsters should be standard also, allowing the die-setter to set any die in the press without having to drill special holes to accommodate it Fig 4 shows a good way to standardize bolsters. The holes are drilled about $1\frac{1}{2}$ inch apart which enables the die-setter to put the die in either a lengthwise or crosswise position — whichever may be the most convenient for the operator in feeding the stock. It might be well to drill cross-holes at 45-degree angles, as there may be some dies which should be set at an angle rather than crossed or straight.

Another great saving of time is accomplished by having a proper place to store bolsters when not in use. Fig. 5 shows a very careless way of storing bolsters; this is not only in

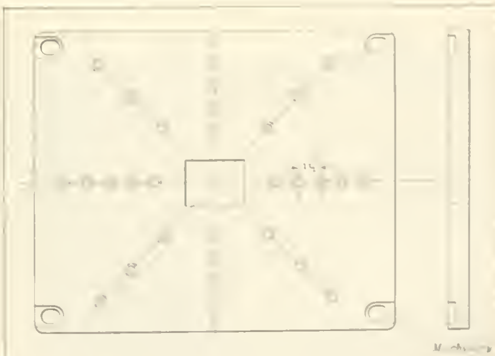


Fig. 4. Bolster standardized as regards Location of Screw-holes

* For information on dies previously published in MACHINERY, see "Some Punch and Die Troubles," February, 1916, and articles there referred to.
† Address: 38 Auburn Ave., S. E., Grand Rapids, Mich.

convenient but dangerous to employes. In the factory where this photograph was taken, several men have been badly hurt getting out bolsters. As these bolsters weigh from two hundred to eight hundred pounds, the extent of the injuries can easily be imagined. Although a portable crane is used as shown at *a*, Fig. 7, to lift the bolster from the pile, it is difficult to get at the bottom one without causing the others to slip, and a great deal of time would be lost in moving all the bolsters off the one wanted and putting them back again. Conditions of this kind are often found in press rooms, but because of the danger and waste of time involved they should not be tolerated by factory inspectors.

Figs. 6 and 7 show a strong and convenient bolster rack

Fig. 5. Improper Method of storing Bolsters

which will pay for itself in a short time. This rack is made from $1\frac{1}{4}$-inch pipe with $1\frac{1}{2}$-inch heavy pipe at *a* and 2-inch extra strong pipe at *b*, Fig. 6, to act as rollers when taking the bolsters out. The portable crane *a*, Fig. 7, may be run up to the rack, quickly attached to the bolster wanted, and pulled out without disturbing any of the other parts. Two or more of the smaller bolsters may be put in the same divisions, the $1\frac{1}{2}$-inch heavy and the 2-inch extra strong pipe holding them separate and allowing one to be rolled out without moving the others.

Standardizing Parts for Dies

Detail drawings should be made of all small parts, such as piercing and blanking punches, button piercing and blanking dies and trigger stops. With this information, the designer would know at all times what sizes and shapes of parts were in stock. In the die repair department, also, it would not be necessary to carry such a large variety of these parts, thus reducing the repair parts to a minimum. Fig. 8 is a detail of the blanking punch *j*, Fig. 13. It will be seen that the dimensions are given and all other information that is neces-

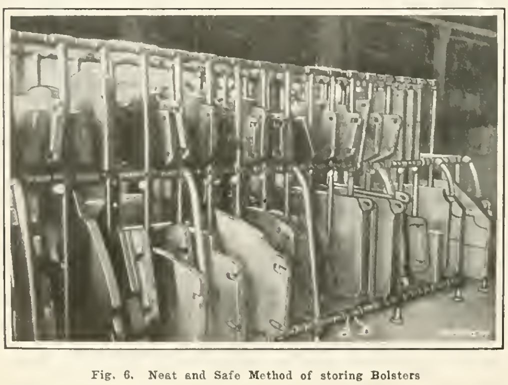


Fig. 6. Neat and Safe Method of storing Bolsters

Fig. 7. Rack for Large Bolsters showing Crane by which they are lifted

sary for making this part. Although this acts as a blanking punch in this case, it will be readily seen that it could be used as a piercing punch in some other die, providing the size was correct.

Blueprints should be made from these details and placed in a loose-leaf ledger that is kept in the drafting department. The number of every die for which this part is used should be added on the catalogue and a new print made from it and put in the ledger, keeping the detail drawings always up to date. Any other method than detail drawings for preserving the original dimensions of small parts is inadequate.

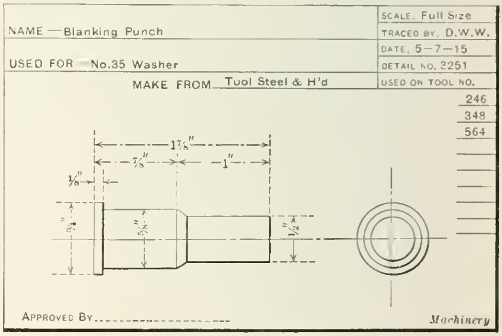


Fig. 8. Detail Drawing of a Standard Punch

The old practice of making new parts by dimensions taken from an old worn part is obviously very poor. A copy of these detail drawings may be kept in the die repair department and when a part is wanted, the detail may be sent to the tool-room and the part made from it.

Efficient Design of Dies

It is needless to say that too much thought cannot be given to the design of dies. There are a great many different ways of designing a die to do a certain piece of work. The first step is to choose which of the numerous types of dies to adopt. A piece such as shown in Fig. 9 has three holes, the holes at each end being embossed or countersunk. Two dies might be used to make this piece, the first being a blanking die and the second a piercing and embossing die. Then, again, it might be

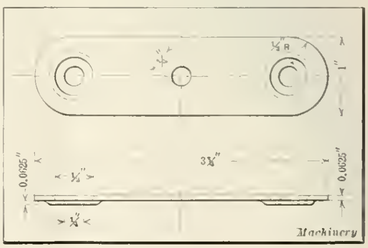


Fig. 9. Sample of Die Work

made in a compound die as shown in Fig. 10 or in a progressive die as shown in Figs. 11 and 12.

The first method suggested is out of the question, as this would require two operations, which is too slow. The compound die in Fig. 10 would do the work all right in one stroke of the press, but it would be very inconvenient for the operator to feed and gage the stock; moreover the die would be expensive to make and is, on the whole, not very satisfactory. The progressive die in Fig. 11 would also do the work in one stroke of the press, and at first thought might be considered the best and cheapest. This type of tool, however, has certain disadvantages. It would be necessary to cut the stock into narrow strips, which is not easily done either on a slitter or a shear. The difficulty lies largely in keeping the width uniform. The stock could easily be gaged and the scrap pushed through the die under the press, but the blank would remain in the die and require a kick-out or would have to be removed by the operator. This all tends to delay the operation and stamps this die as being inefficient.

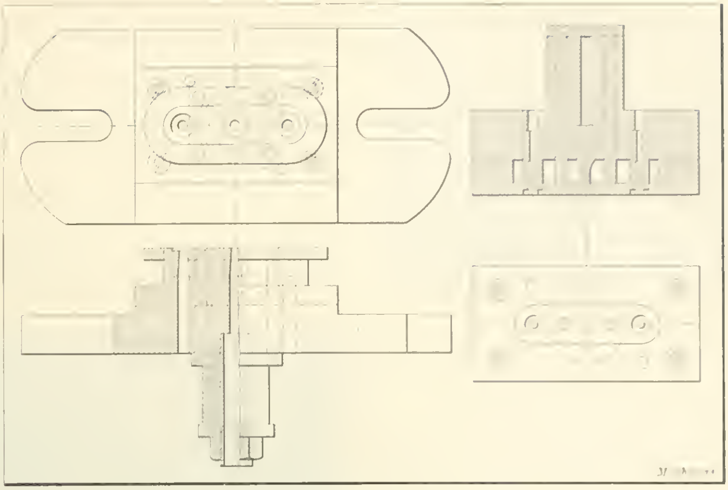


Fig. 10. One Die for making Part shown in Fig. 9

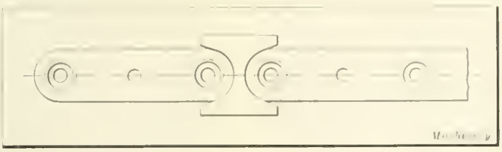


Fig. 11. Another Method of making Part shown in Fig. 9

The die shown in Fig. 12 would be the proper one to make for the following reasons: first, there is a piece made at every stroke of the press; second, the stock could be easily cut on a gang slitter or square shear, as it would not have to be exact in width; third, the stock could be easily gaged; fourth, the blanks and piercings would fall under the press; fifth, the scrap would pass through the die without interfering with the next blank to be made; sixth, there would be little scrap, there being only 1/16 inch on each side of the strip, as there is no web between the blanks; seventh, a chopper or scrap cutter could be put at the back of the die to cut the scrap as it comes out. Undoubtedly this would be the cheapest, simplest and most efficient die to make.

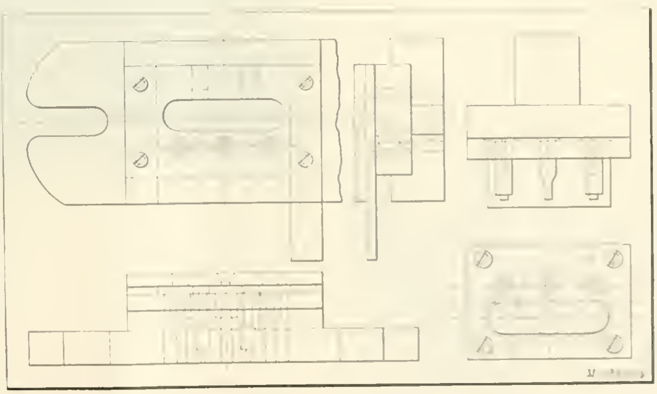


Fig. 12. Best Method of making Part shown in Fig. 9

A Progressive Washer Die

The progressive washer die shown in Fig. 13 for making five washers from 11 gage cold-rolled steel at one stroke of the press needs no demonstration to convince one of its practicability. This is by no means a new type of die, but there are a few points about the design and construction that are worth mentioning. As will be seen by reference to the illustration, the trigger *a* gages the first two holes *b* that are pierced. This trigger has a spring which holds the stop down on the die while the first holes are being pierced; it is then raised on top of the stock by the operator as the stock is pushed forward, and the stock slides under it until the strip is finished. The trigger *d* is the second stop. It has a coiled spring *e* which holds the stop up continually. After the first two holes *b* have been pierced, the stock is pushed forward until the stop end of the trigger *d* enters the hole as the operator raises the end of the trigger to which the spring is connected. In this position the second two holes are pierced. The trigger *d* is used in this manner until the stock strikes the trigger *f* which has a spring *g* with a double action, holding the stop down and forward. This trigger, while it is made the same as *a* and *d*, must have play or side motion in the stripper equal approximately to the thickness of the stock, allowing it to spring on top of the stock when it is raised by the screw *h* at the time the punch descends. The screw *h* should be adjusted to come in contact with the trigger just after the punches enter the stock so that by the time the punches have passed through, the stop will have been raised and the spring *g* will force the stop on top of the stock, ready to drop in the next hole when the stock is pushed forward. This trigger, which works automatically, is used until the strip is finished.

The pilots *i* correct all errors in the triggers. They wear quite fast with the constant bumping of the stock against them, even though made of tool steel and hardened. This is a great improvement over putting pilots in the blanking punches, as they can be made larger and stronger. This has been proved in this die since it was first made. It will be seen by the holes at *j* in the blanking punches that this tool was originally fitted with pilots in the punches which were taken out and replaced by the pilots *i*. The guide pins *k* give much better results in diagonal corners when it is pos-

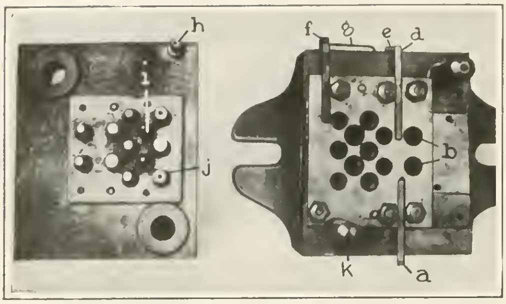


Fig. 13. A Progressive Washer Die

sible to put them there without reducing the production by interfering with the operator.

A Positive-action Cam-operated Forming Die

Very often there are irregular pieces to be formed that have to be shaped on three or more sides. In order to do this in a single-action press, it is necessary to use cams, especially if much pressure is required. The die shown in Fig. 14 is a positive-action cam forming die for forming the tube *a* to the shape shown at *b*. A piece of this kind looks difficult, but is formed nicely in a die of this type. The machine steel plate *c* has tool-steel jaws fastened to it at *d* and two rollers at *e*. These rollers are set into blocks which are attached to plate *c* for the cams *f* to slide between. There are fixed rollers set in the shoe below the movable rollers *e* which are not

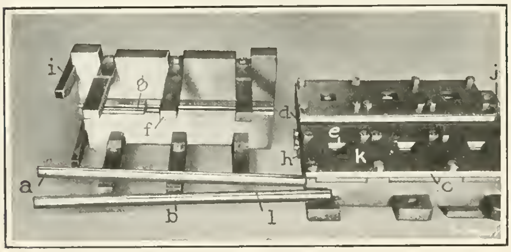


Fig. 14. Cam-operated Tube Forming Die

shown. Their mission is to back up the cams as they force the plate *c* forward. As the punch descends the cams go down between the rollers at *e* and force the jaws together, gripping the tube and collapsing it, while the punch *g* flattens the flanges *l*. As the punch ascends the cams open the jaws, leaving the work loose in the die so that it can be easily removed. This die has a positive action, there being no springs to get out of order. The cams are designed to close the die when the ram descends and open it when the ram ascends.

The jaws *h* which conform to the shape of the tube before being formed are operated by the cams *i*, gripping the tube before the sliding jaws *d* strike it, and holding it in the proper position while being formed. The gage is fastened to the die

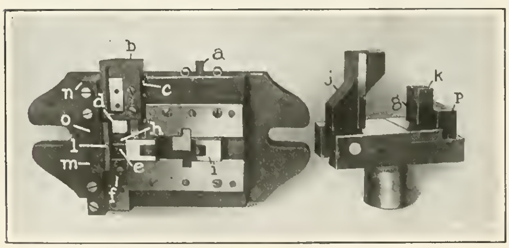


Fig. 15. A Cutting-off and Forming Die

at *j* and is adjustable to any length. The thin sheet metal plates *k* on top of the die prevent dirt from getting into the jaws.

A Cutting-off and Forming Die

The forming of a piece of sheet metal into a cylindrical tube in one operation is difficult to accomplish in a comparatively simple die. Generally, a mandrel is used around which to form a tube of the type shown at *a*, Fig. 15, but in this case it is not necessary. The die shown in Fig. 15 cuts off and forms one split tube *a* with each stroke of the press, which runs at 120 R. P. M. The tubes thus obtained are within 0.002 inch of being perfectly cylindrical. The stock is fed through the guide *b* which is cut out on the top so the stock is visible to the operator. One side of this guide has a flat spring held by the screws *c*, which holds the stock against

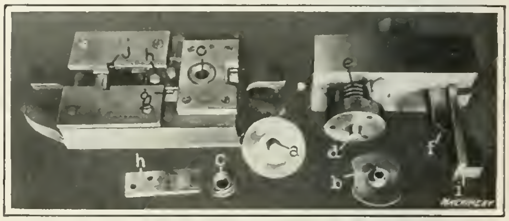


Fig. 16. Cam-operated Trimming Die

one side of the guide so that it will be cut off square. The part marked *d* is the cut-off block; *e* is the first forming die; *f* acts as the stop. The punch *g* cuts off the stock and forms it over *e* in a U shape, which shape is in proportion to the size of the finished tube. The finger *h* is a continuation of the slide and is made of tool steel, hardened. The roll retainers *i* are fastened to the slide by a rib and a small flat-head screw from the bottom. The roll retainers are fastened in this manner to act as a safety for the die in case any foreign condition arises such as a half blank being cut off by mistake and falling between the working parts. The blocks *i* being fastened in this manner allow the screws to break, thus saving some important part from being broken, the screws being easily replaced at a low cost.

While the stock is being cut off and formed over the die *e* by the punch *g*, the slide and finger *h* are held back by the cam *j*. As the punch ascends, the spring pin, not shown but indicated at *k*, in the punch *g* holds the work on the die *e*, stripping it out of the punch *g*. Then the cam *j* forces the

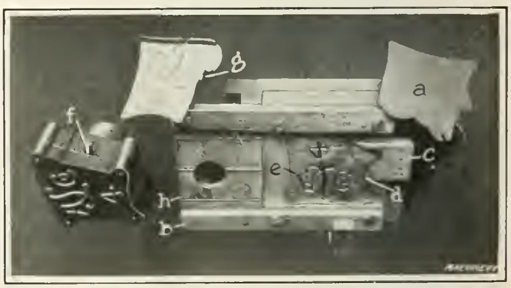


Fig. 17. Die designed for Speed of Production combined with Safety

finger *h* forward, pushing the work through the guide *l*, which is bell-mouthed to receive it, into the dies *m*. These dies are in the form of two semicircles, the lower one being fixed and the upper one sliding on pins o and held up by springs. The top die *m* is limited in its upward travel by the block *n*. The limit of this travel is the point at which the U-shaped blank will maintain an upright position between the upper and lower dies until the next stroke of the press. At the next downward stroke of the press, the top die *m* is forced down by the bumping block *p*, thus forming the tube. The tube is pushed out of the die by the next piece.

The press being set in an incline position, the tubes roll to the back of the press. In order to have the tube cylindrical, the metal must be set or compressed so that it will conform exactly with the shape of the dies m. The form in the dies m should be about 0.002 inch smaller in diameter than the size of the tube required, as the metal will expand this amount after the pressure is released.

The following formula will give very nearly the length of blank required:

$$L = \pi\,(1.5\,T + 0.002 + D)$$

in which T = thickness of stock;

D = inside diameter of tube.

For example, thickness of stock is 0.036 inch and inside diameter, 0.3125 inch. Then,

$(1\frac{1}{2} \times 0.036 + 0.002 + 0.3125) \times 3.1416 = 1.1577$ inch, and

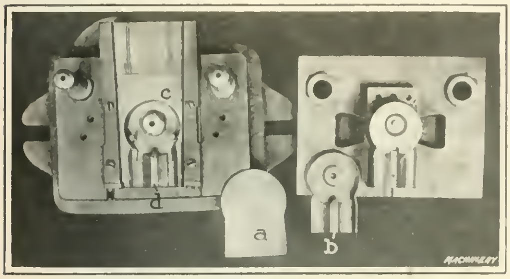


Fig. 18. Die provided with Removable Parts at the Points of Greatest Wear

the correct blank is 1.1563 inch. This was made of bright cold-rolled steel.

Cam-operated Trimming Die

A simple die is shown in Fig. 16 for shearing or trimming the end off the hub on the piece a. The surface must be smooth and free from scratches or cracks, as it has to be curled. The slightest crack or mark on the edge of the hub would start a crack while it was being curled. Before this die was made, a counterbore was used to smooth the edge, but it did not do the work satisfactorily. The piece of work a is placed on the die at c with the hub in the bushing which acts as a gage, the thickness of the bushing determining the length of the hub after being trimmed. As the ram descends, the punch d holds the work down tightly on the die by the

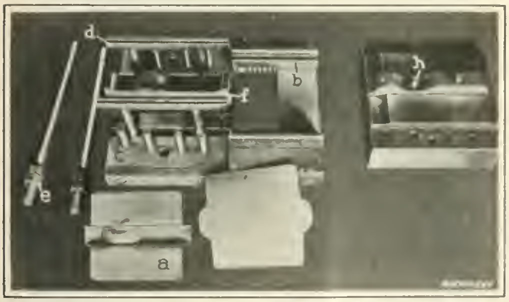


Fig. 19. First-operation Die provided with Means of ejecting Work

pressure of the coil spring e, while the cam f forces the slide g carrying the shear blade h forward and shears off the point of the hub. As the ram ascends the cam forces the slide back again in position for the next piece. The projections i on the sides of the cam slide in the notches in the ways j. The shear blade h should be a sliding fit under the shear die c, which is the exact length of the hub required. The punch d should be about 0.0015 inch shorter than the die plus the thickness of the metal. This gives a nice clean cut without any burr. This die is also commendable because of the safety

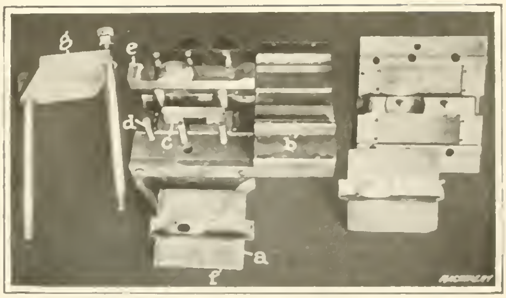


Fig. 20. Second-operation Die provided with Means of ejecting Work

with which it may be operated, a point which should never be overlooked in die design.

Dies which Increase Production and are Safe to Operate

It is just as essential to get the work away from a die rapidly as it is to place the work in the die rapidly. In Fig. 17 a die is shown which extracts the work the moment the punch ascends, this being accomplished by gravity, as the press is set in an inclined position. The blank a is placed on the chute b and slides down against the stop c, which is tapered down at the point d to allow the piece after being formed to slide over it easily. The pad e has strong springs

Fig. 21. Die Storage and Method of grinding Large Dies

under it which keep the piece up against the punch while it is coming out of the die; then the knock-out pin f in the punch, which is backed by a spring, pushes the piece off the die the moment the pressure between the pad and the punch is relieved. The ear g on the piece forces the knock-out pin f into the punch, putting the spring under tension as it is formed in the die. The chute b is carried out far enough from the

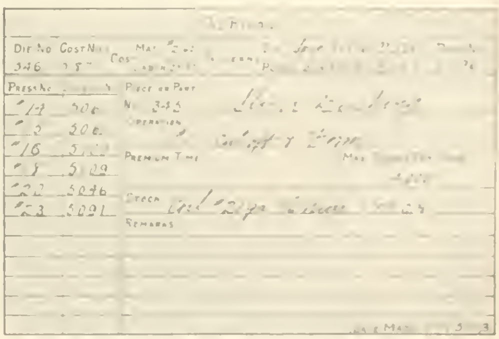


Fig. 22. Die Record Card or Sheet

punch so that when a man's hand is on the chute with his thumb under it his fingers will be a safe distance from the punch when it descends. With a chute of this kind the die should be practically accident-proof. The small bosses *h* on the chute are made to reduce the friction to a minimum.

Design that Reduces Maintenance

A very important point in designing dies is to consider the cost of up-keep and to incorporate replaceable parts in places where the most work is done. Fig. 18 shows a die with pieces of hardened tool steel inserted in the die proper that can be replaced when worn out. This die forms the piece *b* from the blank *a*, and when finished must be smooth and without wrinkles or scratches. As there is a lot of metal to be displaced, there is considerable wear on the die. The ring *c* and the block *d* receive practically all the wear; therefore they are inserted into the die proper which is made of tool steel and hardened. The strippers are removed in order to show the construction of ring *c*.

Extracting an Odd-shaped Piece from the Die

A unique forming die is shown in Fig. 19 which forms 16-gage cold-rolled steel as shown at *a*. A die designed as shown for an inclined press needs no safety guards on the press, as it is accident-proof in every respect and the production is very rapid. The blank is placed on the chute *b* at the front of the die and slides into the die by gravity, being guided between the gage pins *c* onto the slides *d* which act as knockouts as well as slides. The slides *d* are adjusted to the height of the chute *b* by the pull-rods *e* which are screwed to the punch-holder and pass through the die and bolster plate. This pulls the slides *d* up when the ram of the press ascends and allows the piece to slide off to the back of the press. The pad *f* carries two pins (not shown) which pass down through the shoe and bolster and rest on a large coil spring that abuts against the plate attached to the pull-rods as shown at *g*, Fig. 20. This forces the piece out of the die, and the slides carry it clear of the pad. Two pins *h* in the punch backed up by springs force the piece off the punch.

Second-operation Forming Die

Second forming dies are generally more difficult to design than first forming dies because the piece to be fed into the die is of irregular shape and will not slide into the die as easily as a flat blank. The tool shown in Fig. 20 is the second forming die for the piece shown in Fig. 19. It is of similar design and operates in practically the same way. On account of its shape, it is difficult to make a die that is accident-proof for piece *a*. The piece is placed on the chute *b* and slides onto the knockouts or slides *c*, the pins *d* acting as gages and stops. The pad *e* is adjusted low enough to allow the piece to slide over it. As the ram ascends, the pad *e* forces the piece out of the die, then the slides *c* carry it up until it clears *e*. The edges of the piece at *f* are turned up in this operation, making the blank narrower, which allows it to slide between the pins *d* to the back of the press.

Care of Dies

The care of tools and dies in the tool storage is a very important factor. Fig. 21 shows a corner of a tool storage, and it will be seen that the dies are arranged on racks built especially to hold them. Every die should have a particular place which should be numbered the same as the die. Then when the die is returned to storage, it can be easily put back in the proper place, where the man in charge can find it without undue delay.

Fig. 21 also shows a portable grinder *a* with a flexible shaft and revolving table *b* on which to grind large dies. As the motor is on a revolving base *c*, the workman is enabled to move the wheel and die to any position without lifting them or stopping the motor. This equipment is very valuable in a die storage, especially where there are large dies. The revolving table is very handy for inspecting the dies after they come from the press room. All dies should be inspected after being used and before being stored away so they will be ready for use when next wanted.

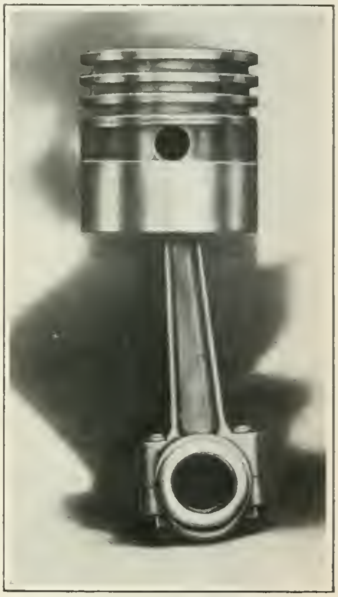
Die Record

A record should be kept of all dies made, and the best record is none too good. The card system is the simplest. Fig. 22 shows a die record which is practically complete and needs little explanation. The name of the part, operation, gage of stock, die cost, pattern and drawing numbers, bolster plate numbers and the numbers of the various presses on which the die may be used are all included.

* * *

MAGNALITE PISTON AND CONNECTING-ROD

The development of motor car engines is in the direction of lighter reciprocating parts and higher speeds. The accompanying illustration shows a "Magnalite" Ford piston and connecting-rod assembly made by the Walker M. Levett Co., 10th Ave. and 36th St., New York City, which weighs complete only twenty-six ounces. The stock cast-iron and steel assembly weighs seventy-four ounces. The difference in weight, forty-eight ounces, multiplied by 4, the number of cylinders, equals 192 ounces or twelve pounds saved in total reciprocating weight.



"Magnalite" Piston and Connecting-rod

It is claimed that the substitution of these pistons and connecting-rods for the stock cast-iron and steel assembly makes an increase of from 25 to 30 per cent efficiency in any Ford motor. The horsepower is increased and the fuel consumption materially reduced. Vibration is eliminated almost entirely. No babbitt is used for the bearing of the crankshaft end of the connecting-rod, the "Magnalite" alloy being used in its place.

* * *

AMERICAN MUSEUM OF SAFETY ANNUAL MEETING

The annual meeting and banquet of the American Museum of Safety was held at the Waldorf-Astoria Hotel, Thursday evening, February 3. Elmer A. Sperry, inventor of the gyroscope compass and stabilizer, briefly described his invention and the manner in which it is applied to stabilize aeroplanes and reduce the rolling of ships. The *Scientific American* medal was awarded to Mr. Sperry for the most efficient safety device exhibited at the Museum. The Travelers Insurance medal was awarded to Wilbur C. Fisk, president of the Hudson & Manhattan Railroad Co. The Louis Livingston Seaman medal was awarded to William Armstrong Fairburn, president of the Diamond Match Co., and the Edward H. Harriman memorial medal to the Cincinnati, New Orleans & Texas Pacific Railway Co. The silver and bronze replicas were awarded to the Norfolk & Western Railway Co. and John O'Brien, switchman and conductor, of the Chicago & Eastern Illinois R. R. The Anthony N. Brady memorial medal was awarded to the Union Traction Co. of Indiana, and the silver and bronze replicas to Harry N. Nicholl, general manager, and John Hancock, motorman.

OXY-ACETYLENE WELDING PRACTICE*

GENERAL CONSIDERATIONS AND DIFFICULTIES MET WITH IN OXY-ACETYLENE WELDING

BY S. W. MILLER†

IT SHOULD be understood that what follows is written, not for the purpose of discouraging anyone who is considering the use of the apparatus, but in order to explode the ideas which frequently exist, and which unfortunately are frequently cultivated by salesmen and advertising matter, that it is an exceedingly simple matter for anyone to learn to do good work by oxy-acetylene welding in a short time, and that by following printed instructions, anyone can become expert. These fallacies are responsible for many disappointments, and the apparatus and method have been denounced many times, when the whole trouble lies in the lack of experience and knowledge, even where the apparatus is first-class and adapted to the purpose.

In his thirty years' experience with mechanical matters of many kinds, the author has not seen any process so apparently easy as the handling of any oxy-acetylene welding torch by an expert welder. It certainly looked to him, when he first began to study the subject, almost as easy as the proverbial "rolling off a log." He soon discovered, however, when he took a torch in his hand, that what appeared so easy, was in reality a complicated matter, comprising, among other things, melting the metal, securing a good weld, adding metal and flux, keeping the melted metal from running away where it was not wanted, preventing hard spots, getting sufficient—but not too much—metal in the weld, avoiding pin holes and strains in the weld, keeping the parts in line, and handling the heated pieces. Besides all this, no two metals were amenable to the same treatment, and still worse, different pieces of the same metal required vastly different methods to handle them successfully. There are two examples of this that the writer recalls. The first was a three-throw crankshaft, with bearings about 3½ inches in diameter, which had the coupling flange, about 8 inches in diameter and 1½ inch thick, broken off square at the end of the end bearing. The material was cast steel, and the shaft was very old, probably twenty-five years. The flange was bored out to within 1/32 inch of the size of the bearing, leaving just enough to set it by, some of the metal was melted down to tack it, and an attempt was made to proceed by using regular steel welding wire, but this could not be done. Several different makes of cast steel were tried without success. It was finally necessary to melt down enough of the flange to extend entirely across the end of the bearing, about 5/16 inch deep, and fill the rest with cast iron. There was no time to experiment, as an important ferry was tied up. At the time, some doubt was entertained as to the strength of the weld; but as it has lasted for three years, and as the break was probably caused by the timbers holding up the driving shaft (which was coupled to the crankshaft) giving way due to decay, there will probably be no more trouble.

Fig. 1. Crank-case in which Shrinkage Strains had to be overcome in Welding

The other case was a casting, apparently of brass, and weighing not more than three pounds. As is customary at the plant where the work was done, rolled tobin bronze rods were used to weld it, but without success. The writer himself then tried, and found the melting points of the casting and tobin bronze so different that a tip heavy enough to melt the casting would blow the tobin bronze away before it could amalgamate with the casting. Fortunately, there were on hand some manganese-bronze sticks with a very high percentage of copper, which had been used experimentally, but were not suitable for ordinary work, and these proved satisfactory. Evidently the casting was a bronze with a high percentage of copper.

Requirements of a Welder

It is true that some men become more proficient in the art in a shorter time than do others; but even with every facility at hand—the welding torch is not all that is needed by any means—much experience is needed to become an all-around welder. The average good machinist would require at least one year in a repair welding shop, before he would be competent to take care of all kinds of metal and the various jobs that come in.

One of the principal qualifications is ingenuity. The welder must never admit to himself the impossibility of any job. Whether it will pay to do it is another question, although it is frequently the determining one. A heavy weld in a cheap casting is possible but uneconomical, and it therefore should not be done unless loss of time in getting a new piece, or some other consideration, outweighs the purely financial one. Careful thought and planning may make a job financially possible, where the ordinary methods would result in the work not being done at all or being done at a loss. Ingenuity is required for such thinking and planning; and from it follow new methods, easier and cheaper, which result in an increase in knowledge and ability, and in the advancement of the art.

It is not necessary for a man to follow any special trade in order to become a good welder; in fact, some knowledge of many trades is necessary, and the more known about them the better the welder is equipped. He should be somewhat of a machinist, blacksmith, boilermaker, patternmaker, molder, stationary engineer, electrician and draftsman. He should have considerable knowledge of the construction and operation of automobiles, gas engines and farm machinery. An acquaintance with contractors' machinery and methods of all kinds is valuable; and any mechanical experience that may have fallen to his lot is certain to be used sooner or later. A knowledge of the principles of the strength of materials is very useful in deciding how to reinforce a weak part in the best manner. For instance, it is common for a customer to request that his automobile frame be strengthened by welding a flat piece to the web of the channel inside, when equal strength with less weight and expense may be obtained by welding a piece to the inside or outside—preferably the latter—of the bottom flange, if that is where the tensile strain comes.

It might seem that anything beyond mere welding is none of the welder's business; but experience proves that in many cases if a welded piece breaks, customers blame the welder when full information shows that the fault is in incorrect construction or assembling. In many cases it is probable that if the original stresses are put on the parts repaired by welding, breakage will again occur, and the work will be criticised adversely. One trouble that frequently arises, or rather a condition which causes trouble, is the inability or failure of the welder to discover the cause of breakage.

At first sight it would appear that this really does not concern him, but when further consideration is given to the matter it will be seen that it is exceedingly important to know

* For information previously published in MACHINERY on oxy-acetylene welding, see "Oxy-acetylene Welding of Aluminum" in the February, 1916, number, and articles there referred to.

† Address: Rochester Welding Works, Rochester, N. Y.

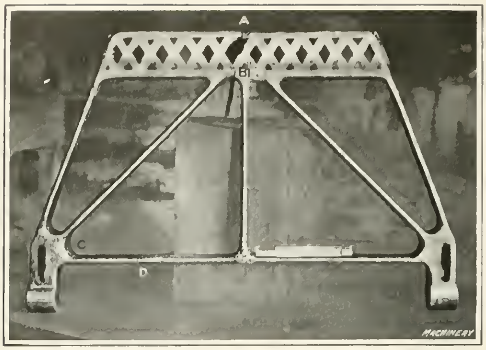


Fig. 2. Foot-treadle illustrating Difficulties in Welding

why a piece breaks. For example, the author frequently runs across cases where the piece is too light, and if this is the cause, it is certainly not fair to the customer to continue to weld the piece, unless he is made aware of the situation and advised that it will be cheaper and more satisfactory to have the piece made heavier, or made of steel instead of cast iron, for instance. Not only is it unfair to the customer to continue to weld a piece that is too light, but it tends to bring the process into disrepute, because the statement is sometimes made (although in the case of proper welding without any basis) that while the metal at the weld is strong enough, the original piece is damaged just outside of the weld. The reason for this kind of breakage is generally that the piece is too weak, although in the case of some metals, such as malleable iron, it is very easy to damage the metal outside the weld, as will be explained later. Aside from the above points, proper advice to a customer creates a feeling of friendship and good will that is an important business asset; so that it is both fair and politic to give ones customer the best advice that is at ones command.

The writer remembers one strange case which may possibly be duplicated in the experience of others. A piece of cast iron had been welded several times, never breaking in the same place. When it was returned the next time, inquiry was made as to the advisability of rewelding it, and it was stated that the piece was so located in the machine to which it belonged as to be the weakest part, so that if any excessive strains were to occur, this piece would break. The total number of welds eventually made in it was fourteen, and the superintendent of the factory operating the machine later stated that the piece had been thrown away, as he was afraid that it was too strong to answer the purpose, inasmuch as there was very little left of it but welds.

Training of Welders

One really serious obstacle to the rapid development of oxy-acetylene welding in all branches is the difficulty of obtaining welders, and this is frequently and successfully urged against the purchase of apparatus. The Germans have overcome this difficulty by establishing welding schools, where not only workmen, but foremen, superintendents and managers receive both theoretical and practical instruction. It is not believed that such work should be done by the government here, but the manufacturers of welding apparatus should, for their own good, take such steps as would enable schools to be maintained. This is a large subject in itself, and cannot be discussed here, except to say that Germany is far in advance of this country in the development of oxy-acetylene welding, largely because of such instruction, and it is believed that a perfectly feasible plan can be readily developed to overcome the present deplorable lack of educational facilities here. Whatever system of education or training be adopted, it is essential that the welder be impressed with the importance and necessity of being absolutely honest, not only with his employer but with himself. There is no credit to anyone in having a piece returned with a defective weld, and a properly trained foreman can instantly tell if carelessness caused the defect. Two or three instances of such work should condemn a welder almost beyond redemption. Aside from this, it would be a serious matter to the average man to feel that any defective work he had knowingly done had resulted in injury to any of his fellow-men. Such accidents have occurred, and show clearly the need of proper education and the most rigid code of honor on the part of the welder.

To obtain competent welders is not so difficult in a shop where the work is largely of one kind—thin sheet metal, for instance. In this case, the men become almost unbelievably expert in a comparatively short time, and far more so than a good all-around man would be on their special work; but such a specialist is of practically no value in a repair shop, where he would have to handle not only all sizes of pieces, but all kinds of metals. The writer has found that the only possible way is to employ a man who knows something about the principles of the art, and to teach him, not so much how to weld, but how to do the work so that as little machining or other finishing as possible has to be done after welding, and so that the piece can be used after being welded. The average welder pays little if any attention to anything except welding, and if he secures a sound weld, he believes he has done his full duty, and feels somewhat aggrieved if his attention is called to the fact that the part is out of line or full of hard spots, or has some other defect so that it is difficult if not impossible to use it. It is possible, however, to avoid machining in many cases by care on the part of the welder. For instance, a frequent accident to an automobile crank-case is a break through the side. No machining should be needed in such a case, and the faces and bearings should be just as true after the welding as before. It is admitted without argument that this is not commonly done, but it should be. Again, a stamping press frame, broken through one of the uprights, even if the section is as large as 4 by 16 inches, should never have the crankshaft bearings out of line with the platen more than 0.010 inch, and good welders repeatedly weld such pieces with less than half this error.

It is also strongly recommended that the superintendent in a shop doing welding himself learn to weld; not with the idea of doing the work, but so that he may be able to check the men as to the quality of their work and to decide how the work should best be done. It is easy to deceive a person who cannot weld, even when he is watching the work.

Wages of Welders

A good welder is worth good wages. It may seem needless to call attention to this fact, but a proper consideration of the

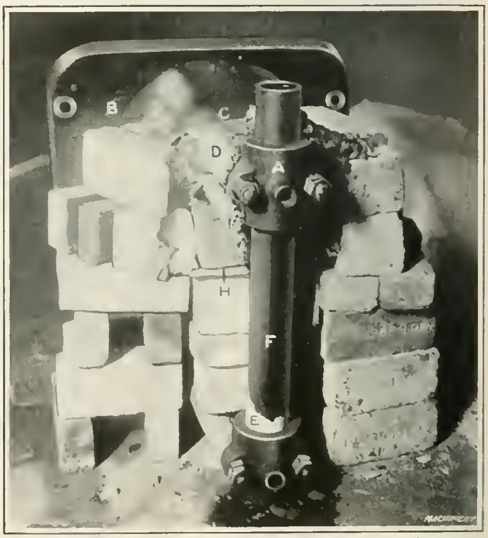


Fig. 3. Duplex Pump Base showing Method of lining up Bearings and saving Babbitt

conditions will show that a careful man can save far more in the cost of gases than any wages which he is paid. Oxygen costs on the average, say, 2½ cents per cubic foot, and a medium size tip uses 25 to 30 feet per hour, so that the oxygen expense runs from 60 to 75 cents per hour. The cost of acetylene will run, depending upon how it is made, from 20 to 50 cents per hour; the total is from $1 to possibly $1.25 per hour. It can be readily seen, therefore, that carelessness or slow speed on the part of the welder is very expensive, and that it is advisable to get good men and pay them good wages.

In repair work no consideration should be given to piecework or bonus systems of paying the men. The writer has had a great deal of experience with piecework, and under certain conditions, if properly handled, it is an admirable method of increasing earnings by stimulating men to eliminate lost time and useless work; but in repair work it is impossible to set any piecework price that will be fair to both the workmen and the employer, and for this reason no attempt should be made to use it. A good welder of the proper temperament who is paid good wages, will do good work, and this is the most important thing in welding, being far more essential than mere speed. Again, repair work is an art; and a self-respecting welder will not permit himself to be hurried beyond the rate which he considers essential to good work. At the same time, he will not permit himself to loaf; and a man who is so constituted that he will allow himself to do poor or slow work deliberately has no place in a repair shop.

Rest Periods Required on Large Work

One of the objections raised by the workmen is the tremendous amount of heat given off by large pieces in a hot fire. A man cannot do good work unless properly protected, and in some cases it is impossible even with the best protection that can be afforded for a man to stand the heat more than fifteen to twenty minutes. In such cases enough extra welders should be provided so that a man will work one period and rest twice as long. This is particularly necessary on large welds that require from eight to ten hours to complete. A number of cases are on record where the actual welding extended over more than twenty-four hours. It has been found that twenty minutes work and forty minutes rest for a man accustomed to such work is satisfactory; in one case, on account of the great heat, fifteen minutes work and forty-five minutes rest was found necessary. It is not advisable in moderately heavy welding to have a man stay at the work more than two hours at a time.

Fig. 4. Duplex Pump Base showing Finished Weld

Fig. 5. Pump Body showing Method of saving Babbitted Bearings

In heavy welding, the torch tips, if made of brass, are likely to become overheated, unless great care is taken, to such a point that the oxygen pressure will blow off the end of the tip. This can be overcome largely by keeping a pail of water nearby in which the end of the tip can be dipped when necessary. It is bad practice to dip the whole head of the torch, as this is likely to distort the end of the tip at the seat and cause a leak. The proper way is to dip the end of the tip into the water and cool it slowly. After the entire tip is cooled, the head may then be cooled, but not rapidly. This difficulty exists generally at the beginning of a deep weld where the whole head of the torch is surrounded by the hot metal. It has been found of great assistance to weld a piece of copper with the proper size hole in it onto the end of a brass tip, being sure that it is aligned carefully with the rest of the tip. This can be done by using a piece of the proper size drill rod. It will be found that this can be pulled out easily as soon as the weld is finished, if care be taken not to weld the drill rod to the tip.

Care of Apparatus

Torches and apparatus are expensive and should be taken good care of. If anything is found wrong, such as leaks in the connections, they should be repaired at once, and if the tips are defective and cannot be repaired, new tips should be provided. Good results cannot be obtained with defective apparatus. The quality of the apparatus purchased should be high. The market is flooded with cheap apparatus such as torches, gages, etc., the vast majority of which are worthless. Imperfect apparatus will produce a welding flame, but will not give good results or be economical in the use of gases; also, they are frequently infringements of patents owned by manufacturers of the better apparatus, and therefore the user is liable for damages as well as the manufacturer. Only first-class apparatus manufactured by responsible firms should be used for welding.

Strength of Welded Forgings

Sometimes trouble occurs, particularly in the case of forged steel parts, from not realizing that an oxy-acetylene weld is really only a casting, and that even with the best possible work the weld will not be as strong as the original piece. If a forged steel piece is broken by carelessness or accident, it may be possible to weld it so that it will be strong enough,

particularly if there is space enough to reinforce the weld sufficiently. On the other hand, if it has to be machined to the original size, and if the fracture is caused by the part being originally too light, the chances are that unsatisfactory results will be obtained in service. It is doubtful if any attempt should be made to weld many kinds of steel forgings. This is particularly true in the case of alloy steels, such as vanadium steel, chrome-nickel steel, etc. These materials occur usually in automobile parts, their use not being frequent in ordinary machinery.

It appears useless to weld such pieces, as they cannot be made anywhere nearly as strong as they were in the first place. Particularly objectionable is the welding of certain parts of an automobile, such as a steering knuckle, where the spindle has broken off. Many such parts have been welded and held satisfactorily, but it is not recommended and should not be done until after the customer's attention is called to the danger, and he has agreed to accept the responsibility for any damage. Even then it may be wise not to run the risk. If it is remembered that cast steel is never as strong as rolled or forged steel, it is hardly possible to go wrong in judging as to the advisability of welding. It is better to err on the side of safety than to take chances.

A further reason for being careful in welding steel is on account of the peculiar property of this metal which requires that under alternating strains a certain proportion of the elastic limit must not be exceeded, otherwise a fracture will occur in the course of time. Now the elastic limit of cast steel, no matter how good, is way below the elastic limit of forged and heat-treated steel, particularly alloy steel. Therefore a fracture will occur much sooner in the case of a weld than in the case of the original piece, even if the weld is sound. Much could be done in the way of strengthening the weld if it were possible to heat-treat it properly, but this branch has not, so far, been developed in connection with welded parts.

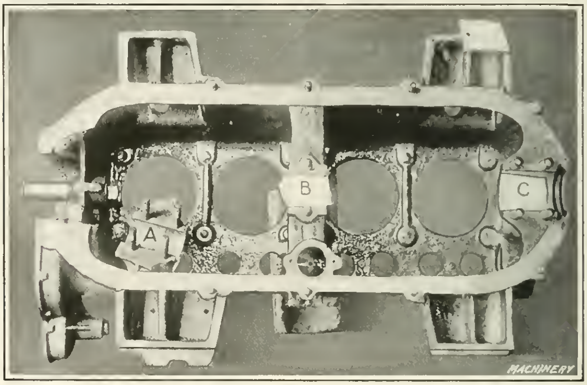


Fig. 6. Crank-case in which End Bearing is broken off

Overhead Cost

The average small shop of any kind is not usually run with the proper attention to the real cost of the work. This is particularly true in connection with welding, because it is not generally understood that there are other costs besides those of the gases and labor. Such expenses as interest, depreciation, insurance, repairs, taxes, advertising, soliciting, etc., have to be paid out of the earnings of the shop, although they are generally not taken into account in the proper way. A large concern with competent accountants does take care of these things, and realizes that its customers have to pay for them in the price of the work. Many small welding shops have lost out by not paying attention to these matters. Again, the cost of gases is frequently taken at the invoice price without considering freight and cartage which have to be paid both ways.

There are quite a number of other items that have to be taken into account in order to be sure that the proper cost of the work is obtained. Let us assume some figures, which, while not exact, will not be far out of the way for a moderate size repair shop. Let us assume that the plant cost $1000, and that the fixed charges will be as follows: Interest 6 per cent, depreciation 10 per cent, repairs 5 per cent, insurance 2 per cent, taxes 1 per cent—a total of 24 per cent or $240 per year. The operating expenses might be about as follows: Rent $35, heat $5, light $2, power $5—a total of $47 per month or $564 per year. There will be miscellaneous charges, depending on the work done, for welding rods, hand tools, such as files, chisels, hacksaw blades, etc., charcoal, cartage, and some other things, which will run up to, let us say, $25 per month or $300 per year. If the welder is an all-around man, his labor will be worth at least forty cents an hour. A competent solicitor will cost at least $75 per month or $900 per year. The total of these charges, exclusive of the welder's labor, amounts to $2000 per year. If oxygen is bought in 500 cubic foot lots and costs two cents a cubic foot, freight and cartage on it will probably cost $3 and $1, respectively, inbound. Outbound, the tanks weigh somewhat less, and we will assume that the freight and cartage amount to $3.50. This is a total of $17.50 or 3½ cents per cubic foot. If two 300-foot tanks of acetylene are procured at once, costing two cents a foot, the freight and cartage will be about the same as in the case of oxygen, or a total of $19.50 or 3.25 cents per cubic foot. If the average size tip uses 25 feet of acetylene and 30 feet of oxygen per hour, the cost of operating the torch, aside from labor, will be $1.86 per hour. To summarize: the cost per hour based on 3000 working hours per year will be as follows: overhead $0.666, labor $0.40, gases $1.86, a total of $2.926. This would be true if the assumptions are correct and if the welding were going on ten hours a day. If a welder were only occupied in welding five hours per day, the cost of gases for the daily ten hours would be 93 cents per hour, making the total cost about $2 per hour. It is evident that care must be taken to insure proper charges being made for the work, although it is to be understood that the figures given are not actual, and that they will have to be modified to suit expenses which will vary with different locations. A common charge for machine shop work is 60 to 75 cents per hour, and this is supposed to cover not only all expenses, but profit as well. The difference between these charges and those necessary to cover the cost and profit of oxy-acetylene welding are so startling that one is likely to feel that the process is very expensive. It should not be forgotten, however, that the cost per hour is not the correct basis on which to make the comparison. The results obtained should also be considered.

The above figures also indicate why in many cases it does not pay to weld inexpensive parts, and show the great necessity of employing competent welders, because it is evident that a small amount of time lost in doing a job may result in its costing more than can be charged for it; so that quick and accurate work must be done, and as little machining or finishing be required as possible, in the case of small or inexpensive pieces. There are many pieces that repair shops cannot weld profitably. For example, the sliding jaw of a vise frequently breaks off in front of the head, and while it is a perfectly possible job, and while the writer knows of no case where one has broken after welding, it being possible to reinforce it considerably, the cost of welding compared with the cost of a new part is excessive. Again, if the vise is considerably worn, as is generally the case, it is a better investment to buy a new vise, as there is no lost motion, and the condition of the jaws is good. In such cases, experience and a thorough knowledge of the real cost of welding, including overhead expenses, is necessary to determine whether it is advisable to weld the broken part. In a number of such cases policy may require the work to be done, even at a loss, for the sake of getting the larger work in the case of a good customer. Such questions have to be decided on their merits.

Difficulties with Cast-iron Welds

A difficulty that is encountered in certain cases, particularly in cast iron, is the formation of blow-holes extending from some distance down in the weld to the surface. These are generally small and in the majority of cases not important. However in gas-engine cylinder water-jackets or similar places where leaks are objectionable, they should be avoided, and in all cases care should be taken to remove them during welding. They are caused by small particles of slag or dirt, which contain in them a certain amount of air or gas. They can generally be noticed by their intensely white color. They are probably composed of silica which will not melt. All that needs to be done is to melt the metal around them and allow them to float to the surface, removing them either with the welding rod or by the use of scaling powder. A similar condition is sometimes noticed in a piece that has not been heated sufficiently; here the remedy is obvious.

There is one condition that exists frequently in cast-iron welds which has caused a great deal of trouble and rather adverse comment, and that is "hard spots." If good welding rods are used, they are the result of carelessness in welding, and generally occur at the points where the old and new metal join. It is very easy to avoid them by making the new metal at the edge of the weld a little higher than the surface of the old metal and then melting the old metal and new metal, allowing the new to run into the old. If this is properly done, there will be no hard spots at that point. It is a mistake to say that scaling powder produces hard spots. Certain kinds may make a very thin hard film on the weld, but the hard spot which gives trouble is the one first referred to. Anyone can readily test this for himself and will be convinced after two or three trials that there is a good reason for hard spots but that there is no excuse for them. Of course in some cases where no finishing is to be done except by grinding, it is not worth while to bother about hard spots, but where any machining or filing is necessary, they should be avoided. The real cause of such hard spots the writer believes to be as follows:

It will be noticed that they generally occur in comparatively thin sections, or if in thicker sections, where the metal has not been thoroughly heated; also that they generally are more frequent in fine-grained iron than in coarser metal. The action of silicon, manganese and sulphur in iron in certain proportions tends to produce an iron that will readily chill when heated and allowed to cool rapidly. The presence of large amounts of the elements favorable to producing soft iron will not, under extremely rapid cooling, make the iron soft. Now in thin sections, air cooling is sufficiently rapid, with the proper chemical composition, to produce chilled iron, and it is surprising how heavy the section may be and still chill when cooled in the air. If allowed to cool in the fire, of course, the cooling will be much slower and there will be less danger of hard spots. The action is really the formation of chilled iron, and from such tests as the writer has made, the chilling does not take place in the added metal, but occurs entirely in the original material. This is on account of the high amount of silicon in the welding rod, which is favorable to the production of soft iron. It is admitted, however, that some further tests are advisable to confirm this theory. Regardless of the theory, however, these spots can be avoided by heating uniformly and cooling slowly.

Malleable iron when heated beyond a certain point will revert to its original state of white or chilled cast iron with consequent hardness. Care should be taken not to heat the metal any more than is absolutely necessary. There is no other metal that gives any trouble from hard spots.

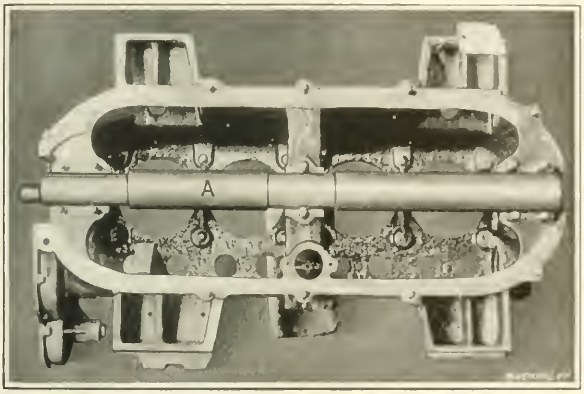


Fig. 7. Same Crank-case as shown in Fig. 6 with End Bearing and Mandrel in Place

Distortion in Welding Cylinders

Another difficulty that quite frequently arises is the claim made by a customer that the piece has been distorted by welding; for instance, an automobile cylinder in which the bore, so it is said, has been warped by heating. It is true that this does occur at times, but only in cases of very bad breaks, in the case of a certain type of cylinders where the connections between the cylinder barrel and jacket are so rigid that it requires a red heat to make the weld, or where the cylinder is carelessly overheated. There are also a number of old-style cylinders which were not annealed after rough-boring, and which warp out of shape even with the moderate heat required for jacket welding. The writer, in the beginning of his work, measured with a micrometer caliper the diameters at both top and bottom of a large number of cylinders, and with the exceptions above noted, he has yet to find any noticeable distortion of cylinders of automobile motors or gas engines. Of course there is always some difference in diameters of such cylinders after a period of service, due to natural wear. This is sometimes excessive, and will be readily detected by proper measurements before welding.

The following case, while not of this type of cylinder, illustrates the point very well. A Corliss engine 16 inches in diameter by 36 inches stroke burst out the top of the steam chest by freezing, due to the man in charge not draining it during cold weather. The cylinder was calipered at three points and gages made to suit, a maximum difference being found of 0.012 inch, due to wear. After welding and cooling, the latter requiring two days, it was found that the maximum change of dimensions of the bore was less than 0.003 inch, not enough to cause any trouble. The claim of the customer that the cylinder had been distorted was, therefore, readily disproved. It is easy to see, however, that if the precaution of measuring before the welding had not been taken, it would have been very difficult, if not impossible, to convince the customer that the welding operation had not injured his cylinder. Therefore, it is advisable in the case of any job about which a question is likely to be raised, that careful measurements be taken, the accuracy depending on conditions, and a record kept for future reference.

Expansion and Contraction

One of the greatest difficulties to be contended with is the control of expansion and contraction due to differences in temperature of different parts of the piece welded. Cast iron, being comparatively brittle, is peculiarly subject to cracks caused by temperature strains, but all other metals have also such strains in them, and while they may not crack, they change their shape if care is not taken to handle them properly.

There is no general rule for taking care of expansion and contraction strains. It must be remembered that they are always present, and experience will show in what way they will manifest themselves. Sometimes they can be avoided by setting the pieces so as to allow the shrinkage to bring the parts to their original shape, but considerable thought and ingenuity has to be exercised at times to take care of it. Sometimes a sound weld can be made, but the strains will have been distributed through the piece, distorting it and requiring

the addition of extra metal to some of the finished surfaces so that they may be machined to their original dimensions.

Fig. 2 is introduced to show the principle of taking care of contraction. It will be noticed that this piece has been welded before and that it did not break in the weld. It really is not strong enough for the work to which it is subjected. Before taking the photograph, the crack was wedged apart to show it more distinctly. A little thought will show that if breaks *A* and *B* are welded at different times, it will be hard to avoid shrinkage strains, as the distance between the two welds is very short, not over 3 inches. If, however, they can be welded at the same time, this difficulty will be overcome, as the shrinkage will be uniform. It will also be seen that if the crack is opened to allow for contraction, the pieces will not separate parallel to each other, but will swing around the point *C* as a center, causing strain at that point.

The method followed, therefore, was to heat the bar *D* with a gas flame sufficiently to open the crack the desired amount. Two welders, one working on each crack, finished the welds at the same time. A heavier tip was used on crack *B* than on crack *A*, as the section was heavier and larger. It might be stated that the old welds shown were made over a year before the piece broke the second time.

Fig. 1 is shown to indicate one method of partly overcoming shrinkage strains that would ordinarily occur. The break does not extend to the bottom flange of the crank-case. The part broken out was in four small pieces when received, and in welding them in, the edges were welded first, leaving the section *B* about 1/16 inch higher than its original location. Before welding, a little metal was added to the edges of the holes *A* in the piece, to provide for the elevation above described, so that the holes could be finished to their original size. The bridge between the holes was welded first, then the sides, and after that the center. While this will not entirely remove the shrinkage strains, it gives a certain opportunity for shrinkage to occur without causing trouble. In this instance, the metal was of good quality and no trouble whatever was experienced. This method can also be followed at times in welding badly frozen cylinder water-jackets. Of course it does not make as good looking a job as if the surfaces were left in their original location, but if possible to do it, it saves trouble.

A method used for saving the babbitt bearings, and also for the purpose of lining up the bearing that was broken off as shown in Fig. 4, is indicated in Fig. 3. A piece of 3-inch seamless tubing was clamped in the bottom bearing, using a piece of asbestos paper *E* to raise it slightly above its original position to allow for shrinkage. Additional allowance was made by raising the bearing *A* about 1/32 inch vertically above the proper position. The bottom of the tube was plugged with wet asbestos, and it was then filled with water. Asbestos, as shown at *D*, was packed around the bearing and the fire built as usual, the sheet of tin *H* being placed to locate the bottom of the fire. The bricks below the tin are simply for the purpose of supporting the fire. The bricks above the tin surround the fire and confine it to the desired location. The break was at *C* and is more clearly shown in Fig. 4 which shows the finished job. The metal was 1½ inch thick and the break 12 inches long. When tested after cooling, it was found that the bearing was in alignment within the thickness of a piece of paper, or about 0.003 inch. A slight scraping was all that was necessary to take care of this.

Fig. 5 shows one method of preserving babbitt bearings in cases where the part is to be heated to a high temperature. The break in this case was on the bottom of the pump body. It is evident that this had to be heated quite hot in order to compensate for shrinkage. This was done in a furnace built of firebrick, the bearings being covered at *A*, *B*, *C*, and *D* with wet asbestos, and the channels at *E* and *F* plugged with asbestos to keep the water in them from running back into the fire. These precautions, together with keeping the asbestos constantly wet and the channels filled with water, answered the purpose admirably and the bearings were not damaged.

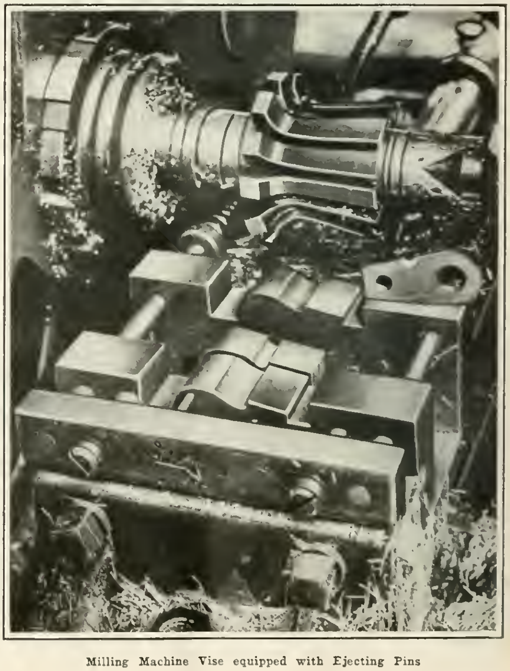
Figs. 6 and 7 show a method that can be frequently employed to replace a bearing so that it is very nearly, if not absolutely, in its original position. In Fig. 6 two pieces of cardboard, each about 0.015 inch thick, have been placed in the two sound bearings. The broken-out end bearing *A* is then put in place without the use of any cardboard, a mandrel being held in bearings *A* and *C*. Bearing *A* is held against the mandrel by means of clamps and the nuts of the bearing cap studs. It is evident that this raises the bearing *A* slightly above its original position. This compensates for the shrinkage of the weld, and in this particular case no finishing was needed except a little scraping of bearing *A*. The three bearings in this instance are of different sizes. It should also be stated that cold-rolled steel, while it is quite heavy, is, as a general rule, cheaper for mandrels than tubing. Of course, if many crank-cases of one kind are to be taken care of, it will be better to use tubing, but this material is expensive and for ordinary purposes is unnecessary.

* * *

EJECTING WORK FROM THE MILLING MACHINE VISE

At W. H. Nichols Co.'s factory in Waltham, Mass., a great deal of accurate milling of adding machine parts and similar devices is done. Many of the parts are of sheet stock, requiring edge milling and must be located by holes that have previously been punched or drilled. This means that the milling fixture must have pins over which the pieces may be located by means of the previously drilled or punched holes. After the milling cut has been taken across the work, it is often difficult to remove these pieces from the pins.

The illustration shows the method used for rapidly stripping the fixture of finished parts. Back of the stationary vise jaw is a strip of steel that carries the ejecting pins—three, in this case. These pins work through holes in the stationary vise jaw directly in back of the work. The ejecting pin bar runs on two studs that extend backward from the stationary vise jaw. The bar is operated by two rods at the ends of the bar that extend through both vise jaws. Collars on these rods are struck by the movable jaw as it opens, and thus the ejecting bar and its pins come forward and strip the work from the locating pins. Spiral springs behind the collars on the operating rods push the ejecting bar and the pins out of the way as soon as back pressure on the collars is released. The work is thus ejected squarely and with no effort other than the usual operation of the vise. C. L. L.



Milling Machine Vise equipped with Ejecting Pins

COST OF GAS CUTTING

BY J. F. SPRINGER*

Some figures are given in Table I relating to the cost of cutting steel by the oxy-hydrogen method. These figures are derived from or based on an authoritative European source. Oxygen is valued at two and one-half cents per cubic foot and hydrogen at one cent. The table may be used to show the cost where the prices of these gases differ from those here employed. The labor is taken at twenty cents an hour. Where the cost is different, the table will still furnish basic figures for a calculation by taking the change into account.

Some years ago, the writer made a calculation of the cost of cutting. It was based on data resulting from a lot of miscellaneous work. That is, there were thirty-eight cuts varying in area from 1.56 to 75.6 square inches. The average was 16.20 square inches. The oxy-acetylene method of cutting was employed. The total oxygen consumption amounted to 195 cubic feet. The average cut required, accordingly, 5.1 cubic feet of oxygen. Assuming the average cut to have been 4 inches square, we have this consumption for a lineal length of one-third foot for work 4 inches thick. Referring now to Table I, we find that 16.3 cubic feet of oxygen was required to cut one lineal foot of steel 4 inches thick. For one-third lineal foot, we get 5.4 cubic feet. There is, accordingly, pretty close harmony in the two cases; that given by the table and that derived from the thirty-eight miscellaneous cuts. Reference to Table I will show that for work thicker than one inch, the oxygen becomes a very decisive factor. It costs more per foot all the time, but for the heavier work the amount becomes rapidly greater relatively as the work increases in thickness.

The cutting of round bars is naturally a different proposition. Table II gives some practical information as to costs. As before, it is the oxy-hydrogen procedure that is used; and the labor is taken at twenty cents per hour, the oxygen at two and one-half cents per cubic foot, and the hydrogen at one cent. We find from this table that 4.8 cubic feet of oxygen is required to cut a 4-inch bar. Here the area of the cut is 12.6 square inches. Compare this with the consumption for 4-inch plate. Table I gives 16.3 cubic feet as the amount of oxygen required for a lineal foot, or 1.36 cubic foot per lineal inch. Now 12.6 square inches will be the area of the cut, when the torch has proceeded 3.15 inches. Multiplying 3.15 and 1.36, we get 4.28 cubic feet for a 4-inch cut having an area of 12.6 square inches. This is a little less than the requirement for a round cut of equal area, but the difference is not great. Hence we may formulate tentatively, the rule that it takes the same amount of oxygen to cut a given area in work of a given thickness, whatever be the form of the cross-section cut. In applying this rule, be careful to take the maximum thickness as the basis.

* Address: 618 W. 136th St., New York City.

TABLE I. COST OF CUTTING STEEL PLATE BY THE OXY-HYDROGEN PROCESS

Thickness of Plate, Inches	Time, in Minutes, consumed in Cutting 1 Foot	Labor Cost	Amount of Hydrogen, Cubic Feet	Amount of Oxygen, Cubic Feet	Cost of Gases	Total Cost
0.08	1.8	0.0060	0.5	0.5	0.0175	0.0235
0.12	1.8	0.0060	0.6	0.6	0.0210	0.0270
0.16	1.8	0.0060	0.8	0.8	0.0280	0.0340
0.20	1.8	0.0060	0.8	0.9	0.0305	0.0365
0.24	1.8	0.0060	0.9	1.1	0.0365	0.0425
0.32	1.8	0.0060	1.1	1.4	0.0460	0.0520
0.40	1.8	0.0060	1.2	1.7	0.0545	0.0605
0.48	2.2	0.0073	1.2	1.9	0.0595	0.0668
0.60	2.2	0.0073	1.3	2.4	0.0730	0.0803
0.80	2.2	0.0073	1.4	2.9	0.0865	0.0938
1.00	2.2	0.0073	1.7	3.7	0.1095	0.1168
1.20	2.2	0.0073	1.9	4.3	0.1265	0.1338
1.40	2.2	0.0073	2.1	5.2	0.1510	0.1583
1.60	2.2	0.0073	2.4	5.7	0.1665	0.1738
1.80	2.2	0.0073	2.6	6.4	0.1860	0.1933
2.00	2.2	0.0073	2.7	7.1	0.2045	0.2118
2.20	2.5	0.0083	3.0	7.9	0.2275	0.2358
2.40	2.5	0.0083	3.1	8.7	0.2485	0.2568
2.60	2.5	0.0083	3.2	9.7	0.2745	0.2828
2.80	2.5	0.0083	3.4	10.1	0.2940	0.3023
3.00	2.5	0.0083	3.5	11.4	0.3200	0.3283
3.20	2.9	0.0097	3.7	12.4	0.3470	0.3567
3.60	2.9	0.0097	3.8	14.2	0.3930	0.4017
4.00	2.9	0.0097	4.0	16.3	0.4475	0.4572
5.00	2.9	0.0097	4.1	21.8	0.5860	0.5957
6.00	2.9	0.0097	4.5	27.7	0.7375	0.7472
7.00	3.7	0.0123	4.7	33.6	0.8870	0.8993
8.00	3.7	0.0123	5.0	39.5	1.0375	1.0498
9.00	3.7	0.0123	5.4	45.5	1.1915	1.2038
10.00	3.7	0.0123	5.9	53.1	1.3865	1.3988

Machinery

TABLE II. COST OF CUTTING STEEL BARS OF CIRCULAR SECTION BY THE OXY-HYDROGEN PROCESS

Diameter, Inches	Time, Minutes	Amount of Hydrogen, Cubic Feet	Amount of Oxygen, Cubic Feet	Cost of Gas	Labor Cost	Total Cost
0.8	0.3	0.5	0.7	0.0225	0.0010	0.0235
1.6	0.4	0.6	0.7	0.0235	0.0013	0.0248
2.4	1.0	0.8	2.1	0.0605	0.0033	0.0638
4.0	1.2	1.7	4.8	0.1370	0.0040	0.1410

Machinery

We have found that our figures show a small advantage in favor of work of even thickness. This becomes more pronounced, apparently, when we take small work. Consider a round bar 1.6 inch in diameter; and plain plate 1.6 inch in thickness. A cut $1\frac{1}{4}$ inch long in the plate will have an area of 2 square inches. So also will a cut clear across the round bar. Table I shows that 1.6-inch plate requires 5.7 cubic feet of oxygen per lineal foot of cut; so that $1\frac{1}{4}$ inch will require 0.594 cubic foot. Table II shows that 0.700 cubic foot will be required for cutting through the 1.6-inch round bar. Nevertheless, the rule may be taken as a fair guide. It will be a pretty safe guide, if we calculate according to the table for round work. That work of uniform thickness should consume less oxygen than the same area of cut where the thickness varies should not surprise us. There is the same amount of steel to be cut away; but we should expect wastage with changes in thickness.

Such tables as the foregoing serve a number of purposes. They give us an idea of the cost of work in advance. Again, if we are doing work covered by the tables, they enable us to determine whether our results are in accord with approved practice. Finally, such tables may prove serviceable in custom cutting, satisfying the customer as to variations in price.

A condition of all cutting is that the metal upon which the high-pressure oxygen plays shall be at a high temperature. The necessity for the flame heating the path sets a limit upon the speed of advance. Next, the amount of oxygen supplied by the cutting jet must be enough to convert the iron into magnetic oxide. Consequently, with a given cutting torch, there must be a certain pressure which corresponds with the speed determined by the heating flame, a pressure sufficient to supply the right amount of oxygen. Possibly, a certain amount of force is required to drive out the oxide. Nevertheless, there will be a pretty definite pressure corresponding to the heat capacity of the heating flame. A stronger pressure will be useless and occasion waste; a weaker pressure will require the forward speed to fall below its possibilities. Economical cutting must find the proper pressure. With a given torch, it will vary with the thickness of the work, etc. We have here an explanation, in part at least, of the greater amount of oxygen required when the thickness varies.

* * *

A new white metal alloy of high luster, capable of taking a brilliant polish and closely resembling silver in appearance, consists of 70 per cent copper, 15 per cent nickel, 9 per cent zinc, 4.3 per cent tin, and 1.7 per cent lead. The alloy is made as follows. The nickel is first melted with a flux of silica, and half of the copper is added gradually and mixed, after which the remainder of copper is added. The zinc is then quickly plunged beneath the surface of the molten metal which is stirred rapidly until the whole is melted. The lead and tin are added last while liquid. The metal is stirred and brought to a temperature of about 1700 degrees F., after which it is poured into ingot molds.

LEAD BURNING

DESCRIPTION OF APPARATUS AND METHODS USED FOR WELDING LEAD PLATES

BY JAMES F. HOBART*

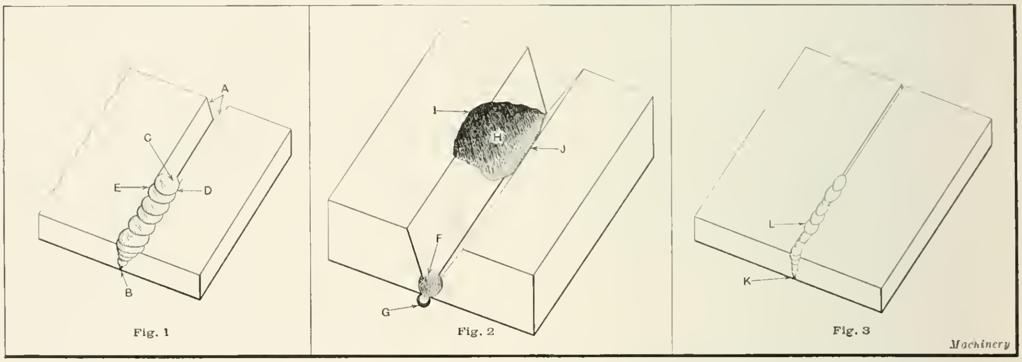
LEAD burning may be defined as a form of autogenous welding, whereby the parts to be united are joined by melting metal between them. This molten metal is obtained by heating the end of a strip of lead of the same composition as that of the lead plates to be united. The addition of metal at the joint is not actually necessary, but it serves to replace the material that was cut away before welding, and the cutting away of metal at the point of fracture is a desirable practice, as it enables the welder to work more rapidly and do better work.

The term "lead burning" is really a misnomer and should never have come into use, because the lead is not burned so long as the welder does his work properly. It would be just as proper to call the welding of iron or steel with the oxy-acetylene flame "iron burning" or "steel burning," as to call the process of welding lead by the oxy-hydrogen flame "lead burning." The operation is essentially one of welding the lead with heat furnished by the combustion of hydrogen, and the technique of the operation is almost exactly the same as that of ordinary oxy-acetylene welding. Indeed, lead burning may be effectively performed with an oxy-acetylene welding torch, and a skillful welder will soon learn the art of lead burning, using the same torch with which he welds iron or steel; but great care must be taken, because the temperature of the oxy-acetylene flame is really too high for working on lead.

However, this article is concerned with the standard method of lead burning, and for this purpose, the gases used in the torch consist of hydrogen under a pressure of from one to two pounds per square inch and air under about the same pressure. The torch in which the hydrogen is burned is designed to mix the hydrogen and air in the correct proportion, and a jet tube in the burner directs the flame against the work at the desired point. To obtain satisfactory results, the flame must have a very fine point. Fig. 1 shows the method usually employed in joining two sheets of lead, the procedure being as follows: The edges of the sheets are first beveled at *A* so that a small trough is formed with an included angle of from 24 to 30 degrees. The welder then starts at one end of this trough *B*, and the oxy-hydrogen flame is allowed to play against the edges of the work until the surfaces of the lead are softened almost to the running point.

Considerable judgment is required to determine the exact instant at which the lead is on the point of melting, and the ability to do this, hour after hour throughout the working day, can only be acquired as the result of wide experience. Just before the lead comes to the melting point, the welder brings his strip of lead or so-called "solder stick" into the flame and heats a small portion of it so that a drop of molten lead will fall into the joint at *B* at the instant that the temperature of the lead at each side of the groove has been raised to the melting point and is about to be changed to the molten condition. But at the instant that the drop of lead falls into the groove the flame is whisked to one side and the drop of molten metal breaks through the heated surface at each side of the groove, uniting with the metal in the plates. The welder carefully observes the falling of the drop of lead and its union with the metal in the plates, and if there is the least indication that all the metal has not united properly, he applies the flame at that point for a sufficient length of time to remelt the metal and allow it to flow together.

An attempt has been made at *C* to show the perfect union of a drop of lead with the metal in the plates. It will be seen that this is quite different from the well defined line between the drop of metal and plates as shown at *D* and *E*. The latter condition results when the temperatures of the drop of metal and the metal in the plates are not the same or where the temperature has not been raised sufficiently; but at *C* the temperatures were correct, with the result that the lead in the drop united with the lead in the plates in such a way that no junction line can be seen. In fact, there is no line of connection or anything that can properly be called a point, as the metal has united to form a homogeneous body. This is the condition which will be produced by a skillful lead burner.



Figs. 1 to 3. "Burning" a Joint, starting a "Burn," and Joint "burned" without beveling Plates

From *B* to *C* are shown several small globules of lead that have been melted into the joint and allowed to unite with the lead plates. It will be noted that these completely fill the groove. If all of the drops are of the same size, and are deposited in a straight line, it indicates that the work was done by a skillful lead burner; and although the beginner may secure a strong and perfect joint between the plates, it is probable that the drops of lead that he deposits in the joint will be of irregular shape and size, and will not be in a straight line.

Fig. 2 shows how a joint may be started, and also illustrates some troubles which may be experienced by a lead burner. At *F* the flame was applied to the work for too long a time with the result that some of the lead *G* has melted and run out of the joint. This must be replaced from the "solder stick" and causes a loss of both time and material. The hole shown at *H* was caused by holding the flame on one side of the joint too long with the result that the metal melted and flowed away at the point *I*. This condition will cause irregularity in the finished seam and remain as a permanent indication that the work was done by a careless or inexperienced operator.

It will be noticed that at *J* the edge of the sheet has not

* Address: 1702 Lockwood St., Indianapolis, Ind.

been melted back; it is still in line with the unwelded part of the plate and there is a probability that a leak may be found at this point when the completed joint is tested. The most skillful welders melt the edges of the plates back far enough to be sure that all the beveled edges of the metal have been heated to the melting point. It is possible to heat the edges of the plates so accurately that the metal will unite with the drops of lead without actually melting back the beveled edges; but the safer plan is to melt the lead back at each side of the joint for at least 1/32 inch, in order to be sure that a perfect union has been obtained.

Fig. 3 shows the result of attempting to burn a joint with square edged plates. This method may be employed on very thin plates but there is always a large element of doubt as to whether a perfect joint will be secured. In fact, you cannot trust a joint made with square edged plates and the chances are heavily against securing a perfect union of the metal where this plan is followed. In attempting to weld two square edged plates, the lead burner starts at end *K* and must melt the top edge of the plate before the lower edge can be heated. By the time that some point *L* is reached, other difficulties will be encountered. For one thing, he will find himself severely handicapped by having to drive the heat down through a layer of molten metal in order to heat the plates to their lower edges, and there is no way of overcoming this difficulty. The result is that there is likely to be a large part of the lower edges of the plates which has not been properly joined. But where the plates have been beveled at the edges, as previously described, the welding is done at the lower edges first, and a strong and uniform joint is secured.

The apparatus used for lead burning consists of a burner provided with two lines of rubber tubing about 1/4 inch in diameter, which connect the burner with suitable sources of air and hydrogen. Rubber tubes from 50 to 75 feet long are sometimes used in order to give the welder sufficient latitude to work inside of large tanks. Metal pipes may be used for part of the distance, but it will usually be found more satisfactory to provide a sufficient length of rubber tubing to reach from the source of oxygen and hydrogen to the most remote point at which welding is to be done. The hydrogen generator should be located out of doors because it gives off noxious gases while in operation. The hydrogen may be stored in pressure tubes and delivered through a reducing valve which will maintain the pressure between one and two pounds per square inch. The air supply may be obtained by any convenient method. A hand pump can be used where power is not available, but in most cases a little motor pump will give satisfactory results. A small gasoline engine will be found satisfactory for driving the air pump if no other source of power is available.

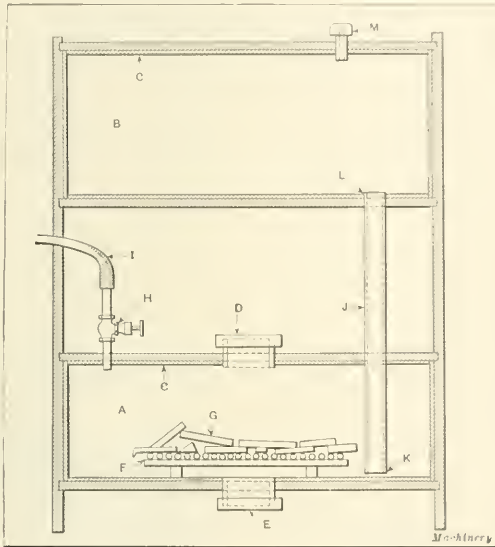


Fig. 4. Cross-sectional View of Hydrogen Generator

Fig. 4 shows the arrangement of a hydrogen generator of the type used for lead burning. This is usually constructed of 1-inch boards screwed together with brass screws, as iron is quickly corroded by the acid fumes. The inside of the generator is covered with lead, and the seams between adjacent lead plates should be burned together, as the tin contained in solder would be quickly attacked by the sulphuric acid used in producing the hydrogen gas. The generating apparatus consists of two tanks located one above the other; and the vertical distance between these tanks regulates the amount of pressure on the hydrogen. The two tanks *A* and *B* are made about 8 inches wide by 8 inches high by 24 inches long and are furnished with a lead lining *C*. The lower tank has an inlet *D* fitted with a screw cap which may be removed for charging the tank with dilute sulphuric acid. A similar opening is provided at *E* for cleaning out the tank and removing the residual sludge which remains from the spent chemicals. The grating *F* is made of wood or metal bars covered with lead, and this grating supports the iron or zinc *G* which reacts with the sulphuric acid to generate hydrogen gas.

Valve *H* provides for shutting off the flow of hydrogen when the apparatus is not in use and there is a second valve at the burner that is used for the same purpose; but valve *H* should always be closed when it is required to shut the gas off for a considerable period of time in order to relieve the rubber tubing from strain. The arrangement of the rubber tubing and the method of connection are shown at *I*. A pipe *J* connects the upper and lower compartments of the generator, the entrance of pipe *J* into the upper compartment being just flush with the lead lining at *L* to which it is joined by burning. It will be obvious that pipe *J* must be made of lead and that it must also be tightly joined to the lining of the lower compartment into which the pipe projects almost to the bottom, as shown at *K*.

The method of operating the generator may be briefly described as follows: The iron or zinc *G* is placed in position on the grating *F*, and clean-out pipe *E* and valve *H* are tightly closed. Sulphuric acid diluted with water is next poured into the generator through opening *D* until tank *A* has been filled within about 2 inches of the top. The introduction of the acid should be done as rapidly as possible, after which opening *D* is closed immediately, as hydrogen gas is liberated the instant the acid comes into contact with the metal at *G*. As the gas is generated it rises through the liquid and soon fills the space at the top of tank *A*. Continued liberation of gas causes pressure to be set up in tank *A*, which results in forcing a portion of the liquid up through pipe *J* into upper compartment *B* of the generator. In case none of the gas is drawn off through valve *H*, more and more of the liquid will be driven up into tank *B* until the level of the liquid in tank *A* has fallen below the level of grating *F*, with the result that metal *G* is removed from contact with the acid, which causes the generation of hydrogen to be automatically stopped.

Should it happen, however, that any of the metal *G* falls through the grating into the bottom of tank *A*, generation of hydrogen will continue until the piece of metal is entirely oxidized. This continued generation of hydrogen will result in driving the liquid up through pipe *J* into upper compartment *B* until the lower end of pipe *J* is uncovered. This will allow hydrogen to escape through pipe *J* into the upper compartment of the generator, from which it escapes through vent *M* provided for that purpose. Vent *M* also provides for the escape or entrance of air as the liquid enters or leaves compartment *B*. In this way pressure is maintained upon the hydrogen gas, the amount of pressure being determined by the difference of level of the liquid in compartments *A* and *B* of the generator. The arrangement is such that the pressure is usually a little over one pound per square inch. When all of the liquid is forced up into compartment *B*, the pressure will naturally be somewhat higher than it is when most of the liquid is in compartment *A*, but the maximum variation is not

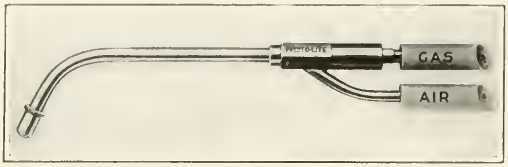


Fig. 5. Modern Lead Burning Torch which uses Acetylene and Air

more than eight or nine ounces and exerts little effect upon the action of the flame at the welding point.

When hydrogen gas is drawn off from tank A, especially if it is drawn off faster than the gas is being generated, liquid flows down through pipe J into the lower compartment A, so that the action of the generator is entirely automatic as long as the supply of metal G and dilute sulphuric acid lasts. Vent tube M may be closed with a pipe cap through which several small holes have been drilled, to prevent large pieces of dirt and insects from finding their way into the tanks.

Since the development of the method of generating acetylene by the chemical reaction of calcium carbide and water, the apparatus used for lead burning has been materially simplified by the substitution of acetylene gas for hydrogen. In the most modern lead burning outfits, the blower or pump for supplying the necessary amount of air has also been dispensed with and a tank of compressed air is substituted, which has a suitable reducing valve to regulate the pressure. Figs. 5 and 6 illustrate a modern lead burning torch and a complete lead burning outfit, respectively, these equipments being of the type manufactured by the Prest-O-Lite Co. of Indianapolis, Ind. Fig. 6 shows a regular oxy-acetylene welding outfit provided with a bench regulating block, acetylene and oxygen tanks, and suitable reducing valves. To change this outfit for use in lead burning, the oxygen cylinder is replaced by a tube of compressed air or the torch may be supplied with air by any convenient method. The ordinary welding torch may be used, or a more simple torch may be employed. Fig. 5 shows a torch of simple design, especially intended for use in lead burning operations; it is not provided with the adjusting valve required on the oxy-acetylene torch, and the combustion of acetylene is effected by supplying air to the torch in place of pure oxygen. This reduces the intensity of the temperature of the flame to such a degree that it is suitable for melting lead without causing excessive oxidation or danger of melting the metal too rapidly.

Fig. 6. Complete Lead Burning Outfit in which Air and Acetylene are used

DESIGN OF BACK-GEARS

BY M. R. BOWERMAN*

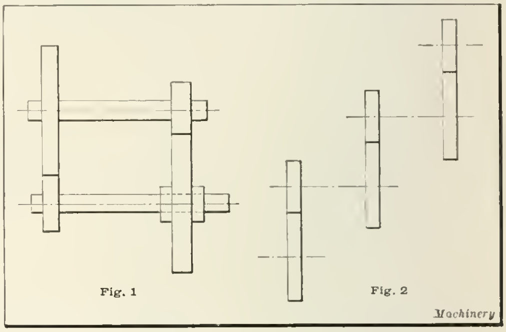
The following method will be found useful for determining the number of teeth in each of the gears of a back-geared train, or in any other train of gears where the center distance is the same for each pair of wheels. The method is based on the assumption that the pitch of the teeth is the same for all pairs of gears. Suppose it is desired to determine the number of teeth for each of the gears in a set of back-gears which are to have a ratio of $\frac{1}{N}$. The familiar arrangement of a set of back-gears is shown diagrammatically in Fig. 1, and to determine the number of teeth for the wheels, the required ratio $\frac{1}{N}$ is factored into two equivalent ratios as follows:

$$\frac{1}{N} = \frac{1}{O} \times \frac{1}{P}$$

The sum of the number of teeth in either pair of wheels is given by the following formula:

Number of teeth $= K\ (O + 1) \times (P + 1)$.

The value of the factor K is such that for the smallest sizes



Figs. 1 and 2. Back-geared and Triple-geared Drives with Constant Center Distance

of gears which can be used, it will reduce the product $(O + 1) \times (P + 1)$ to a whole number. There will, of course, frequently be a minimum limit to the size of the smallest gear which will call for the use of a higher value of K than that which is actually required to reduce the preceding product to an integral number.

The use of this method will be better understood by illustrating its application in an actual problem of gear design. *Example 1:* Suppose it is required to design a set of back-gears which have a ratio of $\frac{1}{56}$. Factoring this ratio, we obtain $\frac{1}{56} = \frac{1}{7} \times \frac{1}{8}$. The sum of the number of teeth in either pair of gears is 1 $(7 + 1) \times (8 + 1) = 72$. $\frac{72}{7+1} = 9$ = number of teeth in one pinion. The number of teeth in the mate for this pinion is $72 - 9 = 63$. $\frac{72}{8+1} = 8$ = number of teeth in the other pinion. The number of teeth in the mate for this pinion is $72 - 8 = 64$. As a check of the accuracy of this solution, the following proof may be employed: $9 + 63 = 8 + 64 = 72$, which is the sum of the number of teeth in each pair of gears; and $\frac{9}{63} \times \frac{8}{64} = \frac{1}{56}$, which is the required ratio for the back-gear.

The following explains the use of the method in a case where it is necessary to employ a fractional value for the factor K in order to obtain an integral value for the sum of the

* Address: Department of Applied Mechanics and Machine Design, Kansas State Agricultural College, Manhattan, Kan.

number of teeth in either pair of gears:

Example 2: Suppose the required ratio of gears is $\frac{1}{17}$. To factor this fraction, it is necessary to multiply and divide by some number, say 5; and using $2\frac{1}{2}$ as the value of K, the sum of the number of teeth in each pair of gears is found to be:

$$2\frac{1}{2}\left(\frac{17}{5}+1\right)\times(5+1)=\frac{5}{2}\times\frac{22}{5}\times 6=66.\quad \frac{66}{\frac{22}{5}}=15=$$

number of teeth in one pinion. The number of teeth in the mate of this pinion is $66-15=51$. $\frac{66}{6}=11=$ number of teeth in the other pinion; and $66-11=55=$ number of teeth in the mate of this pinion. As a check on the accuracy of the result, we have $15+51=11+55=66$; and $\frac{15}{51}\times\frac{11}{55}=\frac{1}{17}$, which is the required ratio.

The same method may be employed in determining the numbers of teeth in the gears of a train composed of any number of pairs of wheels, provided the center distances are the same for all pairs of wheels. Such a condition is shown in Fig. 2 for a train composed of three pairs of gears, and the following example explains the use of the method in determining the numbers of teeth in each of the wheels in the transmission shown in this illustration:

Example 3: Suppose the required ratio of train is $\frac{1}{79}$. To factor, we multiply and divide by 16 and obtain $\frac{1}{4}\times\frac{1}{4}\times\frac{16}{79}$. Using the value of $\frac{16}{25}$ for the value of factor K, the sum of the numbers of teeth in each pair of wheels is found to be

$$\frac{16}{25}(4+1)(4+1)\left(\frac{79}{16}+1\right)=95.$$

Then following the method of procedure already explained in Example 2, we find the following values for the three pairs of gears which compose the train: $\frac{19}{76}$, $\frac{19}{76}$ and $\frac{16}{79}$.

In case gears of different pitches are to be used for the different pairs of wheels in a train, the numbers of teeth may be calculated by the above method by first assuming the same pitch for all of the gears in the train. For the required pitch, the number of teeth in each pair of wheels is then obtained by multiplying the previously determined value of the number of teeth by the ratio of the assumed diametral pitch to the diametral pitch which it is required to employ.

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PRACTICAL APPLICATION OF THE METRIC SYSTEM

During the past year the metric system of measurement has been used to a much greater extent than formerly in the United States, due to the manufacture of munitions of war for European nations employing this system. For this reason it may be of value to give a few of the principal facts relating to the application of the metric system in practical shop and drafting-room work. In doing so, we are concerned primarily with the metric system of length measurements, as this is the only part of the system with which the draftsman and machinist come into direct contact.

The United States by an Act of Congress in 1866 legalized the metric system of weights and measures in this country, and it is one of the most peculiar paradoxes that the metric system is the only one that is legalized by Congress for use in this country. In legalizing the system, Congress decided that one meter is equal to 39.37 inches. There is a slight discrepancy between this value and that considered as the Imperial British standard, which according to the *Encyclopaedia Brittanica*, Volume XXVIII, page 489, makes one meter equal to 39.370113 inches. For ordinary practical work, however, this difference is not great enough to be of any importance. Nevertheless, it is a peculiar state of affairs that Congress decided upon an equivalent for the meter different from that recognized by the rest of the world.

The length units of the metric system that are most generally used in connection with any work relating to mechanical engineering are the meter (39.37 inches), the centimeter (0.3937 inch), and the millimeter (0.03937 inch). One meter equals 100 centimeters or 1000 millimeters. The decimeter is not commonly used as a length measurement. On mechanical drawings all dimensions are generally given in millimeters, no matter how large they may be. In fact, dimensions of such machines as locomotives and large electrical apparatus are given exclusively in millimeters. This practice is adopted to avoid mistakes due to misplacing decimal points, or misreading dimensions if other units are used as well. When dimensions are given in millimeters, the majority can be given without resorting to decimal points, as a millimeter is only a trifle more than 1/32 inch. Only dimensions of precision need be given in decimals of a millimeter; such dimensions are generally given in hundredths of a millimeter—for example, 0.02 millimeter, which is equal to 0.0008 inch. As 0.01 millimeter is equal to 0.0004 inch, it is seldom that dimensions would be given with greater accuracy than to hundredths of a millimeter.

Drawings made to the metric system are not made to scales of ½, ¼, ⅛, etc., as in the case of drawings made to the English system. If the object cannot be drawn full size, it is generally drawn one-fifth size, and, if this is too large, it is drawn one-tenth size. In exceptional cases, when very large objects are to be shown on a drawing, scales of one-twentieth, one-fiftieth, and one-one-hundredth may be used.

Small tools, such as taps, dies, drills, reamers, etc., are made to the metric system by practically all the small tool manufacturers in the United States. There are two standard systems for screw threads based on metric measurements, known, respectively, as the French and the International systems. Tables giving diameters and pitches and all other necessary information relating to this screw thread system will be found in standard handbooks on machine shop practice (see MACHINERY'S HANDBOOK, pages 1018 to 1020, inclusive). Lists of drills made to the metric system are given in the catalogues of the drill manufacturers. Reamers are also obtainable in metric measurements from the makers of these tools. The standard taper sockets generally used in the United States are frequently used in the countries employing the metric system. In Germany a movement was started a few years ago for the introduction of a metric taper shank and sockets for drills and other tools, but this standard has not been used extensively, because of the fact that so many American machine tools provided with the Morse and Brown & Sharpe taper sockets are in use in Europe.

Micrometers for measuring in millimeters are made by the leading makers of these tools in the United States. The divisions on the thimble or sleeve give hundredths of a millimeter. There is no difference in the use of a micrometer reading to the metric system and one reading to the English inch system, provided this value of the graduations is kept in mind. The metric system generally should be easily grasped by American mechanics, because it is based on the same units as our monetary system. It should be just as easy to figure in millimeters and hundredths of a millimeter as to figure in dollars and cents.

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At a colliery in Rutherglen, Scotland, there was, until recently, an old "atmospheric" engine in use. The engine had been at work at the colliery for hoisting coal since it was erected in 1809. During that time, no part had been renewed, with the exception of two spur gears which were broken by accident. The engine was superseded by one of modern construction a few months ago, and was then the oldest engine in use in Scotland, and the only one of the "atmospheric" type in use in Great Britain. The engine was offered to the city of Glasgow with the understanding that it would be placed in one of the parks, and it now constitutes one of the interesting sights in Kelvingrove Park, Glasgow.

WOODRUFF KEYS AND KEYWAYS

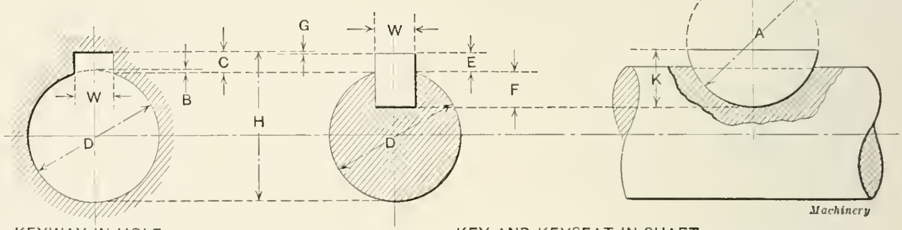
The efficient way of managing a manufacturing plant is to furnish from the designing department or drafting-room all data required for producing a part, leaving nothing to be decided by the operator or foreman that can be simply and clearly expressed on a blueprint. The Frost Gear & Forge Co., Jackson, Mich., issues blueprints of Woodruff keys and keyways to its workmen carrying the data that is reproduced in Tables I and II.

It will be noted that in Table I the dimensions have been computed and tabulated for keys and keyways suitable for shaft diameters from ½ to 2 inches diameter, inclusive. The clearance G between the top of the key and the keyway is 0.005 inch for all shafts up to one inch diameter, and 0.008 inch for all shafts of one inch to two inches diameter. These clearances are allowed for in the table. The depths E and F are given for the various sizes of keys as applied to shafts of varying diameters, and also the distance B between the tangent and the corner of the shaft next to the key. Hence when sinking a keyway, the proper depth can be measured with a micrometer on the lifting screw, starting with the cutter tangent to the shaft. The data in Table I is given in separate columns for keys Nos. 2 and 4; 3, 5, and 7; etc.

Now, for example, what are the essential data for the key and keyseat in a one-inch shaft and hub, the key being a No. 5? The diameter of cutter A is ⅝ inch; the width W of key, ⅛ inch; height E from corner of shaft to top, 1/16 or 0.0625 inch; depth F 0.188 inch; total height K of key, ¼ inch; height B from corner of shaft to tangent, 0.0039 inch; depth C of keyway in hub from corner, 0.071 inch; total dimension H in hub from bottom of keyway to opposite wall of bore, 1.0671 inch. In this case of a one-inch shaft the clearance G is 0.008 inch. Hence the dimension H is composed as follows: $E + G - B + D + 0.0005$ (tolerance of shaft in hub), or $0.0625 + 0.008 - 0.0039 + 1.0000 + 0.0005 = 1.0671$ inch.

Table II gives the dimensions of cutters from Nos. 1 to 36, inclusive of those designated by the letters A, B, C, D, E, F, G, R, S, T, U, and V. Both tables are excellent examples of the kind of data that should be furnished by the designing department of the modern plant. Nothing is left to guesswork or inference; every essential dimension is given in plain figures so that the workman has no excuse for making mistakes.

TABLE I. DIMENSIONS OF WOODRUFF KEYWAYS AND KEYS



KEYWAY IN HOLE

KEY AND KEYSEAT IN SHAFT

Clearance G = 0.005" for holes up to 1" diameter
Clearance G = 0.008" for holes from 1" to 2" diameter

Allowance is made in table for clearance G

Diameter of Shaft	No. of Key	W = 3/32, E = 3/64			No. of Key	W = 1/8, E = 1/16			No. of Key	W = 5/32, E = 5/64			No. of Key	W = 3/16, E = 3/32			No. of Key	W = 7/32, E = 7/64		
		A	F	K		A	F	K		A	F	K		A	F	K		A	F	K
	2	½	0.156	13/64	3	½	0.141	13/64	6	⅝	0.172	¼	9	¾	0.219	5/16	12	⅞	0.266	⅜
	4	⅝	0.203	¼	5	⅝	0.188	¼	8	¾	0.234	5/16	11	⅞	0.281	⅜	14	1	0.328	7/16
	.	.	.....	..	7	¾	0.250	5/16	10	⅞	0.297	⅜	13	1	0.344	7/16	17	1⅛	0.375	31/64
	.	.	.....	..	.	.	.....	..	..	.	.....	..	16	1⅛	0.391	31/64	20	1¼	0.438	35/64
	.	.	.....	..	.	.	.....	..	..	.	.....	..	19	1¼	0.453	35/64	..	.	.....	..
	.	.	.....	..	.	.	.....	..	..	.	.....	..	26	2⅛	0.438	17/32	..	..	.....	..

D	B	C	H	B	C	H	B	C	H	B	C	H	B	C	H
½	0.0044	0.052	0.5476	0.0079	0.068	0.5601	0.0125	0.083	0.5705	0.0183	0.099	0.5807	0.0252	0.114	0.5888
9/16	0.0039	0.052	0.6106	0.0070	0.068	0.6235	0.0111	0.083	0.6344	0.0161	0.099	0.6454	0.0221	0.114	0.6544
⅝	0.0035	0.052	0.6735	0.0063	0.068	0.6867	0.0100	0.083	0.6980	0.0144	0.099	0.7096	0.0198	0.114	0.7192
11/16	0.0032	0.052	0.7363	0.0057	0.068	0.7498	0.0090	0.083	0.7615	0.0130	0.099	0.7735	0.0179	0.114	0.7836
¾	0.0030	0.052	0.7990	0.0052	0.068	0.8128	0.0082	0.083	0.8248	0.0119	0.099	0.8371	0.0163	0.114	0.8477
13/16	0.0028	0.052	0.8617	0.0048	0.068	0.8757	0.0076	0.083	0.8879	0.0110	0.099	0.9005	0.0150	0.114	0.9115
⅞	0.0025	0.052	0.9245	0.0045	0.068	0.9385	0.0070	0.083	0.9510	0.0100	0.099	0.9640	0.0139	0.114	0.9751
15/16	0.0024	0.052	0.9871	0.0042	0.068	1.0013	0.0065	0.083	1.0140	0.0094	0.099	1.0271	0.0129	0.114	1.0386
1	0.0022	0.055	1.0528	0.0039	0.071	1.0671	0.0061	0.086	1.0799	0.0089	0.102	1.0931	0.0121	0.117	1.1049
1 1/16	0.0021	0.055	1.1154	0.0037	0.071	1.1298	0.0058	0.086	1.1427	0.0083	0.102	1.1562	0.0114	0.117	1.1681
1⅛	0.0020	0.055	1.1780	0.0035	0.071	1.1925	0.0055	0.086	1.2055	0.0080	0.102	1.2190	0.0107	0.117	1.2313
1 3/16	0.0018	0.055	1.2406	0.0033	0.071	1.2552	0.0051	0.086	1.2684	0.0075	0.102	1.2820	0.0102	0.117	1.2943
1¼	0.0017	0.055	1.3033	0.0031	0.071	1.3179	0.0049	0.086	1.3311	0.0071	0.102	1.3449	0.0096	0.117	1.3574
1 5/16	0.0016	0.055	1.3658	0.0030	0.071	1.3805	0.0047	0.086	1.3938	0.0067	0.102	1.4078	0.0092	0.117	1.4203
1⅜	0.0016	0.055	1.4284	0.0029	0.071	1.4431	0.0045	0.086	1.4565	0.0065	0.102	1.4705	0.0088	0.117	1.4832
1 7/16	0.0015	0.055	1.4909	0.0027	0.071	1.5058	0.0043	0.086	1.5192	0.0064	0.102	1.5331	0.0084	0.117	1.5461
1½	0.0015	0.055	1.5535	0.0026	0.071	1.5684	0.0041	0.086	1.5819	0.0059	0.102	1.5961	0.0080	0.117	1.6090
1 9/16	0.0014	0.055	1.6161	0.0025	0.071	1.6310	0.0039	0.086	1.6446	0.0056	0.102	1.6589	0.0077	0.117	1.6718
1⅝	0.0014	0.055	1.6886	0.0024	0.071	1.6936	0.0038	0.086	1.7072	0.0054	0.102	1.7216	0.0074	0.117	1.7346
1 11/16	0.0013	0.055	1.7412	0.0023	0.071	1.7562	0.0036	0.086	1.7699	0.0052	0.102	1.7843	0.0071	0.117	1.7974
1¾	0.0013	0.055	1.8037	0.0022	0.071	1.8188	0.0035	0.086	1.8325	0.0051	0.102	1.8469	0.0069	0.117	1.8601
1 13/16	0.0012	0.055	1.8663	0.0021	0.071	1.8814	0.0034	0.086	1.8951	0.0049	0.102	1.9096	0.0066	0.117	1.9229
1⅞	0.0012	0.055	1.9288	0.0021	0.071	1.9439	0.0033	0.086	1.9577	0.0047	0.102	1.9723	0.0064	0.117	1.9856
1 15/16	0.0011	0.055	1.9914	0.0020	0.071	2.0065	0.0032	0.086	2.0203	0.0045	0.102	2.0350	0.0062	0.117	2.0483
2	0.0010	0.055	2.0540	0.0020	0.071	2.0690	0.0031	0.086	2.0829	0.0044	0.102	2.0976	0.0060	0.117	2.1110

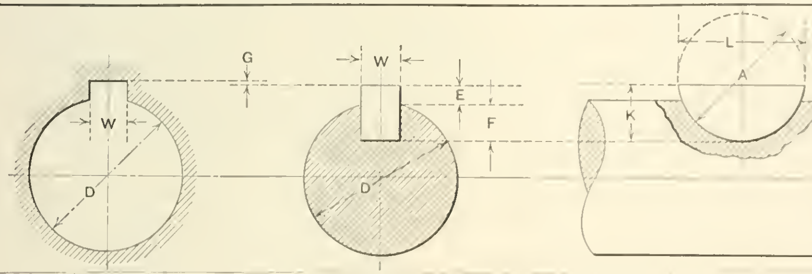
Machinery

TABLE I. DIMENSIONS OF WOODRUFF KEYWAYS AND KEYS—(Continued)

No. of Key	W = 1/4 E = 1/8 A	F	K	No. of Key	W = 5/16 E = 5/32 A	F	K	No. of Key	W = 3/8 E = 3/16 A	F	K	No. of Key	W = 7/16 E = 7/32 A	F	K	No. of Key	W = 1/2 E = 1/4 A	F	K
A	7/8	0.250	3/8	..	..	.....	..	..	..	.....	..	..	..	.....	..	..	..	.....	..
15	1	0.313	7/16	B	1	0.281	7/16	E	1 1/4	0.359	35/64	U	2 3/4	0.531	3/4	V	2 3/4	0.500	3/4
18	1 1/8	0.359	31/64	C	1 1/8	0.328	31/64	F	1 3/8	0.406	19/32	31	3 1/2	0.719	13/16	32	3 1/2	0.688	13/16
21	1 1/4	0.422	35/64	D	1 1/4	0.391	35/64	G	1 1/2	0.453	41/64	..	..	....			.	.....	..
22	1 3/8	0.469	19/32	23	1 3/8	0.438	19/32	29	2 1/8	0.344	17/32	..	..	....			..	.....	..
24	1 1/2	0.516	41/64	25	1 1/2	0.484	41/64	T	2 3/4	0.563	3/4	.				..		...	
27	2 1/8	0.406	17/32	28	2 1/8	0.375	17/32	30	3 1/2	0.750	13/16	..	..	...				...	
R	2 3/4	0.625	3/4	S	2 3/4	0.594	3/4	..	..	.....	..	..	..	.....	..	.	..	.....	..

Diameter of Shaft D	B	C	H	B	C	H	B	C	H	B	C	H	B	C	H
1/2	0.0325	0.130	0.5975	......	......	......	......	......	......	......	......	......	......	......	......
9/16	0.0289	0.130	0.6636	......	......	......	......	......	......	......	......	......	......	......	......
5/8	0.0254	0.130	0.7296	0.0413	0.161	0.7447	......	......	......	......	......	......	......	......	......
11/16	0.0236	0.130	0.7939	0.0379	0.161	0.8106	......	......	......	......	......	......	......	......	......
3/4	0.0220	0.130	0.8580	0.0346	0.161	0.8764	0.0511	0.1925	0.8914	......	......	......	......	......	......
13/16	0.0198	0.130	0.9227	0.0314	0.161	0.9421	0.0465	0.1925	0.9585	......	......	......	......	......	......
7/8	0.0177	0.130	0.9873	0.0283	0.161	1.0077	0.0420	0.1925	1.0255	0.0583	0.2237	1.0404	......	......	......
15/16	0.0164	0.130	1.0511	0.0264	0.161	1.0721	0.0392	0.1925	1.0908	0.0544	0.2237	1.1068	......	......	......
1	0.0152	0.133	1.1178	0.0246	0.164	1.1394	0.0365	0.1955	1.1590	0.0506	0.2267	1.1761	0.0670	0.258	1.1910
1 1/16	0.0143	0.133	1.1812	0.0228	0.164	1.2037	0.0342	0.1955	1.2238	0.0476	0.2267	1.2416	0.0625	0.258	1.2580
1 1/8	0.0136	0.133	1.2444	0.0210	0.164	1.2680	0.0319	0.1955	1.2886	0.0446	0.2267	1.3071	0.0581	0.258	1.3249
1 3/16	0.0131	0.133	1.3074	0.0204	0.164	1.3311	0.0304	0.1955	1.3526	0.0421	0.2267	1.3721	0.0551	0.258	1.3904
1 1/4	0.0127	0.133	1.3703	0.0198	0.164	1.3942	0.0290	0.1955	1.4165	0.0397	0.2267	1.4370	0.0522	0.258	1.4558
1 5/16	0.0123	0.133	1.4332	0.0191	0.164	1.4568	0.0279	0.1955	1.4801	0.0380	0.2267	1.5012	0.0499	0.258	1.5206
1 3/8	0.0120	0.133	1.4960	0.0185	0.164	1.5205	0.0268	0.1955	1.5437	0.0364	0.2267	1.5653	0.0477	0.258	1.5853
1 7/16	0.0114	0.133	1.5591	0.0174	0.161	1.5841	0.0254	0.1955	1.6076	0.0346	0.2267	1.6296	0.0453	0.258	1.6502
1 1/2	0.0110	0.133	1.6220	0.0164	0.164	1.6476	0.0240	0.1955	1.6715	0.0328	0.2267	1.6939	0.0429	0.258	1.7151
1 9/16	0.0107	0.133	1.6848	0.0158	0.164	1.7107	0.0231	0.1955	1.7349	0.0309	0.2267	1.7583	0.0412	0.258	1.7793
1 5/8	0.0105	0.133	1.7475	0.0153	0.164	1.7737	0.0221	0.1955	1.7984	0.0291	0.2267	1.8226	0.0395	0.258	1.8435
1 11/16	0.0102	0.133	1.8103	0.0147	0.164	1.8368	0.0214	0.1955	1.8616	0.0282	0.2267	1.8860	0.0383	0.258	1.9072
1 3/4	0.0099	0.133	1.8731	0.0142	0.164	1.8998	0.0207	0.1955	1.9248	0.0274	0.2267	1.9493	0.0371	0.258	1.9709
1 13/16	0.0095	0.133	1.9360	0.0136	0.164	1.9629	0.0198	0.1955	1.9882	0.0265	0.2267	2 0127	0.0355	0.258	2.0350
1 7/8	0.0093	0.133	1.9987	0.0130	0.164	2.0260	0.0190	0.1955	2.0515	0.0257	0.2267	2 0760	0.0339	0.258	2.0991
1 15/16	0.0090	0.133	2.0615	0.0127	0.164	2.0888	0.0184	0.1955	2.1146	0.0250	0.2267	2.1392	0.0328	0.258	2.1627
2	0.0088	0.133	2.1242	0.0124	0.164	2.1516	0.0179	0.1955	2.1776	0.0243	0.2267	2 2024	0.0317	0.258	2.2263

TABLE II. DIMENSIONS OF WOODRUFF KEYWAYS AND KEYS



No. of Key and Cutter	Diameter of Key A	Thickness of Key W	Depth in Shaft F	Height Above Shaft E	Height of Key K	Length of Key L	No. of Key and Cutter	Diameter of Key A	Thickness of Key W	Depth in Shaft F	Height Above Shaft E	Height of Key K	Length of Key L
1	1/2	1/16	.172	1/32	13/64	1/2	D	1 1/4	5/16	.391	5/32	35/64	1 1/4
2	1/2	3/32	.156	3/64	13/64	1/2	E	1 1/4	3/8	.359	3/16	35/64	1 1/4
3	1/2	1/8	.141	1/16	13/64	1/2	22	1 3/8	1/4	.469	1/8	19/32	1 3/8
4	5/8	3/32	.203	3/64	1/4	5/8	23	1 3/8	5/16	.438	5/32	19/32	1 3/8
5	5/8	1/8	.188	1/16	1/4	5/8	F	1 3/8	3/8	.406	3/16	19/32	1 3/8
6	5/8	5/32	.172	5/64	1/4	5/8	24	1 1/2	1/4	.516	1/8	41/64	1 1/2
7	3/4	1/8	.250	1/16	5/16	3/4	25	1 1/2	5/16	.484	5/32	41/64	1 1/2
8	3/4	5/32	.234	5/64	5/16	3/4	G	1 1/2	3/8	.453	3/16	41/64	1 1/2
9	3/4	3/16	.219	3/32	5/16	3/4	26	2 1/8	3/16	.438	3/32	17/32	1 21/32
10	7/8	5/32	.297	5/64	3/8	7/8	27	2 1/8	1/4	.406	1/8	17/32	1 21/32
11	7/8	3/16	.281	3/32	3/8	7/8	28	2 1/8	5/16	.375	5/32	17/32	1 21/32
12	7/8	7/32	.266	7/64	3/8	7/8	29	2 1/8	3/8	.344	3/16	17/32	1 21/32
A	7/8	1/4	.250	1/8	3/8	7/8	R	2 3/4	1/4	.625	1/8	3/4	2 1/16
13	1	3/16	.344	3/32	7/16	1	S	2 3/4	5/16	.594	5/32	3/4	2 1/16
14	1	7/32	.328	7/64	7/16	1	T	2 3/4	3/8	.563	3/16	3/4	2 1/16
15	1	1/4	.313	1/8	7/16	1	U	2 3/4	7/16	.531	7/32	3/4	2 1/16
B	1	5/16	.281	5/32	7/16	1	V	2 3/4	1/2	.500	1/4	3/4	2 1/16
16	1 1/8	3/16	.391	3/32	31/64	1 1/8	30	3 1/2	3/8	.750	3/16	13/16	2 7/8
17	1 1/8	7/32	.375	7/64	31/64	1 1/8	31	3 1/2	7/16	.719	7/32	13/16	2 7/8
18	1 1/8	1/4	.359	1/8	31/64	1 1/8	32	3 1/2	1/2	.688	1/4	13/16	2 7/8
C	1 1/8	5/16	.328	5/32	31/64	1 1/8	33	3 1/2	9/16	.656	9/32	13/16	2 7/8
19	1 1/4	3/16	.453	3/32	35/64	1 1/4	34	3 1/2	5/8	.625	5/16	13/16	2 7/8
20	1 1/4	7/32	.438	7/64	35/64	1 1/4	35	3 1/2	11/16	.594	11/32	13/16	2 7/8
21	1 1/4	1/4	.422	1/8	35/64	1 1/4	36	3 1/2	3/4	.563	3/8	13/16	2 7/8

FOUR-GEAR EPICYCLIC TRAINS

BY M. TERRY*

The subject of epicyclic gearing is treated to some extent in nearly every textbook and handbook on machine design. In general, after explaining certain rules to be followed in figuring the ratios of the various forms of trains and citing a few practical applications of this type of gearing, the subject is considered exhausted. None of the books that have come to the writer's attention even hint at the incredibly large reduction ratios that are possible with a simple four-spur-gear train, consisting of two central gears, one of which is stationary, and one arm carrying two planetary gears, as shown in Fig. 2.

The nearest approach to the system about to be described can be found in the imperfect mechanism, shown in Fig. 1, described by some writers. Referring to this illustration, *B* is a wide faced pinion having 15 teeth, which meshes with both gears *C* and *D* having 30 and 29 teeth, respectively. Pinion *B* is carried by the arm *A* that is cast integral with the driving pulley which is free to turn about shaft *S*. Gear *D* is keyed to this shaft, and gear *C* is the stationary gear. As arm *A* revolves about shaft *S*, pinion *B*, being in mesh with the stationary gear *C*, is compelled to revolve about its own axis of rotation O–O. If arm *A* makes exactly one revolution, pinion *B* is compelled to engage every one of the 30 teeth on gear *C*; and in doing so, pinion *B* itself makes exactly two revolutions about O–O. At the same time, the teeth of pinion *B* come into engagement with 30 teeth on gear *D*; and as gear *D* has only 29 teeth, it is naturally compelled to move in a direction opposite to the rotation of arm *A* to make good for the difference of one tooth. Thus, for every revolution of arm *A*, gear *D* is advanced one tooth, and it will take 29 revolutions of arm *A* to produce one turn of the shaft *S*; the reduction ratio, then, of this particular train is 29 to 1. It will be observed from the preceding that for very large reduction ratios, gears *C* and *D* must have a large number of teeth. Another inherent limitation of this mechanism lies in the fact that gears *B* and *D* do not mesh on their correct pitch circles, which is productive of both noise and excessive wear, especially if the driving pulley runs at high speed.

Fig. 2 shows a four-gear epicyclic train; *D* is the stationary gear; *B* is pressed on shaft *E* which is integral with gear *C*; *A* is keyed to shaft *S*. The mechanism is encased in a housing made in the form of a hollow pulley, making a compact, dustproof and oil-tight arrangement. Shaft *E* is free to turn in its bearings, which are bored in one setting, after the two halves of the housing are doweled and fastened together by means of six screws. Gear *A* has 59 teeth, 20 pitch; gear *B* has 21 teeth, 20 pitch; gear *C* has 19 teeth, 18 pitch; and gear *D* has 53 teeth, 18 pitch.

$\frac{59 + 21}{2} \div 20 = 2$ inches = center to center distance of gears *A* and *B*.

* Address: 1003 Manning St., Flint, Mich.

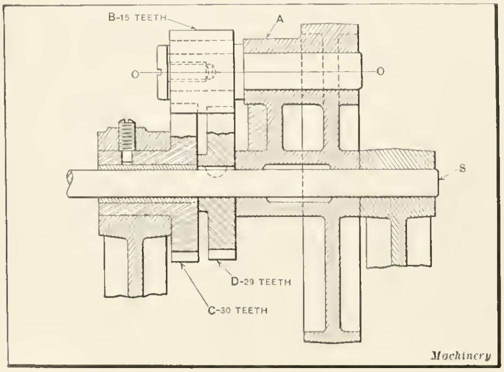


Fig. 1. Epicyclic Gear consisting of Two Central Gears (One stationary) and Arm which carries Wide Faced Planetary Gear

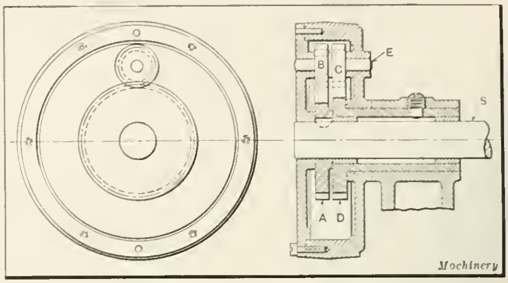


Fig. 2. Epicyclic Gear Train consisting of Two Central Gears (One of which is stationary) and an Arm which carries Two Planetary Gears

$\frac{53 + 19}{2} \div 18 = 2$ inches = center to center distance of gears *C* and *D*.

In other words, the two sets of gears are so proportioned as to insure correct engagement of their teeth. To find the ratio of this train we have: $\frac{53}{19} \times 21 = 58.58$, which is the number of teeth on gear *A* that gear *B* passes in one complete revolution of the housing. Since gear *A* has 59 teeth, it is compelled to advance the difference or $59 - 58.58 = 0.42$ tooth in the same direction as the rotation of the housing. The number of turns of the pulley that will produce one turn of shaft *S* is $\frac{59}{0.42} = 140$, and 140 to 1 is the ratio of the train.

This design is superior to the one shown in Fig. 1 for the following reasons: First, because it is mechanically perfect; and second, because high reduction ratios can be obtained with gears having comparatively few teeth. The possibility of obtaining high ratios lies in proportioning the gears, both in pitch and number of teeth, so as to compel the last of the train to advance a fraction of a tooth for one turn of the driver. Coming back to the design shown in Fig. 2, it may be stated that this mechanism has been actually built at a smaller cost than a worm and gear drive having the same ratio. The pulley housing was made about 1½ inch wide by 6 inches in diameter. To show the possibilities of this type of transmission, examples of two more trains, both of which are mechanically perfect, will be given.

First Train: *A* has 71 teeth, 14 pitch; *B* has 69 teeth, 14 pitch; *C* has 59 teeth, 12 pitch; *D* has 61 teeth, 12 pitch.

$\frac{71 + 69}{2} \div 14 = 5$ inches = distance between centers;

$\frac{59 + 61}{2} \div 12 = 5$ inches = distance between centers;

$\frac{61}{59} \times 69 = 71.34$;

$71.34 - 71 = 0.34$;

$71 \div 0.34 = 209$; and 209 to 1 is the reduction ratio.

Second Train: *A* has 63 teeth, 16 pitch; *B* has 65 teeth, 16 pitch; *C* has 61 teeth, 15 pitch; *D* has 59 teeth, 15 pitch.

$\frac{63 + 65}{2} \div 16 = 4$ inches = distance between centers;

$\frac{61 + 59}{2} \div 15 = 4$ inches = distance between centers;

$\frac{59}{61} \times 65 = 62.87$;

$63 - 62.87 = 0.13$;

$63 \div 0.13 = 484$; and 484 to 1 is the reduction ratio.

It must not be assumed that the utility of this type of train is confined to cases requiring high ratios only, for low ratios are most readily obtained.

* * *

The man who will not listen to the safety rules, may have to hear the ambulance bell.

LAYING OUT CYCLOIDAL PUMP IMPELLERS

BY GUS LUCK*

The graphical method of developing cycloidal pump impellers is not desirable because it is difficult to secure highly accurate results in that way. The following article describes a simple mechanical method of development which enables the work to be done rapidly and results in the production of a perfect cycloidal form. Figs. 1, 2 and 3 show two-, three-, and four-tooth impellers of 4 inches pitch diameter, that were developed with this device, and it may be mentioned in this connection that the three-tooth impeller is the one most generally used. Fig. 4 shows the generating device. In this illustration *A* is a gear of exactly the same pitch diameter as that of the impeller to be generated. This gear meshes with rack *B* and is guided by a tongue which enters the groove in plate *C;* this plate also has a T-slot located at right angles to the groove, which carries the sliding nut that supports pin *D* on which gear *A* revolves.

The 1/32-inch sheet metal plate *E* is slipped over pin *D* and held in place by a pin or screw to insure its revolving with gear *A*. Form *F*, which is the rack model of the cycloidal impeller that is to be developed, is fastened to rack *B* so that it is outside of plate *E* and so that the pitch line of form *F* exactly corresponds to the pitch line of the rack. When rack *B* is moved by the rotation of gear *A*, it will be evident that the position of form *F* is correspondingly changed. A sharp scriber or scratch-awl is used to trace the outline of form *F* on plate *E* for each slight movement of gear *A* and rack *B*, the operation being continued until one of the teeth of the impeller has been completely outlined.

Then by turning gear *A* so that plate *E* has been moved through 1/3 revolution for a three-tooth impeller, the second tooth can be laid out, after which the third tooth is outlined in the same way. A templet is thus obtained of the form shown in Fig. 2. It will be readily seen that the number of teeth in the gear should be divisible by 3 in the case of a three-tooth impeller, and experience has shown that 48 teeth of 12 pitch make a very satisfactory gear. In laying out a templet, it is sufficient to outline one of the impeller teeth for use in making the forming tool for turning the milling cutter. Fig. 6 shows a cutter for generating a three-tooth impeller of 4 inches pitch diameter.

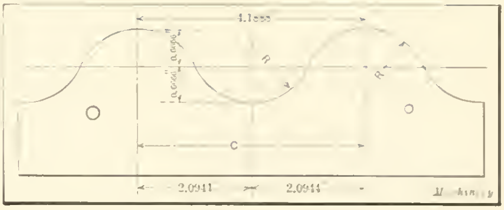
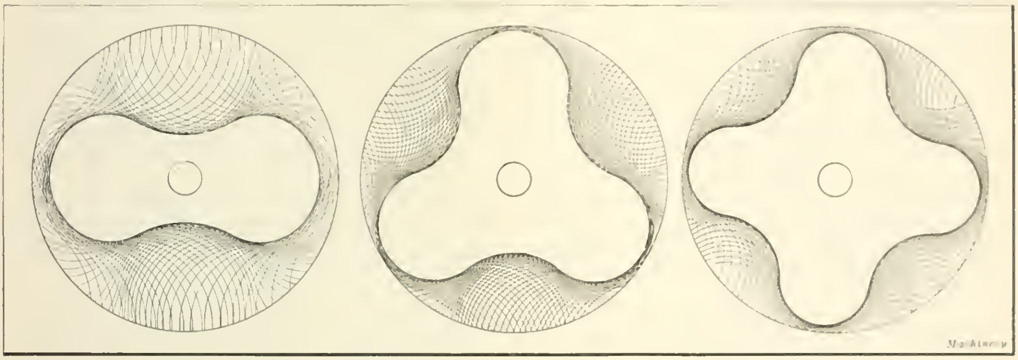


Fig. 5. Master Form for developing a Three-tooth Impeller of 4 inches Pitch Diameter

Great care should be taken to follow the outline accurately in cutting out the templet, in order to produce a templet and milling cutter that will cut an accurate impeller. It will be noticed that the addendum and dedendum are equal and that no clearance is allowed. It will, of course, be understood that the templet laid out in this way is used in making a master forming tool for turning the blank for the milling cutter with which the teeth of the cycloidal impellers are cut.



Figs. 1 to 3. Two-, Three- and Four-tooth Impellor Outlines developed by Mechanical Means

By definition, a cycloid is the curve generated by a point on the circumference of a circle when the circle is rolled on a straight line. For a generating circle 1 inch in diameter, a complete cycloid is generated when the circle rolls through a distance of 3.1416 inches along the line, *i. e.*, a distance equal to the circumference of a circle of 1 inch diameter. An epicycloid is the curve generated by a point on the circumference of a circle when rolled on the outside of a circle called the fundamental circle. Similarly, a hypo-cycloid is the curve generated by a point on the circumference of the generating circle when rolled on the inside of the fundamental circle. On cycloidal impellers, each tooth of the impeller is composed of one complete epicycloidal curve and two halves of one complete hypo-cycloidal curve. It will be seen from Figs. 1 to 3 that the addendum and the dedendum of the impeller teeth are equal, no clearance being allowed.

The following explains the method of determining the form of the templet used on the fixture for laying out the templet employed in making the master forming tool for turning the milling cutter blank. The diameter *D* of the generating circle is obtained from the following formula:

$$D = \frac{P\pi}{2\pi N} = \frac{P}{2N}$$

where P = pitch diameter of impeller;
N = number of teeth in impeller.

* Address: 1140 National Ave., Milwaukee, Wis.

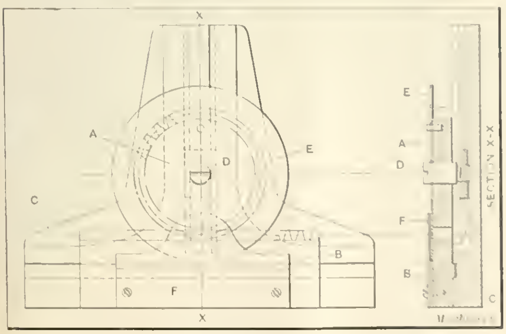


Fig. 4. Device for Use in Mechanical Development of Pump Impeller Outlines

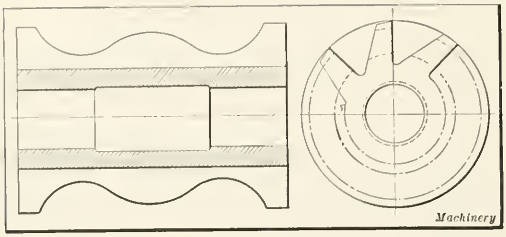


Fig. 6. Milling Cutter for producing Three-tooth Impeller of 4 inches Pitch Diameter

As it can readily be seen that the portion of the circumference of the impeller included in a distance equal to the circular pitch is made up of two halves of an epicycloid and one complete hypo-cycloid, it follows that the circular pitch of the master templet and of the impeller must be equal to twice the circumference of the generating circle, because these curves are obtained by rolling the generating circle on the outside and on the inside of arcs of the fundamental circle, which are each equal in length to the circumference of the generating circle.

The following example will assist the reader to understand the principles set forth. Suppose it is required to find the diameter of a generating circle for a three-tooth impeller of 4 inches pitch diameter:

$$D = \frac{P}{2N} = \frac{4}{2 \times 3} = 0.6666 \text{ inch} = \text{diameter of generating circle.}$$

The outside diameter O of the impeller is:

$$O = P + 2D$$

The root diameter R of the impeller is:

$$R = P - 2D$$

The dimensions of the form for use on the fixture (Fig. 4) for laying out a templet for the milling cutter for a three-tooth cycloidal impeller of 4 inches pitch diameter are given in Fig. 5, and the following explains the method of determining these dimensions: The circular pitch must be exactly equal to the circular pitch of the impeller and the addendum and dedendum must each be equal to the diameter of the generating circle. The circular arcs of which the outline of the templet is composed are struck from the centers of the teeth and spaces, as shown in Fig. 5, and they are of such a radius of curvature that they will be tangent to the pitch line at the center of the circular pitch. The radius R of the arcs is determined by the following formula:

$$R = \frac{\left(\frac{C}{2}\right)^2 + 4\,D^2}{8\,D}$$

where C = circular pitch of impeller;

D = pitch diameter of generating circle.

Fig. 7 shows in diagrammatical form the theoretical way in which the epicycloid and hypo-cycloid curves of an impeller are obtained by rolling the generating circle on the outside and inside of the fundamental circle. This diagram is for an impeller of 4-inch pitch diameter and corresponds to the templet shown in Fig. 5. Similar diagrams for impellers of any given pitch diameter or number of teeth would be laid out with dimensions calculated according to the formulas given.

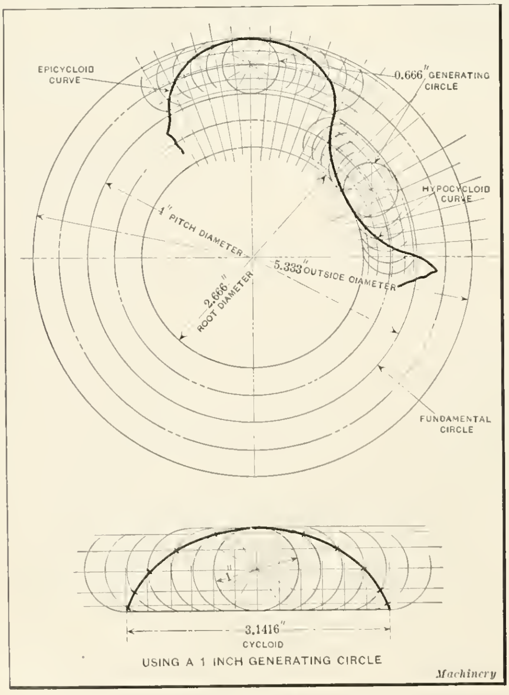


Fig. 7. Diagram showing Theoretical Method of producing Cycloid, Epicycloid and Hypo-cycloid Curves

* * *

WATCH SCREW THREADS

The accompanying table shows the number of threads per inch, the diameter of the thread, and the correct size of tap drill, for all the screws used in the watch movements made by the Waltham Watch Co., Waltham, Mass. Taps for these sizes may be obtained from the Waltham Watch Co. The number of threads is given as an even number per inch, but the diameter of the thread is measured in millimeters, the company employing the metric system. A column is given in the table, showing the diameter of the thread in inches and the diameter of the tap drill is also given in inches.

WATCH SCREW THREADS
(Waltham Watch Co. Standard)

No. of Tap	No. of Threads per Inch	Diam. of Thread, Millimeters	Diam. of Thread, Inches	Diam. of Tap Drill, Millimeters	Diam. of Tap Drill, Inches
1	110	1.50	0.0591	1.32	0.0520
3	110	1.20	0.0473	1.02	0.0402
5	120	1.10	0.0433	0.95	0.0374
7	140	1.00	0.0394	0.85	0.0335
9	160	0.93	0.0366	0.71	0.0280
11	170	1.34	0.0528	1.22	0.0481
13	180	1.00	0.0394	0.85	0.0335
15	180	0.83	0.0327	0.71	0.0280
17	200	0.65	0.0256	0.54	0.0213
19	220	0.55	0.0217	0.45	0.0177
21	240	0.45	0.0177	0.34	0.0134
23	254	0.35	0.0138	0.27	0.0106

Machinery

* * *

THE QUENCHING OF STEEL

Shipley N. Brayshaw in a lecture on "The Quenching of Steel," delivered before a recent meeting of the Huddersfield Engineering Society, Huddersfield, England, claimed that the age of water had a great deal to do with its quenching powers He also stated that some waters were more efficient than others and instanced the water of the River Don in Sheffield, which is carried away in barrels for quenching purposes, some of it even going to the United States. He did not state what peculiar properties the River Don water possessed.

Mr. Brayshaw discussed the properties which determine the value of any quenching liquid, and pointed out that the main items of consideration were specific gravity, specific heat, boiling point, conductivity and fluidity. He laid down as the ideal quenching medium one that was fluid from the temperatures of 100 degrees C. to 800 degrees C., of fairly high specific gravity and of fairly good specific heat. A quenching bath of this fluid would give a glassy hardness to tools, but the quenching should be carried out at such a temperature that the heat left in the parts would prevent breakage.

CUTTING AND DRAWING COMPOUNDS AND OILS

All metal cutting and grinding operations common to the machine shop can be done dry, but water or oil used as a coolant and lubricant lengthens the life of cutting tools, carries off the heat generated, and promotes general efficiency. The theory of the action of lubricants used for cutting operations is not altogether clear. It seems impossible that the point of a lathe tool deeply buried in steel can be lubricated by any compound flowing on the cut. It is clear, however, that the compound lubricates the chip and causes it to slide more easily off the heel of the tool. Most important probably is the fact that it reduces the temperature of the tool by carrying away the heat generated in displacing the chip.

Water alone is an excellent coolant, but its use is objectionable because it rusts the work and machines. Soda mixed with water prevents rusting and makes a compound that has some lubricating quality. Graphite and water in the colloidal form is also a very excellent lubricant and coolant and is free from rusting effect. Pure lard oil probably is the best lubricant for parting tools, screw cutting, screw machine operations, etc., but its cost is high and it presents some danger of infection of abrasions on the hands of operators. Soap-suds are excellent as a coolant and lubricant, and homemade soap compounds are much used. Soap solutions, soluble oils and other manufactured compounds placed on the market under various trade-names are cheap, effective and generally safe to use. The following list of cutting compounds and oils having distinguishing trade-names was compiled from information furnished by the various manufacturers whose names appear, and is given for general convenience in identifying cutting compounds and their makers.

Name	Manufacturer
A1	White & Bagley Co., Worcester, Mass.
Accrus	Internat'l Lubricants Co., Chicago.
Acme	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y
Advance	Advance G. & C. Co., Jackson, Mich.
Ajax	Phoenix Oil Co., Cleveland, Ohio.
A L A	A. L. A. Mfg. & Sup. Co., N. Y. City.
Amalie	L. Sonneborn Sons, Inc., N. Y. City.
American	American Oil Co., Jackson, Mich.
Amoco	American Oil Co., Jackson, Mich.
Anchor	Anchor Oil & Chem. Co., Cleveland, O.
Aquadag	Acheson Gr'ph'te Co., Ni'g'ra Falls
Aqualene	Crescent Oil Co., Inc., New York City.
Baker	Wm. T. Baker, Inc., Jersey City, N. J.
Baum	Baum's Castorine Co., Rome, N. Y.
Bison	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Buckeye	Moore Oil Co., Cincinnati, Ohio.
Cascade	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Challenge	Magic Bros., Chicago, Ill.
Climax Perfection	Climax Refining Co., Cleveland, Ohio.
Cookcom	N. B. Cook Oil Co., New York City.
Corliss	Corliss Supply Co., St. Louis, Mo.
Crescent	S. O. Co. of Ind., Chicago, Ill.
Cut-Rite	Phoenix Oil Co., Cleveland, Ohio.
Cutol	W. C. Robinson & Son Co., Baltimore.
Duocene	Crescent Oil Co., New York City.
Economy	White & Bagley Co., Worcester, Mass.
Emulso	Bayerson Oil Works, Erie, Pa.
Emulsol	Paragon Refining Co., Toledo, Ohio.
Endurance	Endurance Autoil Co., Muncie, Ind.
Ex-el-ard	Buffalo Specialty Co., Buffalo, N. Y.
Faultless	Hawkeye Oil Co., Waterloo, Ia.
501	Cataract Ref. & Mfg. Co., Buffalo, N.Y.
Forster	Forster P'nt & Mfg. Co., Winona, Mn.
Gargoyle	Vacuum Oil Co., New York City.
Germania Lubro	Germania Refining Co., Oil City, Pa.
Green	Monahan Antiseptic Co., Chicago, Ill.
Green Oil Soap	Monahan Antiseptic Co., Chicago, Ill.
Harris	Harris Oil Co., Providence, R. I.
Hosmer	G. A. Hosmer Co., Buffalo, N. Y.
Houghtolard	E. F. Houghton & Co., Phila., Pa.
Hydroil	B. G. Pratt Co., New York City.
Justrite	Crescent Oil Co., Inc., New York City.
Keep-Kool	Phoenix Oil Co., Cleveland, Ohio.
Key Brand	Interstate Chem'c'l Co., Jersey City.
Key Cote	Interstate Chem'c'l Co., Jersey City.
Key Sol	Interstate Chem'c'l Co., Jersey City
Lardral	Farr Mfg. Co., New York City.
L-O	G. Whitfield Richards, Phila., Pa.
Lube-a-Tube	G. Whitfield Richards, Phila., Pa.
Lube-Well	G. Whitfield Richards, Phila., Pa.
Lubricool	Farr Mfg. Co., New York City.
Lubro	G. Whitfield Richards, Phila., Pa.
Magic	Fiske Refining Co., New York City.
Marnile	George A. Haws, Inc., N. Y. City.
Matchless	S. O. Co. of Ind., Chicago, Ill.
Mineral Lard	Union Petroleum Co., Phila., Pa.
Minlardo	American Oil Co., Jackson, Mich.
Minolard	White & Bagley Co., Worcester, Mass.
Minolene	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Misceo	E. F. Houghton & Co., Phila., Pa.
Mogul	S. O. Co. of Ind., Chicago, Ill.
Mohawk	Mohawk Gr'd'g Paste Mg. Co., Albany.
Moores	Moore Oil Co., Cincinnati, Ohio.
Mystic	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Nagle Soluble	Ulco Oil Co., Detroit, Mich.
Near-a-Lard	G. Whitfield Richards, Phila., Pa.
No. 1	Moore Oil Co., Cincinnati, Ohio.
Nonesuch	G. Whitfield Richards, Phila., Pa.
Oakite	Oakley Chemical Co., N. Y. City
Oildag	Acheson Gr'ph'te Co., Ni'g'ra Falls
Opco Lardo	Am. Oil Products Co., Buffalo, N. Y.
Oriole	W. C. Robinson & Son Co., Baltimore.
Palubco	Penn. Lubricating Co., Pittsburg, Pa.
Paragon	Paragon Refining Co., Toledo, Ohio.
Parolenm	Borne, Scrymser Co., New York City.
Peerless	Racine Tool & Mach. Co., Racine, Wis.
Pennant	Pierce Oil Corp., St. Louis, Mo.
Pensico	Carter Petroleum Co., Phila., Pa.
Perfection	Cataract Ref. & Mfg. Co., Buffalo, N.Y.
Petro-Lard-Oil	American Oil Co., Jackson, Mich.
Phoenix	Phoenix Oil Co., Cleveland, Ohio
Plumbers	Standard Oil Co., of N. Y., N. Y. City.
Primus	Penn. Petroleum Sup. Co., Phila., Pa.
Reliable	Gen'r'l Oil Wks. Co., Indianapolis.
Robinson	W. C. Robinson & Son Co., Baltimore.
Royal	Castle Lubricant Co., N. Y. City.
Solcut	E. F. Houghton & Co., Phila., Pa.
Sol-O	Cataract Ref. & Mfg. Co., Buffalo, N.Y.
Sol-O-Ene	Anchor Oil & Chem. Co., Cleveland, O.
Solubo	Moore Oil Co., Cincinnati, Ohio.
Solucene	Crescent Oil Co., Inc., New York City.
Soluline	Star Lub. Oil Co., Cleveland, Ohio.
Solvoline	Phoenix Oil Co., Cleveland, Ohio.
Standard	Standard Oil Co. of N. Y., N. Y. City.
Sub-For-Lard	Anchor Oil & Chem. Co., Cleveland O.
Sullivan	Sullivan Oil Co., Chicago, Ill.
Texaco	Texas Co., New York City.
3A	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Triprocess	Garnet Co., Allentown, Pa
Ulco	Ulco Oil Co., Detroit, Mich.
Union	Standard Oil Co. of N. Y., N. Y. City.
Unity	Sullivan Oil Co., Chicago, Ill.
Velox	W. C. Robinson & Son Co., Baltimore.
Velvet	Advance Oil Co., Oil City, Pa.
Viscos Cutting	National Oil & Sup. Co., Newark, N. J.
Viscos Min'r'l'zed Lard	National Oil & Sup. Co., Newark, N. J
Viscos Soluble	National Oil & Sup. Co., Newark, N. J.
Viscosity	Cataract Ref. & Mfg. Co., Buffalo, N.Y.
Warley	Thomas O. Warley & Co., Phila., Pa.
Waverly	Waverly Oil Wks. Co., Pittsburg, Pa.
XX	Indian Refining Co., New York City.

* * *

An interesting and helpful article on the value of trade literature by James H. Collins appeared in the January 15 number of the *Saturday Evening Post*. Mr. Collins says business books are being published in large numbers, technical journals are growing better, and printed helpers of all sorts are being made available. More and more the American business man is asking "Where can I get good books on so and so?" This is a time when the printed word is utilized by both the big men and the little ones in their jobs. It shows them what others have done and are doing, makes their work fit into the general business scheme, and prevents waste. To find and use the best printed things about ones work is so much a part of present-day business that large concerns are installing business libraries, and no man is so small or his job so new or unusual that some help cannot be found in print—if a fellow only knows where to find it.

* * *

It is estimated that the total amount of radium in all the known radium-carrying ore deposits in the world is about one pound. At the present time, about one-half ounce of this has been extracted from the ores, and this amount constitutes the total store of radium available. It is believed that, at present prices, there is a demand for about two ounces of radium, but the production is not carried on to an extent to meet the demand.

SETTING THE PLANER RADIUS ATTACHMENT

A METHOD OF PLANING TRUE CIRCULAR ARCS

BY JOHN LYNCH*

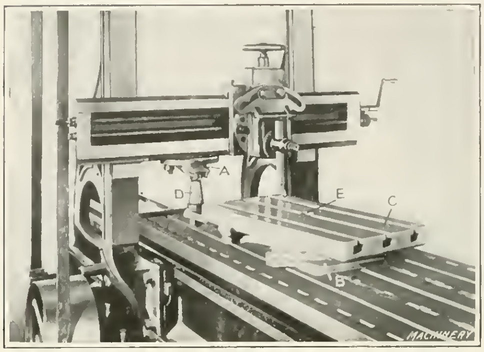


Fig. 1. H. B. Underwood & Co.'s Radius Attachment for Planer

THERE are many machinists who do not fully understand the operation of planing curved work, and some foremen have trouble in handling a job of this kind. It is the purpose of this article to explain the use of a simple attachment, made by H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa., which enables work to be planed to any desired radius of curvature. Referring to Fig. 1, it will be seen that this attachment consists of a longitudinally slotted guide arm *A* provided with an index head for setting the arm at various angles with the line of travel on the planer table, a base *B*, which is secured to the table of the planer, and a work-table *C* that is pivoted on this base. The work-table carries a pin *D* at one of its corners, which projects into the slot in the guide arm *A*, and as the planer table reciprocates back and forth, the movement of the pin *D* in the guide arm causes the work-table to swing on its pivot *E*, with the result that the work follows the arc of a circle in passing under the planer tool. By setting the guide arm at the required angle, the work may be planed to any radius of curvature which comes within the capacity of the attachment.

When the attachment is set up in accordance with the usual method, the curve obtained is a close approximation of a circle when the arc to be planed is not too long; but if it is required to plane an arc of considerable length, the discrepancy from a true circular form will be apparent. For use in cases where a high degree of accuracy is required and where the work is of such a nature that it cannot be handled on a lathe or boring mill, I have developed a method of setting up the planer radius attachment which produces a high degree of accuracy. In setting up the attachment according to this method, the following points must be observed: The pivot on which the work-table swings should be located over the center of the planer table, and the planer tool should be set so that it is over a line drawn through the pivot and parallel to the line of travel of the planer table. The tool should be located at such a distance in front of the cross-rail as to lie at the point of intersection of the line through the pivot and a line through the center of the guide arm. This location of the tool is shown diagrammatically in Fig. 2, which illustrates positive

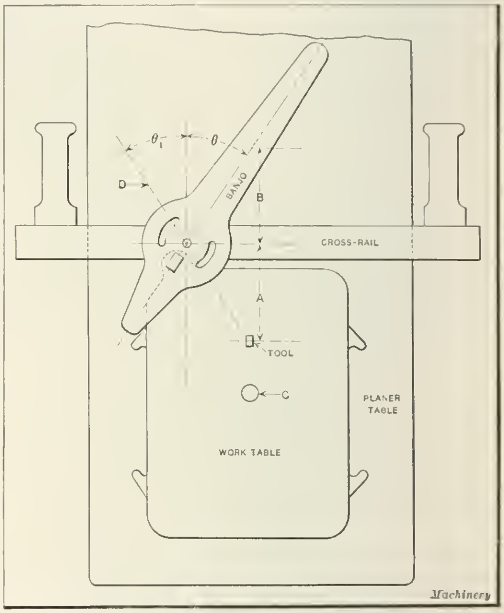
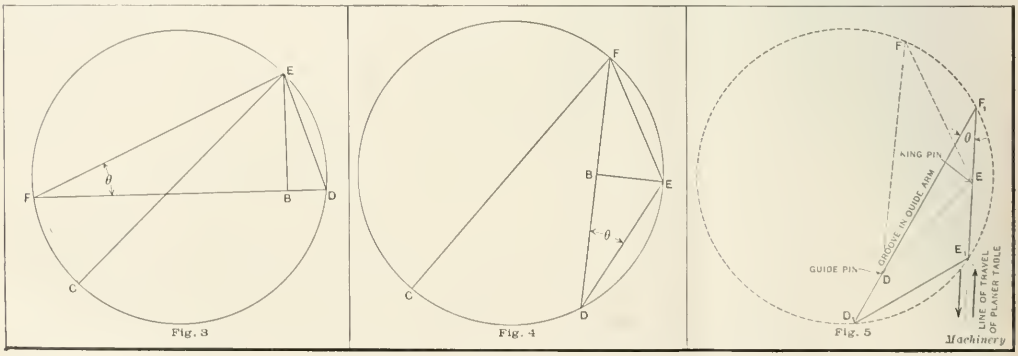


Fig. 2. Diagram showing Method of setting up Attachment to plane a True Circular Arc

and negative settings of the guide arm. With the guide arm set to an angle θ, the attachment will plane a curve of the same radius as if the guide arm were set to an angle θ_1, but the direction of curvature will be opposite. Both curves will be true arcs of circles. It will, of course, be evident that angle θ_1 is equal to θ, and it may be mentioned that the distances *A* and *B* are equal. The location of the tool is the same in both cases, being at the intersection of the line

* Address: Inspection Department, Navy Yard, Boston, Mass.



Figs. 3 to 5. Diagrams illustrating Derivation of Formula for Angle at which to set Guide Arm to plane Work to Any Required Radius R

through pivot C parallel to the line of travel of the planer table and line D which is the center line of the guide arm when set to an angle θ_1 with the line of travel of the planer table.

It has been stated that different radii of curvature are obtained by setting the guide arm at various angles, and the following formula determines the required angular setting to plane any desired radius of curvature:

$$\frac{11.25}{R} = \cos\theta$$

where R = required radius of curvature;

θ = angle at which attachment must be set.

The derivation of this formula is based upon the following:

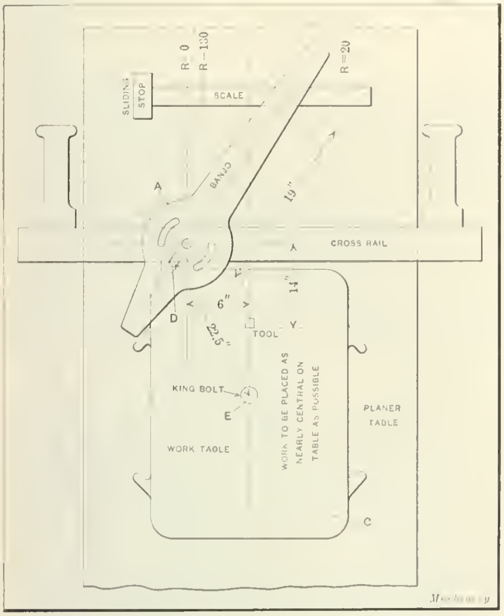


Fig. 6. Diagram showing Method recommended by H. B. Underwood & Co. for setting up Attachment

We know from geometry that in any triangle the product of any two sides is equal to the diameter of the circumscribed circle multiplied by a perpendicular drawn to the third side from the apex of the opposite angle. Bearing this fact in mind, we see from Fig. 3:

$$EC \times EB = ED \times EF$$

$$\frac{ED}{EC} = \frac{EB}{EF}$$

$$\text{But } \frac{EB}{EF} = \sin\theta;$$

EC = diameter D of circumscribed circle.

Let E indicate the center of the pivot about which the work-table oscillates, and D the center of the pin which engages the guide arm. The distance between points E and D is fixed, and on the planer radius attachment this distance is 22.5 inches. Hence we have the following equation:

$$\frac{22.5}{D} = \sin\theta$$

$$\frac{11.25}{R} = \sin\theta$$

where R = required radius of curvature for the work; and θ = angle at which attachment must be set.

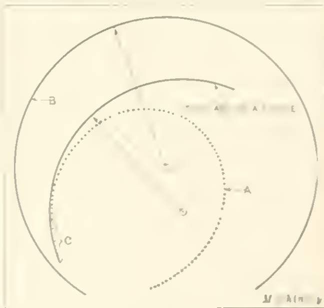


Fig. 7. Arc of True Circle is planed when Attachment is properly set; otherwise, Curve will be of Some Such Form as shown by Dotted Line

The preceding formula assumes that the reading of the graduated head is zero when the guide arm is set parallel to the line of travel of the planer table. As a matter of fact, the index head is graduated in such a way as to read 90 degrees when the guide arm is set parallel to the line of travel of the table. We know from trigonometry that:

$$\sin\theta = \cos(90 \text{ degrees} - \theta)$$

Hence the formula for determining the angle at which to set the radius attachment for planing any required work is:

$$\frac{11.25}{R} = \cos\theta.$$

In deriving the preceding formula for setting the planer radius attachment, use was made of a theorem that the product of any two sides of a triangle is equal to the product of the diameter of the circumscribed circle multiplied by a perpendicular dropped to the third side from the apex of the opposite angle. The proof of this may be briefly given as follows: In Fig. 3 it is required to prove that:

$$EC \times EB = ED \times EF$$

In right triangles EFC and EBD, angle C = angle D. As a result, all of the corresponding angles are respectively equal and the triangles are similar; hence, homologous sides of the triangles are proportional, and we have:

$$\frac{EC}{ED} = \frac{EF}{EB}$$

Therefore, $EC \times EB = ED \times EF$.

The theorem just proved is true for all triangles, so that it holds in the case shown in Fig. 4 where the conditions are the same as those that obtain in the planer radius attachment shown diagrammatically in Fig. 5. In this illustration the line E_1F_1 represents the line of travel of the planer table, D_1F_1 the center line of the groove in the guide arm, E the "king pin" or pivot about which the work-table oscillates, and D the pin which engages the guide arm. The reciprocating travel of the planer table is indicated in this illustration by the reversed arrows. When the planer is in motion, the pin E will move forward to the position indicated by E_1; and this

VALUES USED IN LAYING OUT SCALE FOR SETTING PLANER RADIUS ATTACHMENT

Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches
20	13.40	35	6.41	50	4.32	65	3.28	80	2.65	95	2.23	110	1.91	125	1.67
25	9.63	40	5.52	55	3.90	70	3.04	85	2.50	100	2.11	115	1.82	130	1.61
30	7.65	45	4.84	60	3.56	75	2.85	90	2.35	105	2.01	120	1.74	∞	0

Note: D = distance of radius graduation from straight line graduation.

movement will cause the guide pin D to move forward to the point indicated by D_1. Similarly, the point F will move to point F_1. It will be seen that the point F follows the circumference of a circle, the movement of this point indicating the manner in which the work moves under the planer tool to generate the arc of a true circle.

The method of using this attachment will probably be better understood by carrying through the actual calculation involved in setting up the attachment to plane work to a given radius of curvature. Suppose it is required to plane a piece with a radius of curvature of 42 inches. Using the formula previously determined for finding the required angle θ at which to set the attachment, we have:

$$\frac{11.25}{R} = \cos\theta$$

$$\frac{11.25}{42} = 0.2678$$

$$\theta = 74 \text{ degrees, } 32 \text{ minutes}$$

It has been explained that in order to plane a true circular arc it is necessary to have the planer tool located at the intersection of the center line of the groove in the guide arm and a line drawn through the pivot pin parallel to the line of travel of the planer table. Unless these instructions are followed the true arc of a circle will not be obtained, the curve generated being some such form as shown by the dotted line A in Fig. 7; but when properly set the attachment will generate the arc of a true circle B. Curve A is a close approximation of a true circular arc when only a short length of the arc is considered. This is shown by the fact that the dotted curve A almost coincides with the true circular arc for the portions of the two curves covered by bracket C.

[For the purpose of setting the attachment for planing various radii of curvature, H. B. Underwood & Co. give the following instructions: The center of the guide arm or "banjo" is located 6 inches to the left of the center line of the planer table when viewed from the front of the machine, as shown in Fig. 6; the planer tool is set over the center line of the planer table, at a distance of 14 inches in front of a line drawn through the center of the guide arm and parallel to the cross-rail; and the baseplate of the attachment is bolted to the planer table in such a way that the pivot or "king pin" is set on the center line of the planer table. To provide for setting up the attachment for planing work to curves for various radii of curvature, a scale has been developed, which is laid out according to the results presented in the accompanying table (and is illustrated at the top of the table), from which it will be seen that provision is made for planing work with radii of curvature ranging from 20 to 130 inches. The curve which has an infinite radius of curvature is a straight line, and it will be evident that such a curve is generated by the attachment when the slot in the guide arm is parallel to the line of travel of the planer table. In using the scale, it is laid perpendicular to the center line of the planer table at a point 19 inches from the center of the "banjo" measured along the guide arm as shown in Fig. 6. The use of this scale provides a rapid method of setting the guide arm, and this method of setting up the attachment on the planer possesses a noteworthy advantage over Mr. Lynch's method in that the position of the tool is fixed for all curves, so that no special equipment is necessary for securing the tool to the cross-rail.—EDITOR.]

* * *

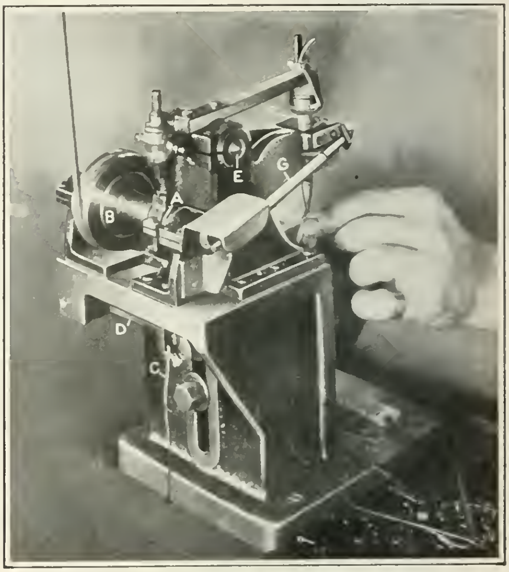
MONTHLY MEETING OF THE A. S. M. E.

At the monthly meeting of the American Society of Mechanical Engineers, held in the Engineering Society's Bldg. in New York City, February 8, T. Russell Robinson, statistical engineer for W. S. Barstow & Co., Inc., New York City, spoke on the subject "Ways of Presenting Data for Executive Purposes." The paper was prepared to present in a complete manner the methods used for showing, by means of diagrams, results obtained in the operation of an industrial undertaking. Comparisons were made with tabulated data, indicating how much clearer the results may be made by means of diagrams. While the paper related particularly to the performance of public service corporations, the methods can be easily adapted to the keeping of any continuous records. Preceding the meeting, an informal dinner was held at a restaurant close to the Engineering Society's building, for the purpose of bringing together the members and enabling them to become acquainted.

MINIATURE RIVETING HAMMERS

The miniature riveting hammer shown in the illustration was patterned after the well-known Bradley hammer; it is so small that it can be readily lifted with one hand, as will be inferred by comparing it with the size of the man's hand. This little riveting hammer is one of fifty or more used in the Remington Typewriter Co.'s plant at Ilion, N. Y. for riveting typewriter parts.

The origin of this small helve type of hammer dates back several years, when it was desired to head over very small rivets for typewriter riveting, leaving them with perfectly shaped heads. Trouble was experienced in securing the right kind of a head with the regular type of riveting machine, and it was decided to try a helve hammer. Accordingly, an arrangement was made with the C. C. Bradley & Son Co. of Syracuse, N. Y., whereby the standard Bradley helve hammer was copied in miniature with slight variations, the parts



A Helve Hammer, made One-sixteenth Usual Size, for Riveting

being made one-sixteenth the size of those in the regulation hammer. The machine has proved very successful, as the rubber cushions and the hickory helve give an elastic blow, allowing the metal to "flow" under the hammer.

The hammer is operated by an eccentric on the driving shaft that may be seen at A at the rear of the hammer. The driving pulley runs continuously, but it is fitted with a friction clutch B so that while the pulley nominally rotates loosely on the driving shaft, it rotates the shaft also when the clutch is thrown in. The clutch is operated by a foot-pedal through a wire C and clutch lever D. When the shaft is made to rotate by engaging the clutch, the helve is reciprocated, being hinged on pin E. The riveting punch is at the end of the helve at F, being mounted upon a rubber cushion supported by the helve. The driving end of the helve also "rides" on rubber cushions.

At the end of the driving shaft opposite the clutch is a bevel gear connection to a worm shaft G that extends to the front of the machine. This shaft terminates in a worm and meshes with a worm-wheel that turns the riveting anvil while the operation is going on, thus assisting in making the head uniform. The machine is extremely sensitive and very rapid in its operation, striking 4500 blows per minute if desired. The action is very flexible, it being possible to strike the blows slowly or rapidly as desired.

This type of riveting machine is now made in several sizes for the market by the High Speed Hammer Co., Rochester, N. Y.

KEEPING MULTIPLE DRILLING MACHINES AT WORK

After making a heavy investment in a machine tool, the ideal condition to maintain would be to keep it working all the time. This is seldom possible, however, owing to the fact that between operations a certain time is taken for removing work from the jigs and replacing new work for the next operation. During such times, the investment of money in the machine tool is still going on, but the machine is standing idle.

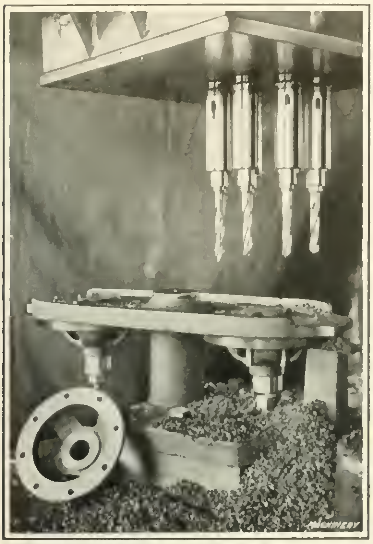


Fig. 1. Two-station Type of Drilling Jig

The New Process Gear Corporation of Syracuse, N. Y., manufacturer of automobile gears, evidently had this point in mind when designing the two drilling fixtures shown in Figs. 1 and 2 that are used on the National Automatic Tool Co.'s multiple drilling machines. The object of these two jigs is to provide a method by which the drilling machine will be kept at work drilling all the time even while the man is removing and replacing work. In Fig. 1 the work being done is the drilling of eight 5/16-inch holes through a 1/4-inch flange on a malleable iron differential gear-case half. The method of using the jig will be apparent at a glance. The jig is of the two-station type and the work is bolted on from the under side, being located on a central stud. The body plate of the fixture carries eight bushings for the 5/16-inch drills. While the drilling operation is proceeding, the operator is removing the piece previously drilled and inserting a new one at the station not in use. The drilling operation gives him just time enough to substitute a new case for the drilled one, index the jig, start drilling the new piece, and then proceed to remove the case just drilled.

The jig in Fig. 2, for use in drilling drop-forged steel drive-gears, is even more interesting in its operation, as it is of the three-station type. The work to be performed is the drilling of four 9/16-inch holes and eight 5/16-inch holes through a flange that is 9/16 inch thick. The drilling is done on a twelve-spindle drilling machine in which the spindles are arranged in two groups of four and eight. The jig has three stations, as shown in the illustration, and is locked in each position by the pin shown at the left. The operator clamps a gear at the front station, indexes the jig to the right and the four 9/16-inch drills go through the work. He then indexes a second time and the same gear blank is drilled again with eight 5/16-inch drills. At the third indexing the piece is brought to the front again, finished, and removed and a new one is inserted. Thus, after every indexing the four 9/16-inch holes are drilled by the first group of spindles simultaneously with the drilling of the eight 5/16-inch holes by the second group of spindles, and during this time the operator is taking off a finished piece and replacing it with a new one.

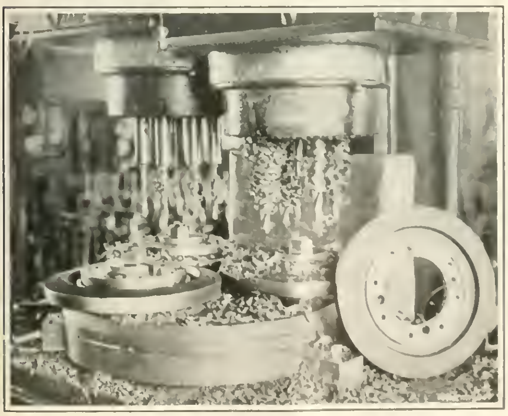


Fig. 2. Three-station Type of Drilling Jig

As the New Process Gear Corporation factory is running night and day, it is evident that these drilling machines spend almost 100 per cent of their time in actually drilling—and none in waiting to drill. C. L. L.

* * *

THE LITTLE SHOP IN THE BACK YARD

BY A. P PRESS

Some months ago we wrote you about "Bill and His Little Shop," and perhaps you would like to hear the rest of the story. Bill has gone. The shop got too small to hold him and his work. It fairly pushed off one side of the building, until he had to do all his pipe work out in the yard, and even then the shop was too small and he had to run nights to get the work done.

This was the way he happened to get out: A member of a large concern came around one day and saw what Bill was doing. He got interested in Bill and his work, and now Bill has a shop nearly 200 feet long, and we had the pleasure of selling him a good power plant for it. (We got our money too.) We were up to see him a few days ago. He has a nice office in one end of his shop with a little drafting-room attached, and while he has a typewriter, Mrs. Bill doesn't run it any more.

Bill (by the way, we must not call him Bill any more) is now a manufacturer in every sense of the word, but when we look over our back fence at the little shop now tenantless, we feel both glad and sorry—glad for Bill because he has branched out and done so well, and sorry because the little shop that used to hum with activity and business, now, like the harp that hung on Tara's walls, is "silent, drear, and dead." Perhaps the environment has something to do with Billy's success in getting ahead. From our back window you can look and see no less than six of these little shops. They don't blow any whistle, although every one has an engine lathe and some of them a complete equipment. They start in about seven o'clock (P. M. mind you), and their lights are never turned out, when we "turn in." The one nearest to us is building an automatic transmission for an automobile. That is, as you go up a grade, the car automatically drops into third speed, and if the grade is still too great for the power of the engine, it drops into second, and then into first if necessary. He has been working on it two years now, and while to us it seems perfect, you know it is hard for a mother to give up her baby, and so he is still at it. The next firm up the back fence is doing die work, and has expert mechanics of the highest ability, but many a time they have made me a set of tools (and they were good ones, too) for half what I could get them made for elsewhere. There is something funny about it. A man puts up a kick when you ask him to work overtime for less than time and a half, but he will go cheerfully into his own shop and work on a job that doesn't pay him more than half his regular day rate.

Bless the little shops in the back yard. They may keep us awake nights, but they are turning out a product which can be produced in no other way, and that is mechanics who handle the business end as well as the mechanical details, and make a success of both.

MODERN MACHINE VISES AND APPLICATIONS

EXAMPLES SHOWING THE UNIVERSAL RANGE OF WORK TO WHICH THIS MACHINE FIXTURE MAY BE ADAPTED

BY FRANK H. MAYOH*

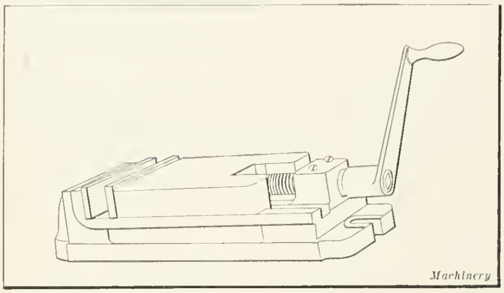


Fig. 1. Plain Flanged Vise

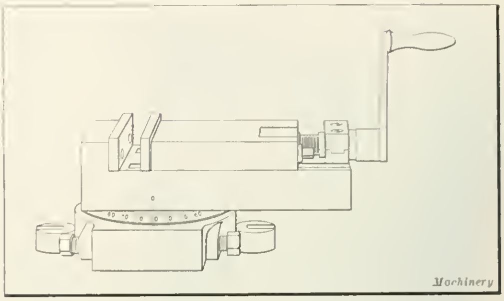


Fig. 2. Typical Swivel Vise

THE machine vise so commonly used on milling machines and other machine tools is as nearly a universal fixture of simple design as can be found in machine tool equipment. The object of this article is to describe some of the uses of modern machine vises in manufacturing and to give examples to illustrate the wide range of work for which they are adapted. The article will show that these vises can be adapted at slight expense, as compared with high-priced special jigs and fixtures, for a wide range of work. Many shop executives, not desiring to build expensive fixtures for the production of a few hundred pieces only, send jobs into the shop and let the machine operators do the work with inadequate tool equipment. A few dollars spent on special vise jaws would often cut down production cost of parts of moderate size very materially. Of course it is true that the vise might not be the cheapest fixture for holding the work were there enough parts to warrant making more elaborate tool equipment.

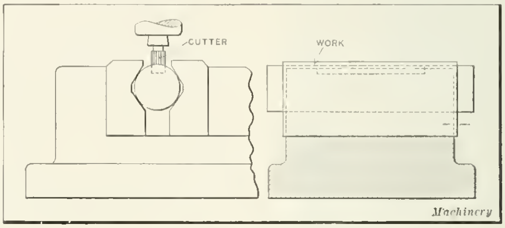


Fig. 3. Vee Jaws for Round Work

Examples of jaw construction for plain and universal vises are shown in the accompanying illustrations. Some of these vises require attachments that are regularly furnished by the makers, while others must be adapted to the work by the user. One of the simplest styles of modern vise is that shown in Fig. 1. It has no angular adjustment and is adapted only for work having parallel sides or square ends. The swivel vise shown

* Address 87 Samuel Ave., Pawtucket, R. I.

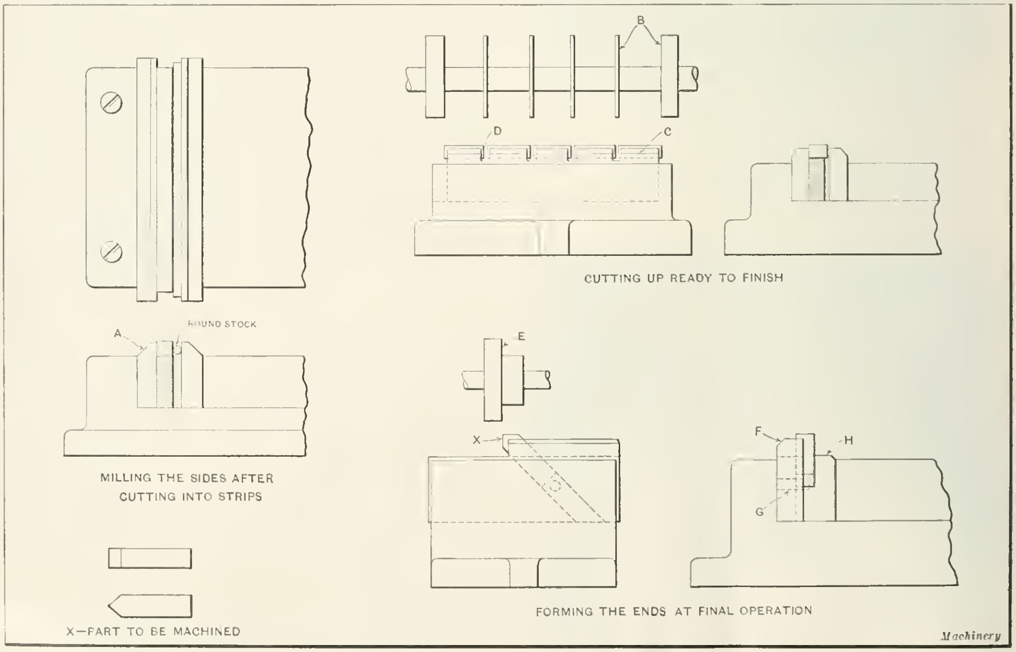


Fig. 4. Method of manufacturing Part X in Vise Jaws

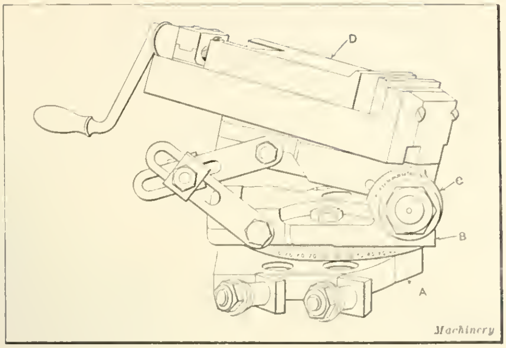


Fig. 5. Toolmakers' Universal Vise

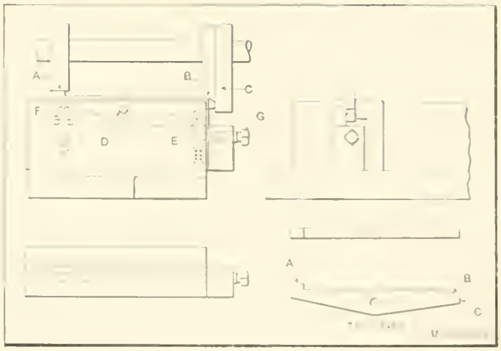


Fig. 6. Gang Milling Trip Lever in Special Vise Jaws

in Fig. 2 has angular adjustment in the horizontal plane only. The plain vise is to be preferred to the angular vise for straight work, as it is cheaper, sets lower on the table and is more rigid. Thus it may be operated under heavier cuts with less vibration.

Perhaps the most highly developed vise as far as mechanical construction is concerned, is the toolmakers' universal vise illustrated in Fig. 5. This is used for fine work and can be set to machine compound angles by bolting the base *A* to the table or platen of a machine. The upper portion *B* may be swiveled to the desired angle, and the reading taken from the scale at its base. Elevating the operating jaw end of the vise to a reading taken from the dial *C* on the stud gives another angle. When desired, the vise proper *D* may be swiveled on its base to still another angle, thus making three independent settings in all. This vise, when rigidly clamped, makes a fairly substantial tool.

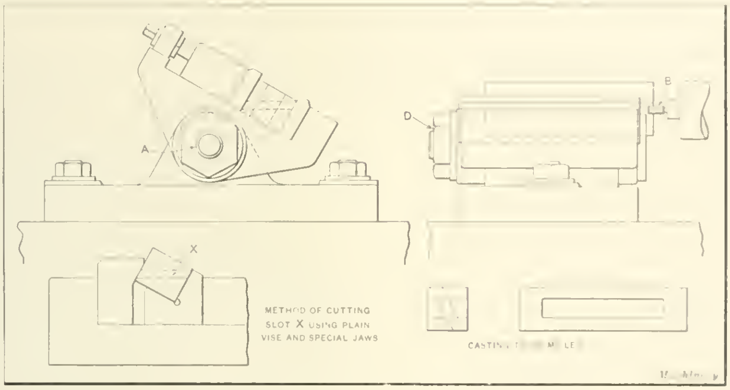


Fig. 7. End-milling a Slot in Swivel Vise

Referring to Fig. 4, examples of the use of a plain flanged vise for milling are shown. The piece *X* is made in three sets of jaws from bar stock. The rough bars come to the first operation in lengths of about twelve inches. The four sides are milled consecutively, and to insure squareness, the bar is forced against the solid vise jaw *A* with a piece of round stock. This insures the work being squared up from one side only, this side always being the last to be milled. A parallel is placed under the work to maintain the correct height. The bars are next cut to a length slightly greater than the finished product by saws and side

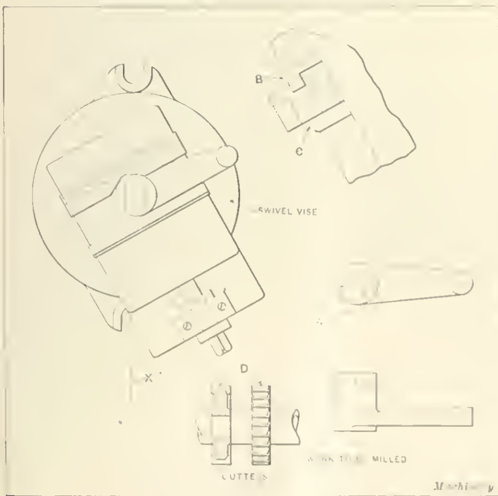


Fig. 8. Milling Flats on Lever Boss in Swivel Vise

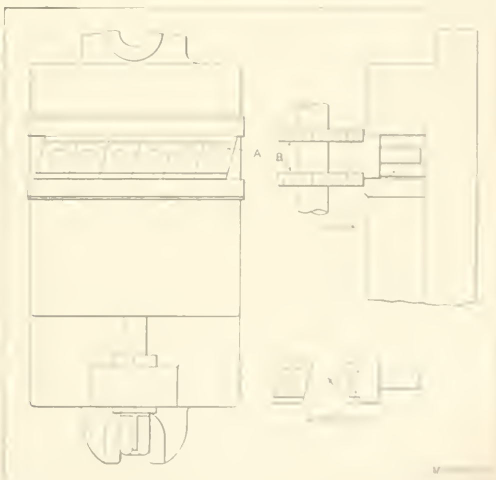


Fig. 9. Work held for Gang Milling

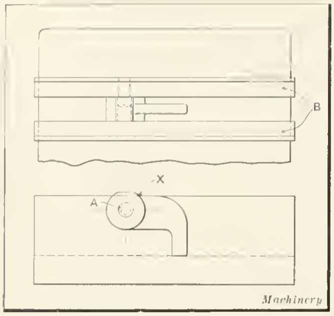


Fig. 10. Locating Work on a Pin in Vise Jaws

milling cutters *B*. The work is held in a set of special vise jaws *C*, which have slots cut where the saws come at *D*. For the final operation, the vise jaw equipment consists of one special jaw and one standard jaw. The operation — milling the angles—is performed with face and side milling cutters *E*. The work *X* is held at an angle in the stationary jaw *F*, locating in a slot against the pin *G* and being clamped by the standard movable jaw *H*. There is a distinct advantage in holding the work at an angle. Since the included angle in this case is ninety degrees, the work is thrown over at an angle of forty-five degrees, enabling a standard side and face milling cutter to be used. Should the included angle be more or less than ninety degrees, the work may be thrown over at one-half the included angle, and the milling can be accomplished with a standard side milling cutter and one special angular face milling cutter. This has an obvious advantage over milling with the work in a vertical position, as in that case two special angular cutters are required.

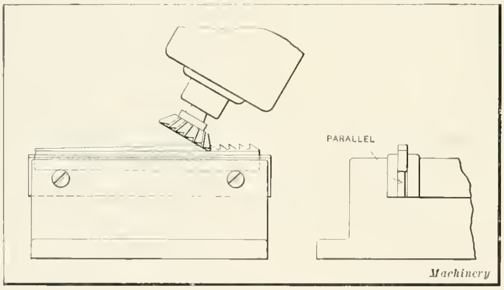


Fig. 11. Milling a Broach with Vertical Attachment and Angular Cutter

An example of work held in a swivel vise is shown in Fig. 8. This vise has one special and one standard jaw. The operations consist of flattening off both sides of the boss *A* in relation to the end of the work. This is accomplished by placing the work in the special vee jaw *B* and binding it with jaw *C*, then swiveling the vise to the desired angle and milling with the straddle milling cutters *D*. The parts are machined in duplicate very rapidly.

It is often necessary to machine work that requires to be supported at four or more points. A rough casting of this kind cannot be held by fixed jaws, and the best way to handle it is by means of a vise that has one equalizing jaw, as shown in Fig. 13. In this illustration the bosses on the work are being surface-milled with cutter *A*. The work is located in the fixed jaw *B* in the vee-shaped groove and clamped against the groove angles *C* by means of the two lugs *D* on the equalizer. This equalizer pivots about the point *E* and is held to the movable jaw *F* by the screw *G*.

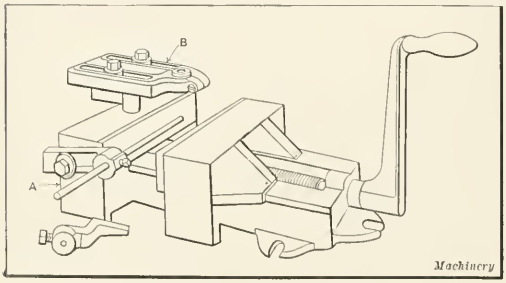


Fig. 12. Graham Vise with Jig Attachment

A very handy set of vise jaws are the vee-shaped jaws shown in Fig. 3, which may be used for milling keyways in shafts and for various other purposes where the work is round or of similar shape.

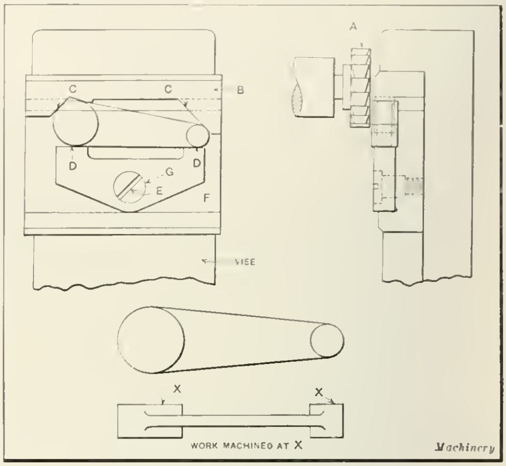


Fig. 13. Example of Equalizing Vise Jaw

Another type of swivel vise is illustrated in Fig. 7 in use on a horizontal milling machine for end-milling a slot across the end of a casting. The vise pivots about the stud *A* and is tilted to the desired angle for milling with cutter *B*. In the event of no vise of this type being on hand, the same result may be obtained by the use of a plain vise and two special jaws cut on an angle as shown.

Fig. 6 shows a gang milling operation on a small piece, using a spring pin, central stud and screw for locating the

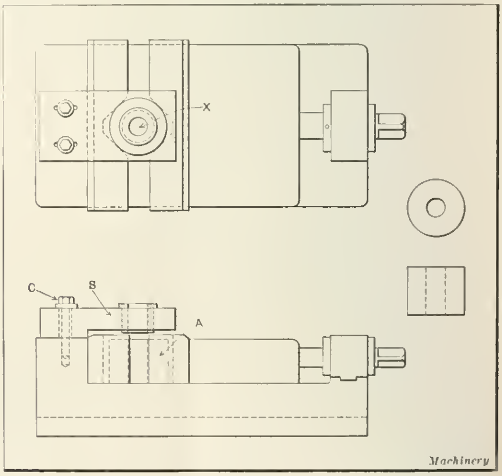


Fig. 14. Simple Vise with Jig Attachment

work. There are three cuts on this piece, milling the lug with surface mill *A*, milling the bevel with angular milling cutter *B* and milling the end with side milling cutter *C*. In placing the work in these vise jaws, it is slipped on the pin *D* and the movable jaw is brought up to just touch the work, when the

spring pin *E* is released, forcing the work against the screw *F*. In this position the spring pin is locked by the screw *G*; then the vise jaw is tightened, holding the work rigidly.

When setting up work, pins can often be used to good advantage under such conditions as locating from a hole and gripping on a boss as shown in Fig. 10. *X* is the work and *A* the locating pin. The jaws *B* are standard, except that a hole is made in the fixed jaw to receive the pin, which holds the

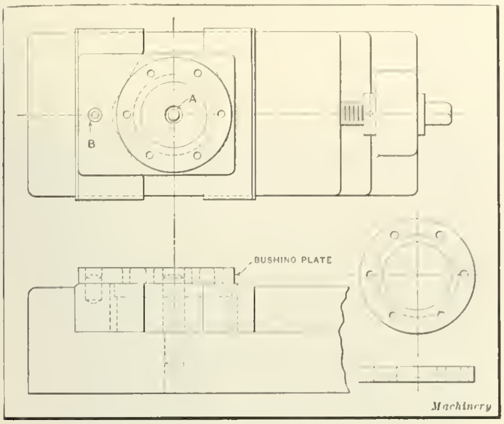


Fig. 15. Drilling Holes on a Circle with Removable Bushing Plate

work at the correct height. Further location of the work is obtained by the end resting on a parallel or the bottom of the vise in the position shown.

Other combinations for milling or planing in vise jaws are often made by holding two or more pieces at one time. Unless the portions of the work gripped between the jaws are finished fairly close, it is necessary to provide some means of compensation in order to grip all the pieces securely, as some of the pieces would be loose and pull out when machining began. An illustration of several pieces being held in a vise for gang

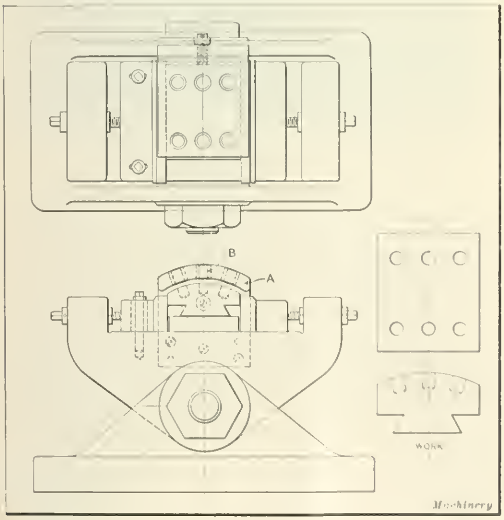


Fig. 16. Drilling Holes on an Angle in Special Vise

milling is shown in Fig. 9. Six pieces *A* are placed in the vise, resting on a block which has six clearance holes for the round shanks. Then the jaws are tightened in the usual manner and the sides *X* are straddle-milled with straddle milling cutters *B*.

A vise for milling broach teeth is shown in Fig. 11, where

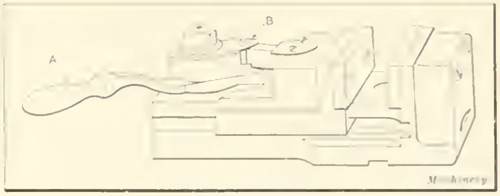


Fig. 17. Quick-action Vise

the angular cutter is held in the vertical milling attachment of a horizontal milling machine. The work is held in a plain vise and the cross-slide is fed in and out when taking the cuts. This arrangement permits a slight undercutting of the broach teeth, which is a very desirable feature.

Drilling in Vises

Although the foregoing examples have been of vises used in milling or planing operations, any of these may be used for drilling in combination with attachments for holding drill bushings or locating stops. There are now on the market vises furnished with jig attachments ready for use. One of these vises as made by the Graham Mfg. Co. is illustrated in

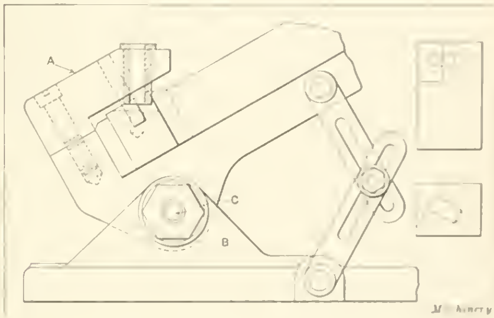


Fig. 18. Drilling on an Angle in Swivel Vise

Fig. 12, where it will be seen that a stop *A* may be used to locate the work while the bracket *B* holds the bushing which guides the drill.

As a simple illustration of the principle involved in using a jig of this type, reference is made to Fig. 14, in which the part being machined is a round collar. This collar *A* is gripped against a vee in the solid jaw, and the bracket containing the bushing *B* is adjusted to the correct position for guiding the drill into the work. It is clamped in place on the solid jaw by means of bolts *C*. To operate the jig, the movable jaw is opened and a piece of work inserted in the V-block.

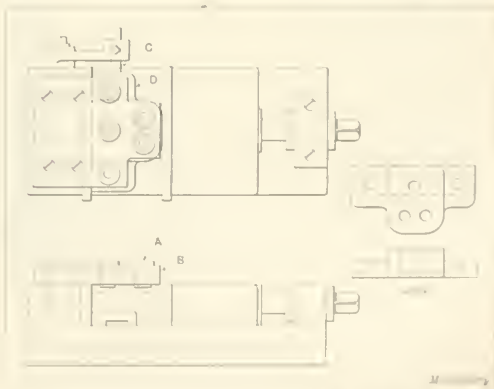


Fig. 19. Drilling Several Holes with a Templet attached to Vise

Then it is only necessary to tighten the jaws and proceed to drill. In this way, duplicate parts are obtained without an elaborate jig. By using suitable plates in these jigs, many odd-shaped pieces can be drilled, of which Fig. 19 is a typical example. The method of using this plate is obvious from the illustration. Bushings *A* are placed in the plate *B* at the proper location to guide the drills into the work. The plate is screwed on top of the vise, the stop *C* is adjusted to the proper location, and the work *D* placed in the vise against the stop, after which the holes are drilled.

This jig construction adapted to drilling holes on an angle is illustrated in Fig. 18. In this case, a swivel vise is fitted with a plate *A* set at the proper angle in relation to the base *B*. Then by swinging the vise up to the proper angle, the parts may be drilled in duplicate as in the previous case cited. That there are infinite possibilities in the fitting of vises with bushing plates when these are intelligently used, will be readily seen by considering the methods of drilling illustrated in Fig. 16. This illustrates a swivel vise used as an indexing jig, and where extreme speed or accuracy is not required it works out very satisfactorily. The first drilling is done with the vise in the position illustrated. The subsequent drilling is accomplished by tilting the swivel vise to the right and left the desired number of degrees.

Another example of drilling in a vise is shown in Fig. 15; here a number of holes are being drilled around a circle. This is accomplished by gripping the work between the jaws in the vise proper and having a bushing plate to set on pins *A* and *B* in the vise. By sliding the vise to various positions the holes are drilled in the usual manner. This bushing plate is removable for taking out the work. Besides the vises with jig attachments, there are a number of quick-operating vises, of which Fig. 17 is a standard model. This vise is operated by a handle *A* and toggle *B* which is suitable for short operations requiring quick releasing of the work, such as milling screw slots, short drilling, etc.

The vises here illustrated are not always the most economical means of handling work, but they are often the best that the extent of the job will warrant. They must not be confused with more elaborate jigs and fixtures which, although vises in principle, are special in construction. Not all shops can afford the costly design that the manufacture of guns or automobiles will warrant. They must compromise on the cheaper and less effective equipment that can be adapted quickly to a wide range of work, and the machine vise, as shown in the foregoing, can be made a universal fixture within its limits.

* * *

MAKING CAMS BY HYDRAULIC PRESSURE

A number of barrel cams which are required to be light and perfectly balanced are employed in a certain textile machine. An ingenious and effective method of making these cams has been worked out, which produces a cam with little machining, and one that is in perfect standing balance and in almost perfect dynamic balance. The method is substantially as follows: A hardened steel pattern of the desired cam is made in two parts, the parting line being along the middle or side of the cam groove. This two-part pattern or mandrel is placed within a section of seamless tubing of the required length to make the barrel cam. The mandrel fits the tubing closely and the ends are covered with rubber gaskets to prevent the ingress of water or other liquid under heavy pressure between the mandrel and the tube. The assembled tube and mandrel are then placed within a steel container and subjected to heavy hydraulic pressure—sufficient to draw the tube wall down in the cam path and form a perfect copy of the master cam. The mandrel and hydraulically formed cam are then removed, and heads are welded to the barrel by the oxy-acetylene process. As stated, the resulting cam is light, in balance, and is made with little machining except cutting off and boring holes in the heads for mounting on the shaft. It is an interesting example of the possibilities of hollow forming of sheet metal by hydraulic pressure. Hollow silverware has been made by hydraulic pressure for many years, rubber pads being used to form a convenient and adaptable hydraulic medium.

WESTINGHOUSE MEMORIAL TABLET

The Veteran Employes' Association of the Westinghouse Electric & Mfg. Co., at its third annual banquet held Saturday evening, January 29, in the Fort Pitt Hotel, Pittsburg, presented to the company a bronze memorial tablet of the late George Westinghouse, founder of the numerous industries bearing his name. About 450 veterans were present, and officers and men from the shop mingled freely and discussed old times when the electrical industry was in its infancy. The organization is composed of those who have been in the employ of the company for twenty years or more. The memorial tablet is about three by four feet, made of solid cast bronze, and weighs about 300 pounds. It shows a true bas-relief like-

Westinghouse Memorial Tablet presented to the Westinghouse Electric & Mfg. Co. by the Veteran Employes' Association

ness of Mr. Westinghouse taken from one of his best photographic poses, and bears the inscription "George Westinghouse, Master Workman, Inventor, Founder, Organizer, 1846-1914." The tablet will be placed in the reception room of the East Pittsburg works of the company.

* * *

MECHANICAL SUBJECTS AS SOMETIMES DESCRIBED

In a work on forging by an author who has published a number of mechanical books over his name, we find the following item, which we could not withhold from our readers:

Description of Hydraulic Press

For the benefit of those who are not familiar with a forging machine or press, a description of one will be given here. We will describe a large press. Most forgings made by pressing in shaped dies can be produced on a small press. The smaller the press used for accomplishing your work the greater the economy.

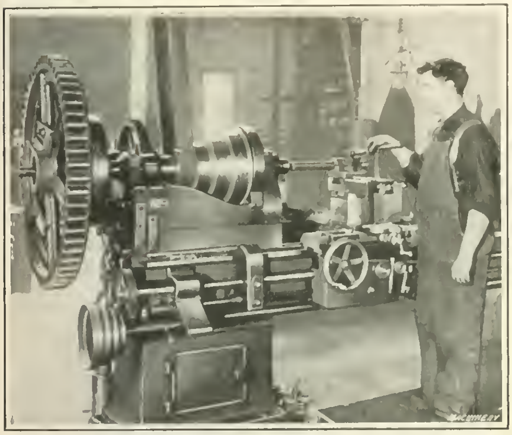
Embodied in the press proper is an operating plunger. This is pulled back after performing its stroke by a plunger. A platen is made movable to facilitate the handling of heavy dies. The dies are secured to the plunger and platen by means of bolts in tee slots. The press is usually operated by 500 pounds water pressure. When greater pressure is required an intensifier on the left of the press is used.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

BORING LARGE WORK ON A LATHE

Jobbing shops are frequently called upon to perform a boring operation on some part that is too large for the swing of any machine in the shop, and the following describes a method by which such parts can be handled on the lathe. The large gear shown in the illustration was the intermediate wheel on a steam tractor, and the bearing of this gear had become



Method of boring Work on Lathe, that is too Large for Swing of Machine

so badly worn that it had to be rebored. For handling such work we adopted the expedient of making a special faceplate and chuck, with a long hub on the faceplate bored to fit the rear end of the lathe spindle. This faceplate was secured to the spindle by means of set-screws carried in tapped holes in the hub. A special tool-block was made to hold the center of the boring-bar at the same height as the center of the spindle, and the bar was made long enough to reach through the spindle. To steady the bar while boring, a bushing was provided that was a tight fit in the spindle and a running fit on the bar. It will be evident that the cutter was located at the outer end of the bar, and provision was made for taking successive cuts by adjusting the tool. The regular longitudinal feed was employed to traverse the bar through the work.

Mankato, Minn. GEORGE WILSON

PRECISION GRINDING KINK

The following method will be found useful in handling toolroom work or any other class of work in which it is required to finish a piece perfectly square. The method is particularly applicable for sizing and finishing square or hexagonal broaches, plug gages, keyway gages and similar parts, where a high degree of accuracy is required. In order to explain the method of procedure, suppose that a square plug has been roughed out to within 0.005 inch on a universal grinder, using a dividing head for locating successive sides in relation to each other. After taking a cut 0.003 or 0.004 inch deep all around, the plug will show an error of from 0.00025 to 0.001 inch, no matter how carefully the work has been done.

If the variation is slight, an indicator may be employed to determine the amount of error. Suppose the error does not exceed 0.00025 inch. The plug should be ground to within 0.00075 inch of size, after which the following kink may be employed for the finishing operation. First, determine the high and low sides of the plug and then place it on a magnetic chuck on the surface grinder. Start with a cut about 0.00025 inch deep on the high side and run to within about 1/32 inch of the low side. Then turn the plug over so that the opposite side is at the top and the 1/32 inch of stock left on the first side will raise the low side an amount equal to the error. A cut is now taken right across the work, after which the plug is again turned over to enable a slight cut to be taken across the first side. The two opposite sides will now be found to be perfectly parallel with each other. The two remaining sides of the work are then treated in the same way.

This idea is far better than attempting to shim up the work, a method which is entirely impractical where the total error is not more than 0.005 inch. It will be evident that by the method which has been described, a part of the work becomes the shim and this part is sure to be free of inequalities in thickness which would affect the accuracy of the work produced. The method has been thoroughly tried out in the toolroom in which the writer is employed, and it has given very satisfactory results.

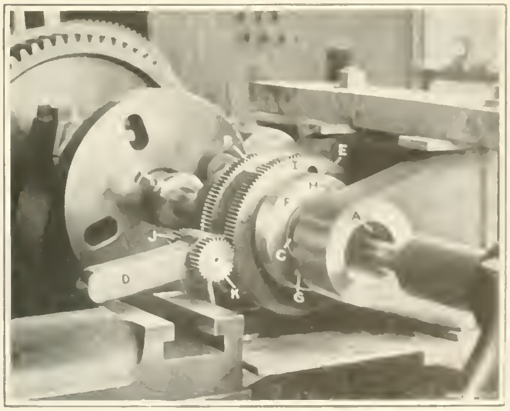
Plainfield, N. J. GUS ENGLER

AN UNUSUAL FACING DEVICE

The criticism is often made of manual training that the work is impractical and that it is only boy's play. The Stout Institute of Menomonie, Wis., works on the policy that the information a manual training school boy is given should be the same as that given to a vocational school boy or to an apprentice. The courses given to boys specializing in some particular branch of shop work are very practical. As an example of this, there is now being built by one group of boys, a couple of patternmaker's disk sanders. These machines were carefully designed and are being well built.

The equipment of the school does not include a boring machine, so it was necessary to bore the bearings of the main frame on the large lathe. The boring presented no especial difficulty, but the facing of the ends of the bearings was quite a problem. This was foreseen by the instructor and so the problem was presented to the class several weeks before the tools were needed. The various members of the class submitted solutions, many of which were impractical. After the design was agreed upon, the job was turned over to one Joe Prisk, who made the patterns and did the machine work.

The problem, simply stated, is to get a tool to travel across a radial face which must be truly flat and square with the



Facing Device developed to machine a Piece too Long to swing on the Lathe

axis of hole *A*. The accuracy required made it advisable to use a small pointed single tool. The lathe attachment shown in the accompanying illustration afforded a satisfactory solution of the problem. It consists of a differential gear and an eccentric. Gear *B* and eccentric *C* are secured to the shaft and lever *D* is a running fit on the shaft. Gear *E* is mounted

on a hub integral with lever D, and ring F is a working fit on eccentric C and carries tool G. Ring F is driven by the pin H which continues through gear E which is slotted at I to receive it. The gear must be slotted because in one position the pin is at the high side of the eccentric and at another it is at the low side. Lever D carries the two pinions J and K which are keyed to the shaft that carries them.

Gear B has 121 teeth and gear E has 120 teeth. Now as gear B is fixed to the shaft, it drives pinion J, meshing with it when the shaft is turned. This, in turn, drives pinion K on the opposite side of lever D and transmits motion to gear E. But the difference of one tooth causes gear E to gain one tooth during each revolution, thus causing ring F to slip ahead on eccentric C which is fixed to the shaft. If tool G is at the low side of the eccentric it will fall inside the hole. As ring F slips around eccentric C, tool G will move toward the high side of the eccentric, and in so doing will pass across the face of the casting. The attachment worked perfectly from the first and did not need any improvements to produce satisfactory results.

Menomonie, Wis. F. F. Hillix

HOW WE MADE THE SWITCH PARTS

We were hard pushed with work in the press department last fall, and there was nothing to do but put some of the work out. So we picked out the parts we didn't have tools for, and sent them out to a lot of shops in that line of work to see what prices we could get. We found one place up the valley that made us an exceptionally good offer, and they had a name for doing good work, so we sent them quite a lot—mostly switch parts—and among these was a piece like that

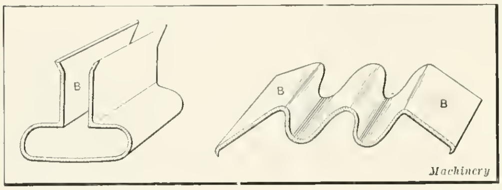


Fig. 1. Switch Part to be made Fig. 2. Blank produced by First Operation on Switch Part

shown in Fig. 1. It was not a hard piece to make—at least, we did not think so then—and the only difficult point was that the printed matter guaranteed 80 per cent contact at B, where the switch blade fitted in when the switch was closed.

They accepted the offer, made their own tools, and in due time the parts began to come back. They were fine. In fact, it was the best press work we had seen in a good while, even better than we were doing ourselves, and we claimed to do good work too. Well, they made the parts for nearly a year, and then we got over our rush. The original contract had long expired, so as fast as we could make the tools we took the work into our own shop, but when we came to the switch springs we seemed to be "up against it." We tried two or three ways to make them. First we tried to U them up and flatten the U, and then we tried a press with a side attachment that was used on other work of this kind, but in spite of all we could do, we could not get the 80 per cent contact on the side. It would come out nearer 8 than 80 per cent.

One day the "super" came along and saw what we were trying to do and said:

"Don't fool all your time away on those tools. I'll write up the valley and ask Brown how he makes them. In fact, I'll get him to send a sketch of the tools."

He wrote up, and got a nice letter back. They said they were glad we liked the punchings and were sorry we were going to make the parts ourselves, and while the contract called for making the punchings at such a price, they did not find anything in it about furnishing tools or information how to make them, and though they would be pleased to renew the contract they humbly begged to be excused from furnishing any sketches for tools. They said they did not know much about press tools anyhow. That put us in a hole; or rather it left us in the same cavity we were in before we wrote for the information.

Now, when Brown sent the work in, we used to check up the amount in the usual manner, by weighing the lot and counting out a pound to see if it was O. K. One day the girl who was doing this work said:

"Mr. Press, here are two pieces of work that look funny. I don't think they belong to us. Will I throw them out?"

She was talking to the "super," but the foreman of the toolroom happened to be passing at just that moment, and he grabbed the pieces as though they were made of gold instead of copper.

"Throw out nothing," said he, "pay for them; they are worth their weight in gold to us."

And as he turned to the "super," he said, "There it is, Mr. Press, right there. That's the first operation we've been trying so hard to get. We can make the switch parts without any trouble now, and save an operation in doing it, too."

As will be seen from Fig. 2, the principle employed in making the pieces was to use the whole power of the press on the contact surfaces, leaving them straight and true and just the shape desired.

We went ahead and finished the tools and are now making the parts, and poor Brown has really shown us how to do it, although he doesn't know it. A. P. Press

THE REAL PURPOSE OF A DRAWING

The real purpose of a drawing is often misunderstood by the mechanic who uses it. This is especially true in the development of new apparatus. The prevailing idea among mechanics is that the drawing should be correct in details and design. That is the designer's job, and if not correct, he is a "light weight" in the mechanic's opinion. This is the wrong viewpoint. Since it is utterly impossible to explain verbally or in writing what is wanted, the drawing acts as the most satisfactory medium of explanation. If verbal or written explanation were possible, there would be no need of designs and drawings except for the sake of record and duplication. It is impossible for the mechanic to view a new piece of apparatus in his mind as it will actually appear, from a description only, and it is the designer's duty to picture the apparatus on paper so that the mechanic can build it. Simplicity constitutes good design, and in order to obtain it frequent changes and improvements are necessary in building an apparatus.

The real purpose of the preliminary drawing is to give the mechanic the knowledge necessary to start work. If, in the mechanic's opinion, some improvements can be effected over the method shown on the drawing, his ideas should be advanced and considered. Many mechanics know that a design is wrong or could be improved upon but keep silent, delighting in "putting it over" on the designer by making the part wrong because it is shown wrong on the drawing. Eventually the designer or someone not directly connected with the work will see the error and receive credit for the improvement. There are instances where four, five or six machines are built before one is fully satisfactory, but each one develops improvements. A drawing was required to start the first one, so the real purpose of the drawing was to make the start. When the machine is satisfactory, the drawings are corrected for record and duplication. After the drawings are corrected, the mechanic may be justified in "knocking" the draftsman if he finds an error.

This misunderstanding of the purpose of a drawing is not always confined to mechanics, but extends even to some foremen. If they look forward to greater responsibilities, they should strive to improve and not condemn a poor design.

There is a somewhat similar weakness in some draftsmen—and incidentally they will remain draftsmen all their lives—who draw only that which is told them and nothing more. If they have any ideas of their own they should incorporate them in the design, even if they are not accepted. Whatever may have been put on the drawing leads to discussion, and discussion leads to other ideas, some of which may be utilized in the final design. The man in charge can explain changes in design more readily than he can furnish all the information necessary. In this case the purpose of the drawing is to de-

velop the imaginary ideas of the inventor or designer in their preliminary stages.

Watertown, Mass. W. J. Bitterlich

[The foregoing refers, of course, only to preliminary drawings of new mechanisms or machines. A drawing which is to furnish directions regarding the manufacture of a part of some standard machine such as an automobile or typewriter should contain specific information regarding size, finish, material, etc. There should not be the slightest doubt of the correctness of this information. It is generally accepted that data contained on drawings of this type should be infallible, the same as all other data that is supplied to a manufacturing department, such as instruction cards, etc. To furnish a manufacturing drawing that is not complete in every detail is a serious matter. The proper condition is for the drafting-room and planning department to cooperate in furnishing the shop or manufacturing department with all the drawings, orders and various other information necessary to produce a part that must be interchangeable.

In the development of a new mechanism on the drawing-board, however, there is a definite limit to the ideas that can be laid out in the drawing. After a design has been carried so far on a drawing-board, it is absolutely essential that a model be made. The making of this model will no doubt bring out ideas that will make it advisable to redesign the mechanism on the drawing-board. Thus it is essential that the closest cooperation exist between the makers of the experimental mechanism and the engineering department. The value of cooperation cannot be over-emphasized by the management. Also, no pains should be spared to acknowledge the value of an idea submitted by a subordinate. The overlooking of this point has killed originality in many a young man. Editor.]

MACHINING ANGULAR SURFACES

One of the most common complaints which the machinist makes about the draftsman's work is that he has failed to give complete dimensions for angular surfaces which have to be machined. As a result, the machinist is required to do a certain amount of figuring for himself, and as this is work with which he may not be thoroughly familiar, he may make a mistake. It is my purpose to describe a method of machining such surfaces, in which the machine is required to make the calculations, and this will doubtless prove of interest to machinists who are not thoroughly grounded in mathematics. Fig. 1 shows part of an angular sided groove in a circular cutter, the drawing for which was dimensioned as shown. As the inner corners of such grooves are generally filleted it is not possible to start the angular cut at the bottom of the groove and work out—a method which would result in determining the width *AD* by setting over the compound slide to an angle of 2 degrees, 30 minutes. But with a filleted groove of the form shown, it is necessary to set over the compound rest to the required angle and start the cut at the top of the groove, as shown in Fig. 2.

The method of procedure is as follows: With the compound rest set at an angle of 2 degrees, 30 minutes, in the proper direction for cutting the right-hand side of the groove, the tool is made to touch corner *A*; and with the carriage and cross-feed locked the tool will traverse along line *AG* when moved by the compound slide. But if, when the cutting point of the tool is just touching corner *A*, it is first traversed back along line *GH* for a distance slightly in excess of 0.375 inch and then traversed forward 0.375 inch by the cross-feed slide, the cutting point of the tool will lie on line *IF* which is a continuation of surface *FB* which it is required to machine. Should it happen that the wedge shaped piece *ABF* is too large to be removed by a single cut, it may be divided into as many cuts as required by feeding the cross-slide forward through any suitable portion of the total 0.375 inch before starting to take each cut.

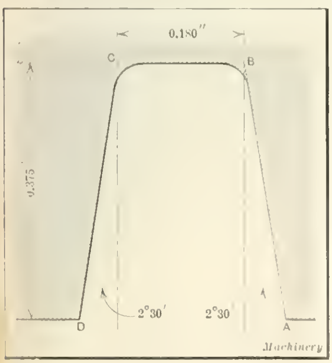


Fig. 1. The Way in which Dimensions were given

Should it happen that corner *A* is not perfect, a trial cut may be taken, after which the distance of the point from the outside of the work may be measured; the cross-feed slide is then fed up the remainder of the 0.375 inch, after which a finishing cut is taken. In doing work of this kind it will be found advisable to leave a light finishing cut to be taken over the outside of the work after the angular surfaces have been machined. When this practice is followed, the finishing cut will decrease the depth of the groove. It will be readily seen that the method described can be applied to any form of angular or taper work.

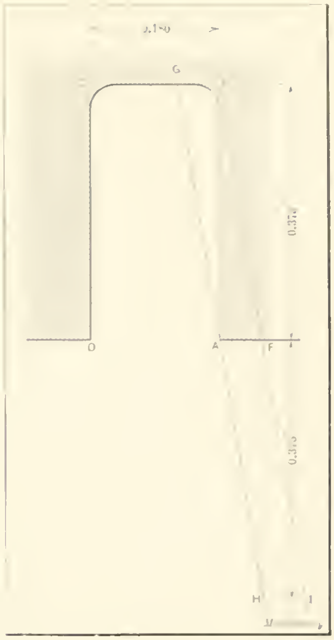


Fig. 2. Method of doing Work by which Dimensions are determined by Machine

Wilkinsburg, Pa. William S. Rowell

DRILLING PIN HOLES FOR DRIVING FIT

When it is required to drill holes of such a size that pins inserted in them will have a driving fit, the following method will give satisfactory results. Each hole is first drilled with a drill one size smaller than the stock from which the pin is made. A drill of the same size as the stock is then mounted in the drill spindle and the lever feed is employed to feed the drill through the work as rapidly as possible. The faster the drill is fed, the smaller will be the size of the hole, and hence the tighter the fit of the pin.

Wausaukee, Wis. W. E. Butler

BABBITT BEARING MOLD

In the October number of Machinery, a description was published of a babbitt bearing mold which was claimed to be more efficient and longer-lived than the mold I described in the March number. In view of the fact that I am concerned with the babbitting of bearings and similar work almost every day, I feel justified in offering a few criticisms not because the design referred to differs from my own, but because some of its shortcomings are too serious to pass unnoticed.

In the first place, the mold sections are held together by a spring extending across pins that are located so close to the hinge that only a small leverage is provided. Furthermore, any slight wear in the hinge, which is practically bound to occur, will result in throwing the molds out of alignment. Another difficulty is likely to result from the fact that the high temperature of the mold will be likely to affect the tension of the spring and allow the mold to open enough to cause leakage between the core and mold sections. Even if the spring is in good condition, sticking of the mold will often cause leakage and the metal will overflow into the hinge and cause trouble. Unless the molds are absolutely tight and always kept accurate, the wall of the bearing will not be uniform.

After casting a bearing liner in this mold, a center piece is driven up with a hammer in order to cut off the gate or sprue. In the writer's opinion an operation of this kind, performed while the bearing is still hot, will be almost sure to cause serious distortion. But probably the most serious defect of the mold is the fact that no provision appears to have been made for allowing the air to escape, and such provision is more necessary in a steel mold than in a sand mold. The casting is also gated at the top, which would increase the probability of trapping the air in the mold. After noticing these defects, I fail to see the justification for the claim that this mold is more efficient than the one described in the March number of MACHINERY. S. SUCRAM

DRYING AIR FOR THE SAND BLAST

On damp days we experienced trouble from the moisture in compressed air causing the sand to clog in the nozzles of our sand blasts, and at times from one-third to one-fourth of the operator's time would be occupied in endeavoring to clear away the obstruction. Several ways were suggested for drying the air, such as using a filter composed of pebbles and spongy material or passing the air through calcium chloride which is successfully used as a laboratory drying agent. The method which finally offered a solution of the problem consisted of placing gas burners beneath the main air pipe leading to the sand blasts, and since this plan was put into operation we have had absolutely no trouble from moist sand causing the apparatus to clog.

The reason is quite simple. When moist air is compressed its volume is reduced, but the moisture remains the same. As the air leaves the compressor and passes into the air tank, it cools and allows some of the excess moisture to drop to the bottom of the tank where it causes no further trouble; but the air as it leaves the compressor tank continues to cool and lose moisture. If, on the other hand, the air is heated just before it goes to the sand blast, the moisture is retained and the air is said to be "dry." Only a small flame is required to heat the air, as a few degrees rise in temperature accomplishes the desired result. The same method may be employed in all processes using compressed air, where the presence of much moisture in the air is found to be objectionable.

Kenmore, N. Y. GEORGE B. MORRIS

APPLICATION OF DOUBLE WEDGE TO DIE WORK

In designing special fixtures for punch press work, it frequently happens that some part of the fixture must travel in a horizontal plane while the ram of the press moves in a vertical plane. In cases of this kind, it is customary to fasten a cam directly to the punch-block or holder, as shown in Fig. 1. Y indicates the vertical travel of the ram, causing the slide A to move through the distance X. As long as the distance X is the same or smaller than Y, no particular trouble will be encountered, but with a reversal of conditions, difficulties are experienced. The angle P should not exceed 40 to 45 degrees. If the power necessary to move the slide A is excessive, a small angle at P would be necessary. This small angle of necessity limits the length of the travel of the part A. If the travel of the slide A is considerable, some modified cam principle must be used.

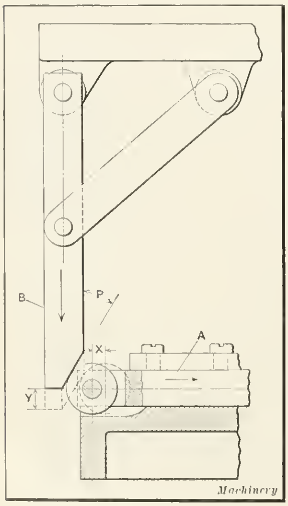


Fig. 1. Simple Single Angle Cam

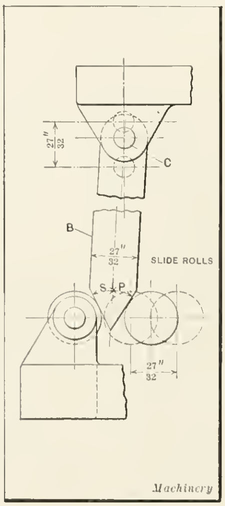


Fig. 2. Double Wedge Cam

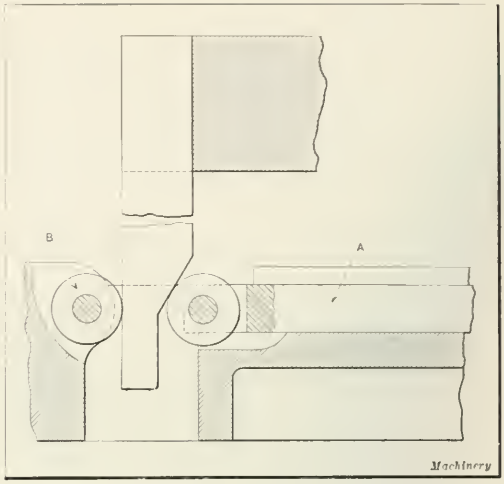


Fig. 3. Single Angle Cam with Roll for taking Thrust

A simple modification is suggested in Fig. 2. The cam B instead of being firmly attached to the punch-holder is free to rock about the pin C. The working end has a double taper, one side bearing on a roll in the slide and the other against a stationary roll on the fixture. In this instance, the angles S and P are each equal to 30 degrees, and the slide moves 27/32 inch forward while the cam descends the same distance.

It will be seen that by this device the downward component of the pressure on the slide may be kept quite small; furthermore, the resistance offered to the slide produces internal stresses within the base instead of making a cantilever of the cam B, as in Fig. 1.

Flint, Mich. M. TERRY

[An improvement over the method shown in Fig. 1 is shown in Fig. 3. Here, instead of the thrust of the slide being taken by the cam as in Fig. 1, it is taken by the roll B, which is mounted in the die.—EDITOR.]

DRILLING SMALL HOLES STRAIGHT

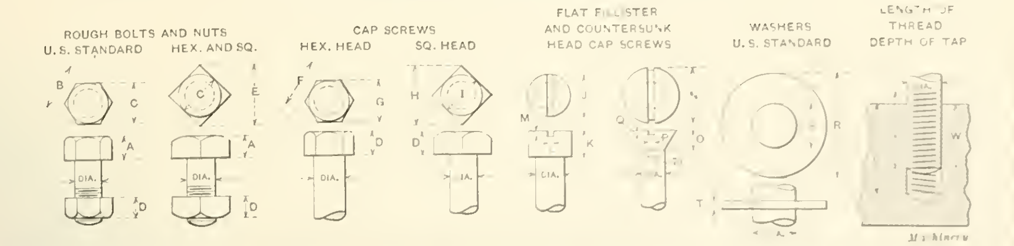
When it is required to drill deep holes with a small drill of some such size as No. 30, it is not an easy matter to keep the holes straight. The first step is to grind the drill carefully. The work is then clamped to the faceplate of a lathe, using a center indicator to locate it in the desired position. The drill is then mounted in a drill chuck and the chuck placed in the tailstock, but left loose so that it may be turned from time to time. After drilling to a depth of from 1/16 to 1/8 inch, the drill chuck is turned from one-quarter to one-half revolution, so that all the cutting will not be done with the drill in the same position. By turning the chuck in this way at intervals of about 1/8 inch, holes as deep as 3 inches may be drilled perfectly straight.

Wausaukee, Wis. W. E. BUTLER

MARKING SCALES ON DRAWINGS

Here is a suggestion for draftsmen when marking the scales of drawings. Instead of marking the drawing scale one-half size, or twice the actual size, make a large S, and in the upper

TABLE OF CONDENSED SCREW DATA



Dia.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1/8	..	..	..	..	..	..	..	..	..	3/16	1/8	0.032	1/16	1/4	3/32	0.040	3/64						
3/16	..	..	..	..	..	..	..	..	..	1/4	3/16	0.040	1/16	3/8	9/64	0.064	3/64	[illegible]	1/4	3/64	.	.	
1/4	1/4	37/64	1/2	1/4	23/32	1/2	7/16	17/32	3/8	3/8	1/4	0.064	1/16	15/32	[illegible]	0.072	1/16	3/4	[illegible]	1/16	.	.	
5/16	19/64	11/16	19/32	5/16	27/32	37/64	1/2	5/8	7/16	7/16	5/16	0.072	5/64	5/8	7/32	0.102	5/64	7/8	3/8	[illegible]			
3/8	11/32	51/64	11/16	3/8	31/32	21/32	9/16	47/64	1/2	9/16	3/8	0.091	3/32	3/4	17/64	0.114	3/32	1	[illegible]	[illegible]	.		
7/16	25/64	29/32	25/32	7/16	1 7/64	23/32	5/8	51/64	9/16	5/8	7/16	0.102	7/64	13/16	[illegible]	0.114	3/32	1 1/4	1/2	[illegible]			
1/2	7/16	1 1/64	7/8	1/2	1 1/4	7/8	3/4	57/64	5/8	3/4	1/2	0.114	1/8	7/8	[illegible]	0.128	[illegible]	1 3/8	[illegible]	[illegible]	1	7/8	3/4
9/16	31/64	1 1/8	31/32	9/16	1 3/8	15/16	13/16	31/32	11/16	13/16	9/16	0.114	9/64	1	[illegible]	0.133	7/64	1 1/2	5/8	[illegible]	1	[illegible]	
5/8	17/32	1 15/64	1 1/16	5/8	1 1/2	1 1/64	7/8	1 1/16	3/4	7/8	5/8	0.128	5/32	1 1/8	[illegible]	0.133	1/8	1 3/4	[illegible]	1/8	1 1/8	1	7/8
3/4	5/8	1 29/64	1 1/4	3/4	1 25/32	1 5/32	1	1 15/64	7/8	1	3/4	0.133	3/16	1 3/8	[illegible]	0.133	5/32	2	[illegible]	[illegible]	1 3/8	1 1/8	1
7/8	23/32	1 43/64	1 7/16	7/8	2 1/32	1 19/64	1 1/8	1 13/32	1 1/8	1 1/8	7/8	0.133	7/32	..	..	.....	..	2 1/4	[illegible]	[illegible]	1 5/8	1 3/8	1 1/8
1	13/16	1 7/8	1 5/8	1	2 19/64	1 7/16	1 1/4	1 39/64	1 1/4	1 1/4	1	0.165	1/4	..	..	.....	..	2 1/2	[illegible]	[illegible]	1 3/4	1 1/2	1 1/4

loop put the numerator, and in the lower loop the denominator of the fraction indicating the scale. Thus in one-half scale, it would be indicated by a large S in which 1 would appear in the upper loop and 2 in the lower loop. In the same way if the scale were twice normal size, the 2 would appear in the upper loop and the 1 in the lower loop. By the same rule, 1 would appear in the upper loop of the S and 1 in the lower loop also when the drawing is full size, or 1 to 1.

Prince Bay, S. I., N. Y. WILLIAM H. DAVID

CONDENSED SCREW DATA

The table given herewith is of interest only because of the condensed manner in which the data is presented. The information is not new, but was gathered from different parts of standard handbooks and made into one table. The designer who wishes to obtain the dimensions on bolts, cap-screws, flat and fillister head screws, washers, and depth of tapped holes, may get this information quickly by referring to the table.

Cleveland, Ohio. L. J. HENGESBACH

BOOKS ON SCIENTIFIC MANAGEMENT*

The editor of MACHINERY receives many inquiries relating to books on various subjects, and is often requested to recommend the best works dealing with the different phases of management and engineering. These requests indicate that many more readers are interested in the literature of management and kindred topics, and it is believed that the following list of books, which are conceded to be authoritative, will be appreciated by a wide circle of readers.

* The books given in the accompanying list are not published by the Industrial Press, but the names of the publishers will be furnished on request, or copies will be sent postpaid on receipt of price.

Applied Method of Scientific Management. By F. A. Parkhurst. 325 pages, 6 by 9 inches. Price, $2.

This book gives a description, in complete detail, of the methods of scientific management installed at the works of the Ferracute Machine Co. As regards details of scientific management, it is unusually complete.

Cost Keeping and Scientific Management. By H. A. Evans. 252 pages, 6 by 9 inches. Price, $3.

This is a practical treatise especially applied to machine shop work, describing the author's methods as applied at the Mare Island Navy Yard. It shows what may be done in installing scientific management by a competent manager, without the aid of experts.

Factory Organization and Administration. By Hugo Diemer. 380 pages, 6 by 9 inches. Price, $3.

This is an unusually complete book covering the details of organization and administration, from factory location and building, through departmental organization and relation, to cost and wage systems.

Industrial Plants. By Charles Day. 294 pages, 5 by 7½ inches. Price, $3.

This book contains instances of the application of some of the principles of scientific management to the design and construction of industrial plants. The book is recommended as a reliable guide in modern plant construction.

Installing Efficiency Methods. By C. E. Knoeppel. 260 pages, 7 by 10 inches. Price, $3.

This book explains step by step the method used for attaining greater output at lower cost, and contains descriptions of practice as distinct from a mere declaration of principles. The book undertakes to answer the questions which any one planning to install scientific management would naturally ask.

Maximum Production. By C. E. Knoeppel. 365 pages, 5 by 7½ inches. Price, $2.50.

In this book the machine shop and foundry are considered as twin factors in production, and the principles of scientific management are explained in their application, first to the shop and then to the foundry.

Motion Study. By F. B. Gilbreth. 116 pages, 5¼ by 8 inches. Price, $2.

This is a valuable study of the various factors involved in the performance of manual labor, and is illustrated with photographs and tables showing the author's methods and results in studying workman's motions in the brick-laying trade. It is highly recommended for students of the details of time and motion study.

Primer of Scientific Management. By Frank B. Gilbreth. 108 pages, 5¼ by 8 inches. Price, $1.

This is an elementary, popularly written presentation of the fundamental principles of scientific management, explaining the Taylor system and answering some of the criticisms raised against it.

Principles of Industrial Organization. By Dexter S. Kimball. 300 pages, 6 by 9 inches. Price, $2.50.

This book does not explain any special form of industrial management, nor does it undertake to give complete details, but it contains a careful analysis of the principles underlying the problem of industrial organization.

Principles of Scientific Management. By F. W. Taylor. 144 pages, 6 by 9 inches. Price, $1.50.

This is a popular restatement of the principles of scientific management, as made by the author after his retirement from active practice. It deals with the principles in a more general way than in the author's "Shop Management."

Production Factors. By A. Hamilton Church. 200 pages, 5 by 7½ inches. Price, $2.

This book deals with the proper distribution of the expense burden in manufacturing, and relates especially to the cost system and the work of the cost accountant.

Science and Practice of Management. By A. Hamilton Church. 535 pages, 5 by 7½ inches. Price, $2.

This book contains a general analysis of the factors involved in industrial management, the purpose being to ascertain the fundamental factors influencing production, not from the viewpoint of cost, but of management.

Scientific Management. By C. B. Thompson. 878 pages, 6 by 9 inches. Price, $4.

This is a collection of articles published in the engineering press and papers presented before engineering societies, dealing with the various phases of scientific management. The work gives a clear and complete survey of the subject of scientific management.

Shop Management. By F. W. Taylor. 144 pages, 6 by 9 inches. Price, $1.50.

This was the first important contribution to the subject of scientific management, and comprises a summary of Taylor's theories. The book is a reprint of the paper delivered by Mr. Taylor before the June, 1903, meeting of the American Society of Mechanical Engineers.

Twelve Principles of Efficiency. By Harrington Emerson. 423 pages, 5 by 7½ inches. Price, $2.

This book deals with the philosophy of scientific management, dividing the subject into twelve principal parts, five of which concern the relations between employer and employe, and seven, industrial methods in the works.

Work, Wages and Profit. By H. L. Gantt. 312 pages, 5 by 7½ inches. Price, $2.

The main principles of the application of scientific management to industrial work are dealt with in this book, the essential factors involved in the system being explained without going into minute details as to how the system is applied in any specific case. It is a "classic" on general principles.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

CADILLAC SCREW THREAD

C. M. C.—What is the Cadillac screw thread?

A.—The Cadillac screw thread is the thread used by the Cadillac Motor Car Co., Detroit, Mich. It differs from the U. S. standard thread in that, while the sides are inclined to each other 60 degrees and it has a flat top, the bottom or root of the thread is a sharp V. Thus it partakes of the characteristics of both the U. S. standard thread and the sharp V-thread. In this respect, the Cadillac thread is like the International metric thread. The specifications for the International metric thread leave the shape of the root of the thread to the discretion of the user. It may be a sharp V and have a rounded fillet, or flat top, so long as the depth is sufficient to clear the tops of the thread in the nut.

KEROSENE IN BEARINGS

W. E. R.—I would like to have your opinion on the use of kerosene oil in bearings. "A" claims that putting kerosene in the bearings of a machine is beneficial, as it removes the gum and worn-out oil, while "B" claims that kerosene is necessarily injurious, because it dissolves rust and therefore it might dissolve the metal of the bearings.

A.—Kerosene oil has little or no lubricating property, but its use in bearings to remove gum and worn-out oil is an excellent practice provided it is flushed out with a liberal application of lubricating oil so that the bearings are left in a well lubricated condition to start. The fact that kerosene dissolves rust is no indication whatsoever that it would dissolve metal; as a matter of fact, it has little or no deteriorating effect on steel, brass, bronze or iron.

REMOVING SCALE FROM SHRAPNEL FORGINGS

C. C. N.—We would appreciate information on the following questions in connection with the pickling of forgings for three-inch Russian shrapnel. Would the method of pickling be the same for a shell that has been rough-turned from soft forging and then heat-treated, the remainder of the machining operations having been performed on the oil-tempered forging, as for an oil-tempered forging on which the machining operations have been performed so that no heat-treatment is necessary? Is a ten per cent solution of sulphuric acid in water most satisfactory for pickling? If not, what per cent of acid is recommended? At what temperature should the solution be maintained for the most effective removal of the scale? How long should the forging be submerged in the pickling solution? When neutralizing the acid, should a hot soda solution bath be used followed by a second washing in hot water, or is the soda solution bath sufficient? Has experience shown that pickling will entirely loosen the scale, or is it necessary to tumble the shells to knock the scale off during pickling or after pickling?

A.—The accepted method of manufacturing shrapnel shells is to perform the preliminary operations before heat-treating; then to heat-treat the shell and close in the nose. After that, the second series of operations is performed. Some manufacturers are machining shrapnel shell forgings without pickling, but unless the forgings are quite free from scale, this is not advisable. Very few, if any, manufacturers are pickling the shrapnel shells after heat-treatment. The scale is removed by sand-blasting only at the base end in order to take the scleroscope reading. Of course, the shells are either turned or ground after heat-treatment and scale is seldom objectionable for either of these machining operations. For cleaning forgings, a ten per cent sulphuric acid pickling solution is sufficient, and its temperature should never be above 150 degrees F. A high temperature of the pickling solution is objectionable because of the noxious fumes that are given off. The forging should remain in the pickling solution for forty-five to sixty minutes, depending on the size and the amount of scale to be removed. The best method of neutralizing the acid is to wash the forgings in a solution of hot limewater, then in either hot water or running cold water. Both methods are employed, but the use of hot water is preferable. There is a difference of opinion as regards results of pickling. The French government specifies that its high-explosive shells shall be wire-brushed following heat-treatment to remove all the scale, but one manufacturer making French shells has found that this operation is unnecessary and that pickling the forgings in a ten per cent solution for one hour removes all scale.

HOW TO READ A MICROMETER

A. L. M.—Will you please publish plain instructions for reading the micrometer? I do not understand the principle on which it operates.

Answered by J. T. Slocomb, Providence, R. I.

The micrometer divides the inch into one thousand parts. As usually made it has a 40 pitch screw which advances though its nut 0.025 inch per revolution. It is evident that if the measurements to be made were 0.025 inch or less, the graduations on the end of the revolving thimble, and the indicating or datum line on the stationary part would be sufficient. But to measure a greater range, it is necessary to have some means of counting and adding together the additional revolutions of the screw. This is accomplished in an ingenious and simple manner by the graduating and numbering used, and is plainly shown in the accompanying illustration. The cross lines on the sleeve are spaced 0.025 inch apart—a distance equal to the pitch of the screw. A revolution line is cut lengthways of the

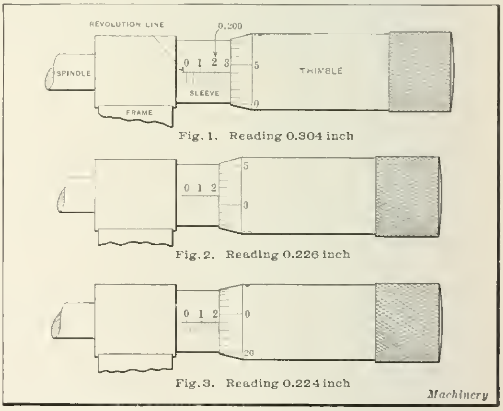


Fig. 1. Reading 0.304 inch

Fig. 2. Reading 0.226 inch

Fig. 3. Reading 0.224 inch

How to read a Micrometer

sleeve which, in connection with the zero line on the thimble, records whole revolutions of the screw. When the end of the thimble matches any one of the cross lines and the zero line matches with the revolution line, the number of spaces exposed denotes the number of revolutions made. Every fourth cross line is numbered from 0 to 10. In Fig. 1 the reading is 0.304 inch, showing 0.300 inch on the sleeve and 0.004 inch on the thimble. In Fig. 2 the reading is 0.226, showing 0.225 inch on the sleeve and 0.001 inch on the thimble. In Fig. 3 the reading is 0.224 inch, showing 0.200 inch on the sleeve and 0.024 inch on the thimble. The figures should be taken off the sleeve as hundreds, that is, 100, 200, 300, etc. The thimble is shown purposely close to the lines in the illustration, as these are the points where a mistake is most likely to be made. In the 0.226 reading, the end of the thimble appears to match the cross lines nearly, but it is evident that it really does not, for the reason that the zero lines on the thimble and sleeve do not coincide but are one space advanced, which, of course, we add to the 0.225 making the reading 0.226 inches. The same is true in the 0.224 reading, but the zero line has gone by one space, making the reading 0.224.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

DIAMOND RIFLE BARREL AND RECEIVER DRILLING MACHINES

It will be seen that these machines provide for drilling two rifle barrels or two rifle receivers simultaneously. They are duplex machines in every sense of the word, being provided with two heads for driving the work, two tailstocks for holding the drills, and independent feed mechanisms and oil pumps for delivering lubricant to the work through the hollow drills. Connection between the pumps and tailstocks is made by telescopic tubes which adjust themselves to the constantly changing positions of the carriages as the drills are fed into the work. The design of these machines, as well as of the reaming and rifling machines described on the following pages, follows established practice for machines of these types, but the present activity in munitions manufacture makes them of peculiar interest. The manufacture of these machines has only recently been taken up by the Diamond Machine Co.

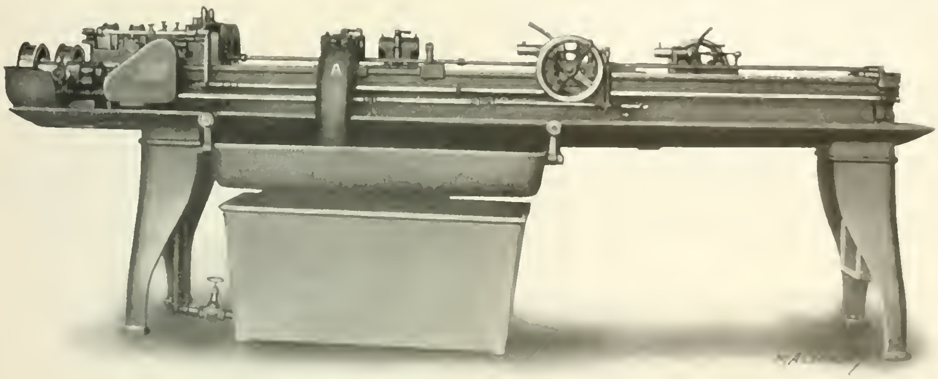


Fig. 1. Rifle Barrel Drilling Machine built by the Diamond Machine Co.

Any machinist who has had experience in the drilling of deep holes will appreciate the difficulties encountered in drilling a hole through steel rifle barrels 30 inches in length and maintaining an extremely high degree of accuracy in the work. But the study which has been made of the method of doing this work by the Diamond Machine Co., Providence, R. I., has resulted in the production of machines and drills capable of giving extremely satisfactory results. The most noteworthy feature of the operation to the mechanic who has had experience in drilling deep holes with ordinary drills, where it is necessary to back the drill out at frequent intervals in order to clear the chips, is the fact that the operation is continuous. This has been made possible by constructing a special type of drill which is made hollow so that a copious flow of cutting compound may be delivered right to the point of the drill where it is most effective in dissipating the heat of the cut, and which has a groove down the side through which the oil escapes, washing away the chips as fast as they are produced.

The drill is made of sufficient length to extend entirely through the rifle barrel. The body of the drill is made of steel tubing which is rolled in at one side in order to produce the groove which provides for the escape of oil and chips from the work. The point of the drill is made of drill rod, and, as previously mentioned, there is a hole which provides for the delivery of oil direct to the point. A groove is ground down the side of the drill in order to continue the groove which has been rolled in the steel tube; and the drill point is soldered to the end of the tube. The description will be better understood by referring to Fig. 4 which shows one of the drills.

It will be seen that the drilling machine provides for working on two rifle barrels at a time. The barrel forging is supported in a chuck in the headstock spindle, this chuck consisting of a tapered socket which is serrated so that a firm

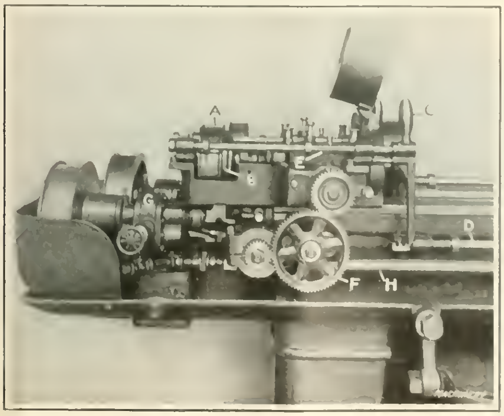


Fig. 2. Close View of Driving Mechanism with Gear Guard removed

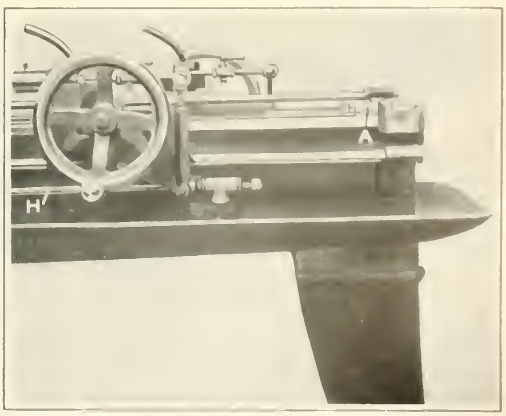


Fig. 3. Tail End of Machine, showing Tailstock Buffer Springs

grip is secured on the work when the end of the forging is driven into place by tapping the opposite end of the barrel with a lead hammer. The outer end of the work is supported by a bushing at the left-hand side of rest A, and at the right-hand side of this rest there is a guide bushing which is a close fit around the point of the drill. The work rotates and the drill is fed to the work by traversing the tailstock in which the shank of the drill is supported. As the drills are long and thin, it will be evident that some intermediate support is necessary, and this support is afforded by means of a steadyrest. This description and that which follows apply to one side of the machine, but it will be evident that the entire machine is composed of two sets of mechanism like that described.

Fig. 4. Cutting End of a Rifle Barrel Drill

The arrangement of the drive will be best understood by referring to Fig. 2 which shows the mechanism quite clearly, but in connection with this description it should be understood that guards are provided over all gearing on the machine. The drill at the front of the machine is driven by pulley A which is mounted at the back of the spindle, and the power is transmitted through a friction clutch B which is held in engagement by the pointed end of lever C that engages a shoulder at the end of the horizontal rod D. But when the tailstock has been traversed far enough along the bed of the machine so that the hole has been drilled entirely through the rifle barrel, a dog on the tailstock engages an adjustable stop carried by rod D, with the result that this rod is rocked down so that the shoulder disengages the end of lever C. As a result, compression spring E becomes effective and throws clutch B out of engagement, thus stopping both the rotation of the spindle and the feeding of the drill to the work. The feed motion for the tailstock is transmitted from the spindle through a worm and wheel, change-gears F, and a second worm and wheel to a lead-screw located inside the bed of the machine. This lead-screw traverses the tailstock in the same way that the lead-screw of an ordinary engine lathe moves the carriage along the bed of the machine.

In connection with the description of the drill it was mentioned that means are provided for clearing the chips from the hole by delivering a flow of oil through a tube in the drill and allowing it to escape by way of a groove at the side. The oil employed for this purpose is contained in a reservoir located beneath the machine, and the pump which is connected with this reservoir is shown at G, this pump being driven by a large pulley at the left-hand end of the machine. In order to provide for supplying the hollow drill with oil as the tailstock is traversed along the bed of the machine, connection is made with the tailstock and end of the hollow drill by means of a telescopic tube H through which oil is pumped from the reservoir. In order to secure satisfactory results in clearing the chips from the hole, it is necessary to have the oil at a pressure of not less than 800 pounds per square inch, and under actual working conditions this pressure is generally quite close to 1000 pounds per square inch. It will be evident that this pressure resists the action of the lead-screw in traversing the tailstock along the bed, and results in a tendency for the tailstock to move over toward the right-hand end of the bed.

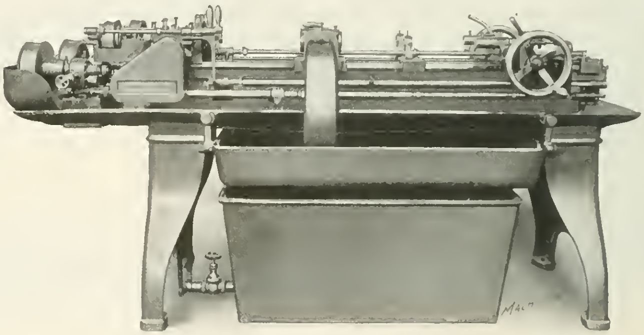


Fig. 5. Diamond Rifle Receiver Drilling Machine

After the drilling operation has been completed, the split nut by which connection is made between the lead-screw and tailstock is released in order to move the tailstock back to the starting position. Evidently when the split nut is released in this way there is a possibility of the residual pressure in the oil tube causing the tailstock to be thrown back with considerable force, and cases are on record where a machine has actually been wrecked in this way. To obviate trouble from this source, a buffer spring is provided as shown at A, Fig. 3, which will absorb the shock in case the tailstock is thrown back in this way. It will be evident that with oil at a pressure exceeding 800 pounds per square inch, it is necessary to provide an effective form of guard to prevent it from being thrown from the point at which it escapes from the end of

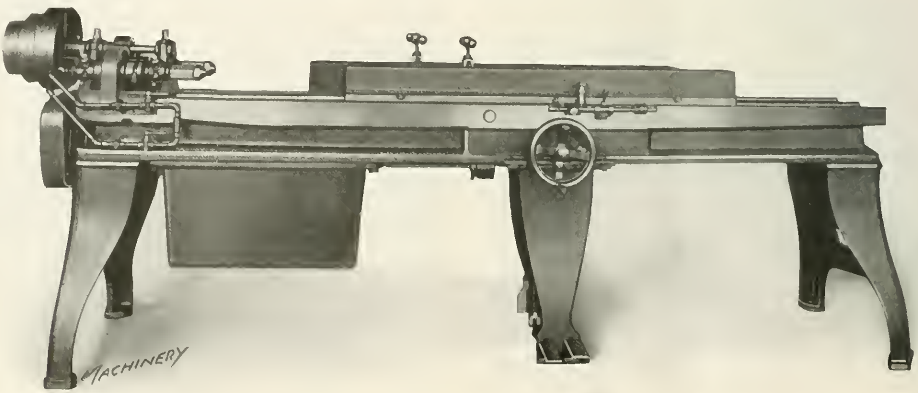


Fig. 1. Rifle Barrel Reaming Machine built by the Diamond Machine Co.

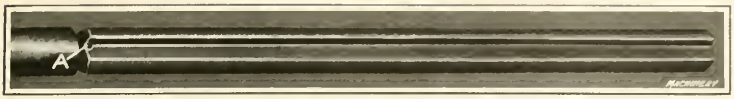


Fig. 2. Type of Reamer used for reaming Rifle Barrels

the hole in the work. These means are provided by guard *A*, Fig. 1, which carries the bushing that supports the outer end of the rifle barrel; the oil and chips escape into this guard from which they drop down into the pan under the machine. This pan is provided with a strainer which holds back the chips, but allows the oil to flow through into the reservoir where it is ready to once more be pumped to the work.

When working on military rifles, these machines are ordinarily driven at a speed of 1500 revolutions per minute and the drill is fed to the work at rates of feed which cover a range of from 0.2 to 1.0 inch per minute. The rate of production is about three barrels per hour from each two-spindle machine, *i. e.*, a barrel forging can be set up in the machine, drilled and removed in approximately forty minutes. Fig. 5 shows a machine built by the Diamond Machine Co. which is

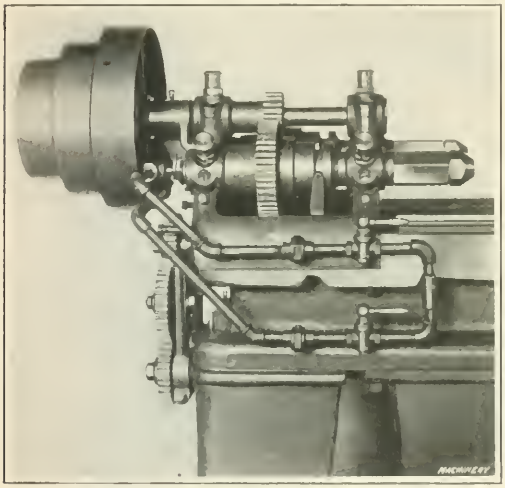


Fig. 3. Close View of Head End of Machine with Guards removed to show Transmission

of essentially the same design as the rifle barrel drilling machine which has just been described. This machine, however, is used for drilling the receivers of rifles, and as the work is considerably shorter than a rifle barrel, it is unnecessary to provide so great a capacity. As a result, the rifle receiver drilling machine is made much shorter.

DIAMOND RIFLE BARREL AND RECEIVER REAMING MACHINES

As in the case of the Diamond drilling machines, these machines for reaming rifle barrels and receivers provide for working on two barrels or two receivers at a time. It will be evident that the work is supported by fixtures mounted in independent carriages which provide for feeding it over the reamers mounted in the revolving spindles. The rifle barrel reamers are hollow so that oil is fed through them to the work. The reamers used for the receivers are solid, and in this case lubricant is supplied through a tube connected to the open end of the work by means of special stuffing-boxes clamped to the ends of the rifle receivers.

After rifle barrels have been drilled they are subjected to a reaming operation, and for doing this work the Diamond Machine Co., Providence, R. I., is building a duplex barrel reamer which is shown in Fig. 1. The machine is provided with two work-holding carriages, which are reciprocated on the bed by independent drives; and the reamers are mounted in the spindles of the machine. Located in the bed are two driving rods which transmit motion to the carriages by means of a worm and wheel, a set of three bevel gears, and a pinion on a vertical shaft, which meshes with a rack on the carriage. Between the two bevel gears on the driving shaft is a clutch which may be shifted to engage either of the gears to provide

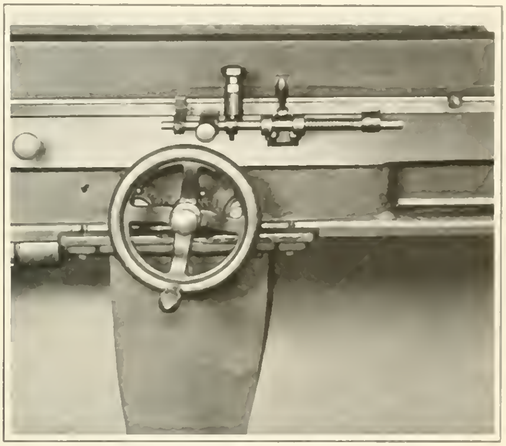


Fig. 4. Close View at Center of Bed, showing Feed Reversing Mechanism and Wheel for Rapid Hand Traverse

for feeding the carriage and work over the reamer or traversing it back to the starting point. The handwheel located above the middle leg provides rapid hand traverse for both carriages, and the clutches on each drive are automatically tripped to provide for reversing the motion to return the carriage to the starting point.

Fig. 2 shows a reamer of the type used on this machine; these reamers are hollow so that oil can be passed through the tool, from which it escapes by way of hole *A*. Referring to the close view of the head end of the machine shown in Fig. 3, it will be seen that oil pipes are provided to deliver lubricant to each of the spindles and thence through the reamer to the work. In this illustration the guards have been removed from the gearing to show the way in which power is transmitted to the carriages and spindles. The gears at the end of the machine transmit motion to the driving rods which transmit power to the feed mechanism below the carriages

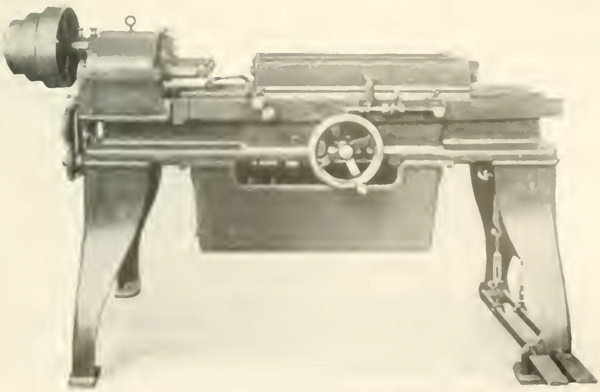


Fig. 5. Short Machine for Use in reaming Rifle Receivers

It will also be noticed that clutches are provided on each of the spindles; these are controlled by the two treadles shown at the base of the middle leg in Fig. 1, and by depressing either or both of these treadles the rotation of one or both of the reamers may be stopped.

For the purpose of reaming rifle receivers, the Diamond Machine Co. is building a tool of practically the same design as that shown in Fig. 1; but as the work handled on this machine is much shorter than the rifle barrels, it is unnecessary to provide carriages and a bed of such great length. By comparing the illustrations of the rifle receiver reaming machine shown in Fig. 5, with the rifle barrel reaming machine illustrated in Fig. 1, it will be evident that they are practically identical so that a detailed description of the receiver reamer is unnecessary. In this connection it may be well to point out that solid reamers are used for the rifle receivers in place of the oil-tube reamers used in the barrels. In reaming the receivers, a stuffing-box is screwed up against the end of the work and this is connected with a tube through which a copious supply of lubricant is delivered to the work. In this way the reamer is kept flooded so that heating of the tool is impossible. The pump for this purpose is contained in the reservoir under the bed.

DIAMOND RIFLING MACHINE

This rifling machine employs what is known as the "hook" type of cutter which cuts the groove as it is drawn through the barrel. The cutter is idle on the forward stroke of the bar. The required lead for the spiral grooves in the barrel is obtained by a rack and pinion actuated by an adjustable guide on the machine. The rifle barrel is automatically indexed to bring successive grooves into the working position, and the feed of the tool for taking cuts of constantly increased depth is also automatically controlled.

In the type of rifling machine now being built by the Diamond Machine Co., Providence, R. I., the rotation of the cutter-bar to make it follow the twist in the barrel is obtained by quite a different form of mechanism from that employed on the crank type of machine built by the Bausch Machine Tool Co. and described in the November number of MACHINERY. In the present case the cutter-bar is mounted in a carriage which is given a reciprocating motion along the bed of the machine by means of a lead-screw and planer type of belt drive. The mounting which holds the cutter-bar is free to revolve in bearings in the carriage, and a pinion is provided on this mounting which meshes with a rack *A* supported in cross-slide *B* which is an integral part of the carriage.

At the top of rack *A* there is a roller which enters a slot in the under side of guide arm *C*. This guide arm may be set at any desired angle with the line of travel of the carriage, graduated scales *D* being provided to facilitate the making of this setting. It will, of course, be evident that as the carriage moves back and forth on the bed of the machine the travel of the roller carried by rack *A* in the groove in guide *C* will result in giving the rack a transverse movement, and this movement of the rack results in rotating the pinion on the cutter-bar mounting and also the cutter-bar. By making the proper angular setting of guide *C* the cutter-bar may be given the necessary rotation so that the required form of groove will be cut in the rifle barrel.

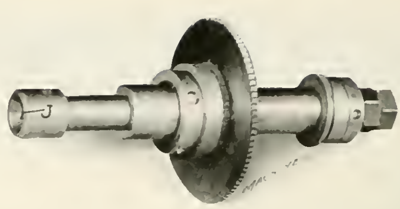


Fig. 3. Close View of Feed Mechanism

In considering the work done by this machine, it must be borne in mind that there are four grooves in most types of military rifle barrels, and in cutting these grooves it is necessary to index the work at each stroke of the cutter-bar. On the rifling machines built by the Diamond Machine Co., this is accomplished by means of a pinion *E* on the work-spindle which meshes with a transverse rack carried in a slide on the bed of the machine. As the carriage and cutter-bar move forward, the plunger is automatically withdrawn from index plate *G*, after which a transverse movement is imparted to rack *F*, which results in rotating pinion *E* and the work-spindle until the plunger drops into the next notch in the index plate. The work is thus located in position ready for the grooving operation to be performed on the return stroke of the cutter-bar. The rifle barrel is held in a three-jawed chuck *H*.

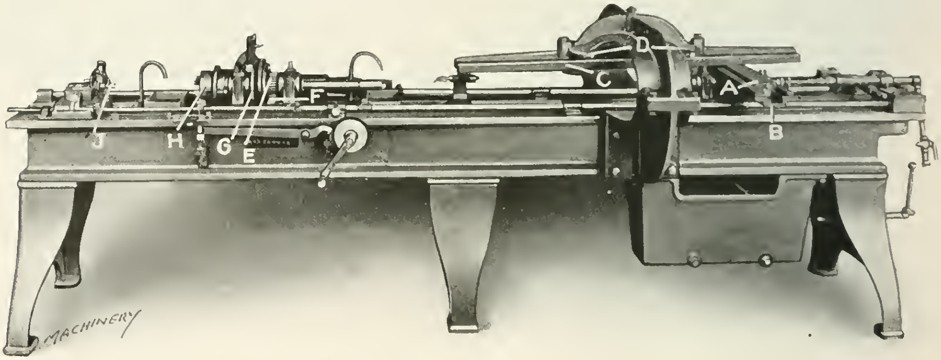


Fig. 1. Rifling Machine built by the Diamond Machine Co.

This machine employs what is known as the "hook" type of cutter, and it has already been stated that the cutting action of this tool takes place during the return stroke of the bar through the rifle barrel. Fig. 2 shows the end of the cutter-bar, the hook cutter being shown at *A*. In the case of a rifle barrel having four grooves, it is necessary to adjust the tool to take a deeper cut after each four strokes of the bar through the rifle barrel. This is accomplished by means of a square headed screw *B* which pushes in a wedge under the hook cutter to force it out so that the cutting edge is at a greater distance from the axis of the bar. This adjustment is made automatically through the entrance of the

Fig. 2. End of Rifling Bar, showing Cutter and Feed-screw

square head *B* of the screw into socket *J* of the feed mechanism, as shown in detail in Fig. 3, from which the construction will be readily understood.

When the cutter-bar has reached the end of its forward movement, the square head of the feed-screw on the cutter-bar enters socket *J*, and while in this position the ratchet and pawl on the feed mechanism turn the feed-screw, which results in driving in the wedge under the hook cutter so that the cutting edge is moved out from the axis of the bar through the required distance. It must be understood that this movement of the cutter is extremely slight, as the entire depth of the groove in the barrel is only 0.004 inch. In order to prevent damaging the edge of the cutter during the forward or idle stroke of the bar through the rifle barrel, the design has been worked out in such a way that the cutter automatically slips back off the wedge which controls its position, so that it is entirely clear of the work.

LEWIS SPRING MACHINE

The machine shown in the accompanying illustrations was designed and perfected by Fred H. Lewis, president of the Lewis Spring & Axle Co., Chelsea, Mich., for the purpose of forming and hardening automobile springs, and this concern is now manufacturing the machine for the market. It is claimed that this equipment not only constructs springs rapidly and with a great saving of labor, but that it also effects an increase in the strength of the spring. It will be evident from the illustrations that the machine employs the revolving head principle; the spring leaves are heated and then placed in the forming holder, shown in Fig. 1, after which the head revolves and plunges the spring into a tempering bath. At the same time the other head is brought to the top of the receiver ready to have another spring leaf put in position. The machine will turn out leaves at the rate of 1800 per day. The steel is drawn to shape and hardened without the necessity of hammering, and this is said to be the means of preserving the original fiber structure of the metal.

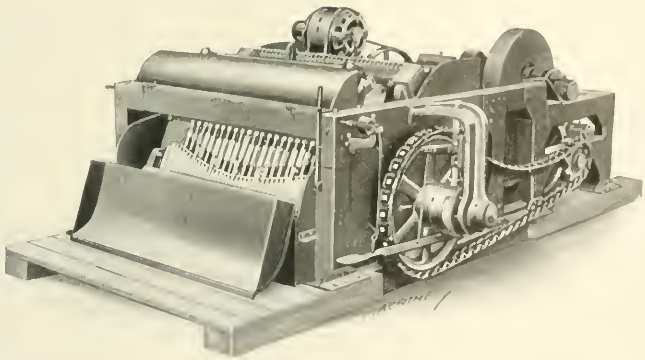


Fig. 1. Lewis Spring Machine with Cover opened to show Forming Holder

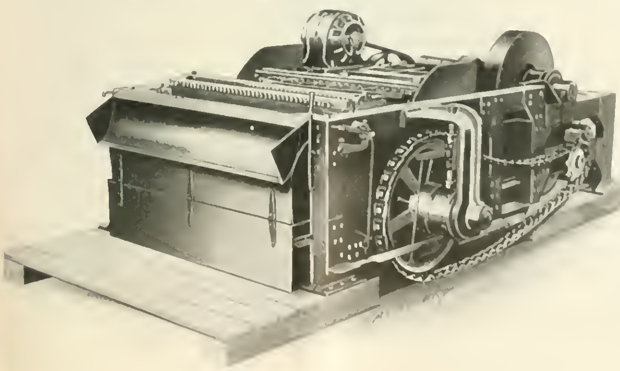
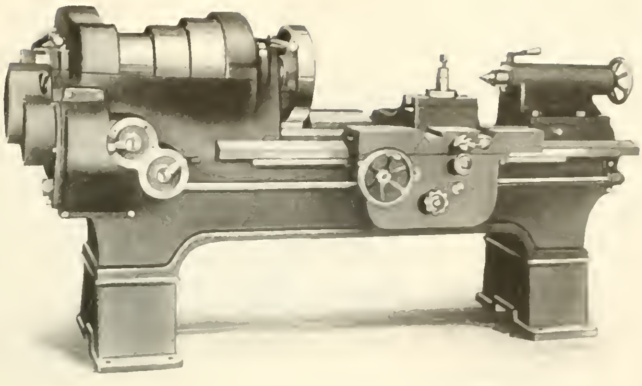


Fig. 2. Same View of Machine as shown in Fig. 1, but with Cover closed

ECONOMY ENGINE LATHE



Heavy-duty 20-inch Lathe built by the Economy Engineering Co.

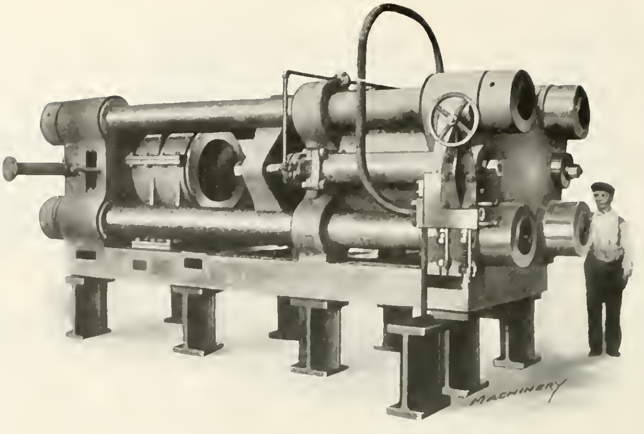
The Economy Engineering Co., Willoughby, Ohio, is now building a single-purpose manufacturing lathe which is shown in the accompanying illustration. The machine is provided with eighteen changes of speed and a sufficient number of feed changes to cover all ordinary requirements; in fact, it will handle all ordinary classes of work done on an engine lathe, with the exception of thread cutting, and is well adapted for heavy machining operations on forgings due to its exceptional weight and rigidity.

The headstock is of an improved construction with the outside housing brought up to the center line of the cone which has three steps 11, 13 11/16 and 16 3/8 inches in diameter by 5 inches face width. A double back-geared drive is provided, the ratios being 3.17 to 1, and 11 to 1. The spindle is made of high-carbon steel and has a No. 6 Morse taper, the diameter of the hole through the spindle is 2 1/16 inches. The front spindle bearing is 4 inches in diameter by 7 inches long, and the rear spindle bearing is 3 1/2 inches in diameter by 5 inches long. Eighteen spindle speeds are provided which are in geometrical progression and range from 11 to 335 revolutions per minute.

The bed is made unusually deep and is furnished with a wide V-bearing at the front which resists the thrust of the tool in all directions, and a flat bearing at the rear. The length of the carriage bearing on the bed is 32 inches, and the carriage is clamped down at the rear in such a way that easy movement is secured without any backlash. The bridge is 11 inches in width which affords an ample bearing for the cross-slide. The apron is of the box type, and so constructed that all shafts have bearings at both ends. The feeds are operated by frictions and are positively geared through a quick-change box. All bearings in the headstock, feed-box and apron are bronze bushed throughout. The countershaft

is provided with double friction pulleys 18 inches in diameter by 5 inches face width, and both belts should run forward.

The lathe is made with a plain block rest and the slide is furnished with a tapered gib. The regular equipment includes a plain rest, faceplate, countershaft and wrenches. The following special equipment may be provided: Compound rest in place of plain rest; square turret tool-post on cross-slide; four-hole turret mounted on ways in place of tailstock; and power feed. The machine swings 22 inches over the ways and 13 inches over the carriage; the maximum distance between centers is 3 feet 1 inch; and with an eight-foot bed the approximate weight of the machine is 5100 pounds.



Extrusion Press built by the Southwark Foundry & Machine Co.

SOUTHWARK EXTRUSION PRESS

In the extrusion press recently developed by the Southwark Foundry & Machine Co., Philadelphia, Pa., the design and method of operation have been worked out in a way which insures a high rate of production with the minimum cost for tool upkeep and power. The method of operation is such that no annealing is required and the extrusion is completed in a single operation. Furthermore, it is unnecessary to employ a pickling operation except in cases where some special finish is required.

The pressure chamber is made of special alloy steel which has a high tensile strength, and it is provided with a jacket through which the heated gases from the fireplace beneath the chamber are passed, so that the chamber is heated to the required temperature. The gases escape through a pipe located above the pressure chamber and provide for heating the chamber to a temperature of 600 degrees F. The chamber is heated so that the metal blocks which have been heated to a temperature of from 1650 to 1800 degrees F. may not be suddenly cooled when placed in position. If they were cooled suddenly, the surface of the metal would lose its plasticity, thereby unduly delaying the extrusion operation or making its successful performance a practical impossibility. The high temperature to which the walls of the pressure chamber are raised, during the time in which the extrusion operation is being performed, requires the chamber to be made of steel of an exceptionally high quality. A special grade of alloy steel is used for this purpose.

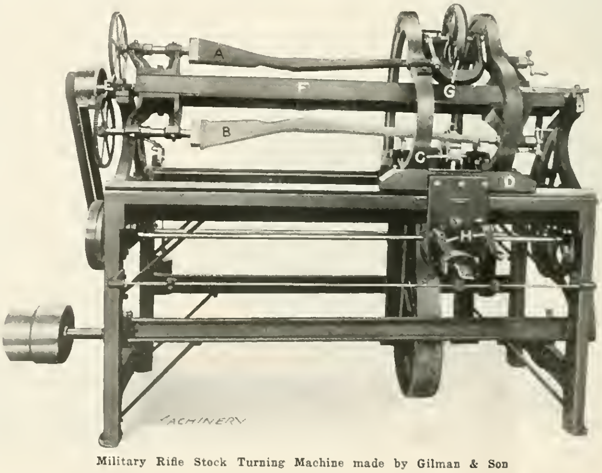
The Southwark extrusion press is operated from an accumulator which is fitted with a special safety valve that absolutely prevents dropping at a dangerous speed, even though a pipe line should fail. The safety valve also acts as a governor and automatically regulates the extruding speed to that which is most economical. The press has a cast-iron table 50 feet long to support the extruded rods, and between this table and the back edge of the press there is a 30-ton cutting-off press to sever the ram stump of the billet from the die-block. The stroke is of ample length to enable the press to be used for drawing hot copper tubes after the container castings are removed.

GILMAN RIFLE STOCK TURNING MACHINE

For some years the firm of Gilman & Son, Inc., Springfield, Vt., has been manufacturing a gun stock turning machine adapted for making short stocks for shot guns and sporting rifles. But this machine has not sufficient capacity for handling military rifles in which the stock extends along under the barrel almost to the muzzle; and to meet the requirements of such work a new machine has been developed, which operates along essentially the same lines as the standard gun stock turning machine, except that it has an increased capacity between centers. As the turning of rifle stocks is work that is necessarily done in only a few shops, the operation of a stock turning machine is probably a matter with which most mechanics are unfamiliar, and on that account a description of the new Gilman machine will doubtless prove of interest.

In operation, the stock to be turned is sawed out on a band saw so that there is not more than ½ inch of material to be removed at any point. This rough block is then set up on the machine and the forming of a rifle stock from the block is performed by a rotary cutter-head mounted on a carriage which runs on V-bearings on the bed. The roughing out of the stock is completed at a single traverse, and the form of the work is governed by a model carried on the machine.

With the brief explanation given, we are in a position to enter into a detailed description of the manner in which the machine operates. The model which governs the form of the work is shown at *A*, and *B* shows a rifle stock which has just been roughed out. The rotary cutter-head *C* is equipped with four tools equally spaced around its periphery; this cutter-head is mounted on the carriage *D* which runs on V-bearings on the bed, and receives its traverse motion from a rack and pinion. The model *A* and work *B* are rotated by means of gears *E* which mesh with a common pinion, and both the work and model are supported on centers carried by a cradle *F* which rocks on a central pivotal support. The engagement of wheel *G* with



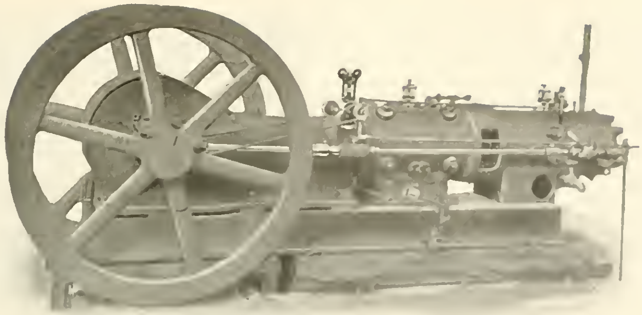
Military Rifle Stock Turning Machine made by Gilman & Son

model A results in swinging cradle F about its pivotal support in such a way that the depth of cut taken by the tools in head C will be so regulated that work B will be an exact reproduction of model A. The general structural features of the machine will be evident from the illustration.

It has been mentioned that the turning of a stock is completed by a single traverse of the carriage, and the carriage is fed along the bed at a rate of 3 inches per minute. There are four cutters in the cutter-head, but only three of these are active during a single traverse of the carriage. The reason for this is that the gearing in the apron of the machine is designed to provide for reversing the power traverse of the carriage in order to save the time which would otherwise be lost in returning the carriage to the starting position. There are two roughing cutters, one intermediate and one finishing cutter in the head, but the roughing cutters are so arranged that one cutter takes a cut when the carriage is being traversed in one direction and the other roughing cutter is idle; when traversing in the opposite direction, the cutter which was formerly idle does the work. The power traverse of the apron is automatically tripped when the cutters reach the end of the work, and when a fresh blank has been set up on the machine the gearing must be reversed by adjusting handles H, in order to provide power traverse in the opposite direction. Stocks for military rifles can be turned out on this machine at the rate of four per hour.

CHICAGO FUEL OIL DRIVEN AIR COMPRESSORS

For the purpose of reducing the cost of operating an air compressor, the Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., has developed a type N-SO compressor which is driven by an engine capable of operating successfully on the lowest grades of fuel oil. One of these machines is shown in the accompanying illustration, and they are said to be well suited to heavy duty under such severe conditions as exist in mines and on contracting jobs, in addition to regular stationary service. The engine is guaranteed to run satisfactorily on any mineral oil having a specific gravity of 28 degrees Baumé or lighter, which does not contain over 1 per cent of sulphur. There are a number of commercial fuel oils obtainable for three cents per gallon which fulfill these specifications, and with such fuel the type N-SO compressor is warranted to compress air to a pressure of 100 pounds per square inch at a cost of not over fifty-six cents per nine-hour day for each 100 cubic feet per minute of free air which is delivered to the receiver. These figures are so low that they seem almost incredible, but it is claimed that machines which have been in service long enough to fully demonstrate their economy of operation are actually running at a figure well under this cost.

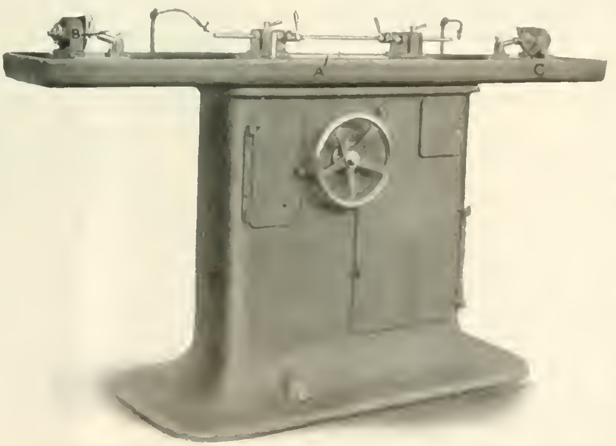


Chicago Pneumatic Tool Co.'s Type N-SO Air Compressor driven by a Fuel Oil Engine

It will be seen that the type N-SO compressor is a horizontal unit; it is of the straight-line, single-stage type with the compression cylinder bolted to the main frame and connected in tandem to the power ends. The propulsive cylinders are of the valveless, two-cycle, low-compression type; and ignition is produced by a positive acting hot plate system. As in the case of the Diesel engine, combustion takes place at the end of the compression stroke and the combustion is so complete by the time the exhaust port is opened that the fuel loss is practically negligible. A small oil pump injects the oil against the hot plate on the piston as it approaches the end of the compression stroke, and increased economy of operation is obtained by the use of water with the fuel oil. The quantity of both oil and water admitted to the combustion chamber is controlled by a fly ball governor. An important feature of the compressing cylinders is that they employ the Chicago Pneumatic "Simplate" flat disk air inlet and discharge valves which were described in the December number of MACHINERY. The type N-SO compressors are made in both single and duplex units. The single compressors come in six standard sizes having strokes of 8, 10, 12, 14, 18 and 21 inches.

BAUSH RIFLE RECEIVER SPLINING MACHINE

In the action of a military rifle, the cartridge is pushed into the chamber, after which the bolt is moved forward to bring the firing pin into contact with the cartridge primer. After the bolt has been pushed forward in this manner, it is necessary to have it clamped in place, and this is done by having keys on the bolt which fit into splined grooves in the receiver. When the bolt is pushed forward these keys slide in the spline groove and it is not free to turn until the firing pin comes into contact with the base of the cartridge; but at this point the back ends of the keys are just beyond the ends of the spline grooves, the keys themselves being in a socket at the end of the receiver. As a result, the bolt may now be turned to move the keys out of alignment with the spline grooves in the receiver, so that they bear against the end of the receiver and hold the bolt firmly in place against the base of the cartridge.



Rifle Receiver Splining Machine built by the Baush Machine Tool Co.

In machining the receivers, the work of cutting these spline grooves is somewhat analogous to that of cutting the rifling grooves in the barrels. The work is done by a tool similar to the "hook" cutter used on the rifling machine, and the method by which the position of the cutter is adjusted in the

bar to provide for taking a deeper cut at each stroke is controlled by a screw and wedge mechanism of similar construction to that of a rifling bar equipped with a "hook" cutter. But there is one important difference, *i. e.*, the cutter does not clear the work on the return stroke but cuts on both forward and return strokes.

It will be evident from the illustration that this is a duplex machine, *i. e.*, there is a cutter-bar carried at each end of the slide *A* at the center of the machine, and two work-holding fixtures (not shown in the illustration) in which the receivers are supported while the splining operation is performed. The sockets by which the position of the cutters in the splining bars is adjusted to take progressively deeper cuts are shown at *B* and *C*, and it will also be observed that oil tubes provide for delivering a supply of lubricant to the work. Oil for this purpose is delivered by a pump located in the reservoir inside the column of the machine. The cutter-slide is reciprocated on the bed by means of a pitman which may be set for any required length of stroke. Hand adjustment of the position of the slide is obtained by means of the handwheel at the front of the machine. This machine is a product of the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass.

THREAD MILLING ATTACHMENT

To provide for the rapid performance of threading operations, the New England Butt Co., Providence, R. I., has recently designed a thread milling attachment for use on an ordinary 16-inch engine lathe. This equipment is used for milling the coarse thread on the outside of the ogive for 70-millimeter shrapnel shells, and has now been in operation for a sufficient length of time to fully demonstrate its ability to give satisfactory results as regards both finish and rate of production.

Fig. 1. New England Butt Co.'s Thread Milling Attachment for the Lathe

By referring to Fig. 1, the design of the mechanism and method of operation will be readily understood. The bronze worm-wheel in case *A* is driven by pulley *B*, and the worm-wheel shaft carries pinion *C* which meshes with the large gear on the cone pulley. In this way the spindle is given a backward motion. Piece *D* to be threaded is held in the chuck by means of a collapsible collet, and after it has been set up cutter *E* is moved in to the full depth to which the thread is to be cut. The cutter is located by bringing the carriage up against stop *F*, and the cutter is then fed in to the full depth of the thread by bringing the cross-slide into contact with stop *G*. Clutch *H* is next engaged by pulling forward knob *J* until stops *K* are engaged, which results in starting the spindle rotating. After the spindle has made about 1.1 revolution—the movement being governed by gears *M*—stop *K* is automatically thrown out by the action of knock-out pin *O*, and the work is then ready to be removed from the chuck.

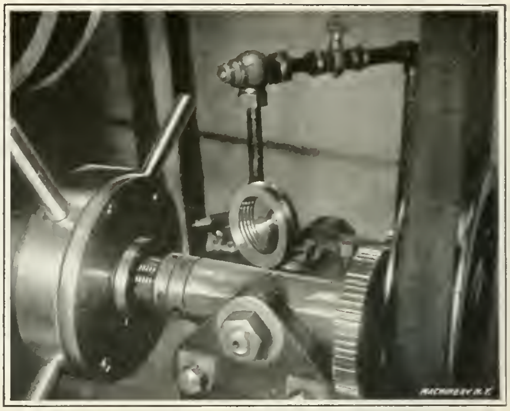


Fig. 2. Close View of Chuck and Cutter Spindle

The lathe is geared up in the same way as for a regular thread cutting operation. The cutter resembles a hob in appearance, but the grooves are straight instead of spiral, *i. e.*, the cutters are of exactly the same form as those used on several types of thread milling machines recently placed on the market. The movement of the carriage along the bed gives the required pitch for the thread, this pitch being obtained by the gearing of the lathe as previously mentioned. Fig. 1 shows the attachment engaged in cutting an 8-pitch Whitworth standard thread in the ogive of a 70-millimeter shrapnel shell, and the time required for threading a piece of this type is 2½ minutes, which includes the time required for handling.

MURCHEY THREADING DIE AND TAP

In the manufacture of fuses for shrapnel and high-explosive shells, the necessity has arisen for machining various parts on which there is an internal and an external thread. To handle this work in the most expeditious manner, it is obviously desirable to perform the internal and external threading operations simultaneously, and the demand for tools for this purpose has been well met by the Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich., in the combination threading die and tap illustrated and described herewith. Reference to the illustration will make it evident that this tool consists of the combination of a sizing tap with one of the Murchey threading dies; and both the tap and the die are provided with means of adjustment to control the size of the work.

The adjustment of the tap is obtained by a screw that governs the position of a tapered plug which is engaged by the

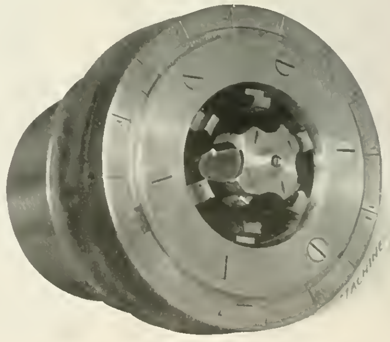


Fig. 1. Combination Threading Die and Tap made by the Murchey Machine & Tool Co.

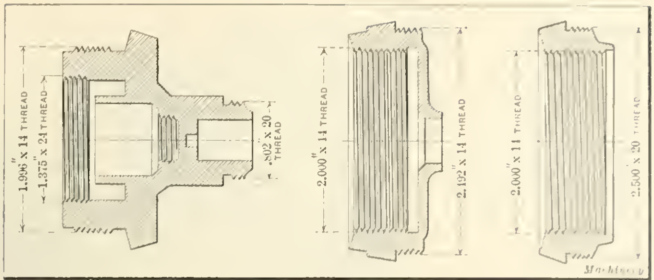


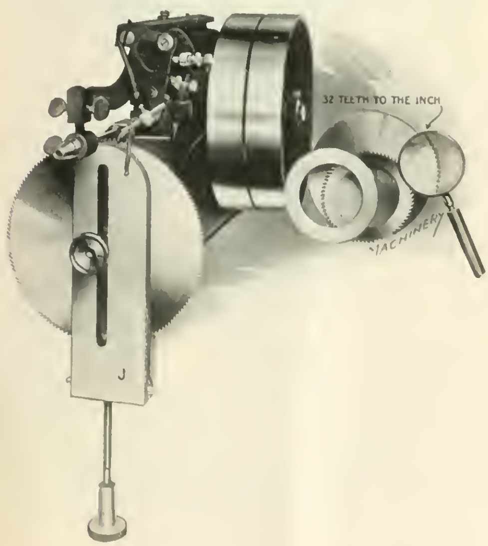
Fig. 2. Types of Work on which Combination Threading Die and Tap is used

backs of the chasers. Similarly, the adjustment of the die is obtained by drawing a tapered collar up over the backs of the chasers. This, of course, is practically the standard form of construction. Fig. 2 shows typical examples of the classes of work for which a tool of this type is adapted, and in addition to its application in threading fuse parts, a combination tap and die of this type could be used to advantage in machining a variety of other metal products. It will be evident from Fig. 2 that the use of this tool is not limited to work where the pitches of the internal and external threads are the same. To provide for handling work where the pitches vary in this way, the tap is free to move longitudinally, thus making correction for the difference in movement of the tap and die along the work.

WARDWELL CIRCULAR SAW SHARPENER

The following describes a filing machine for sharpening circular saws, which has recently been placed on the market by the Wardwell Mfg. Co., 110-112 Hamilton Ave., Cleveland, Ohio This machine is adapted for resharpening small circular saws ranging from 3 to 12 inches in diameter, with from 2 to 32 teeth per inch. The machine is known as the model J saw sharpener, and is particularly adapted for sharpening fine toothed saws used for cutting brass and copper tubing. It was originally designed to meet the special requirements of an automobile plant, but has proved so successful that it was decided to build the tool for the market.

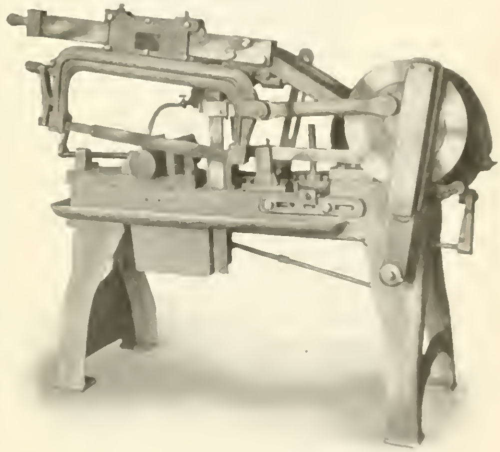
The filing arm works between heavy adjustable steel slides, and when it is known that the sharpening of fine saws is done at a speed of from 80 to 90 teeth per minute, it will be evident that this steel slide construction is important. The elliptical movement which may be imparted to the filing arm enables teeth having a hook to be resharpened. Another important feature is the double pawl positive feed movement which was designed to operate as follows: One feed pawl works on each side of the file, so that the pawl on the left side is always pushing against a tooth that has been evenly spaced and given a clean face, while the pawl on the right side of the file works one tooth behind the tooth that is being sharpened and provides for evening up the teeth. By means of this double pawl feed movement all teeth are filed absolutely uniform, *i. e.*, they are brought to the same width and length. But the chief feature of the double pawl movement is that where small teeth are broken out—a condition frequently met with where fine toothed saws are used for cutting metal—the saw still continues to be fed through the machine. All wearing parts of the machine are made of steel.



Wardwell Saw Sharpener working on a Saw Blade with Thirty-two Teeth per Inch

DIAMOND HACKSAW MACHINE

The Diamond Saw & Stamping Works, Buffalo, N. Y., have recently added to their line of "Sterling" power hacksaws a No. 5 heavy-duty machine which is illustrated and described herewith. The design and construction of this saw have been worked out along lines which enable it to cut very rapidly when running at only fifty or fifty-five strokes per minute, and operating at this slow speed means a material increase in the life of the saw blades. The latter is a particularly important factor at the present time, owing to the large number of round steel bars, high in carbon and manganese, which are being cut up for manufacture into shrapnel and high-explosive shells. Normally weighted and equipped with a sharp new blade, this machine has a capacity for cutting a $3\frac{1}{2}$-inch round steel bar in from three to four minutes and has made thirty-two cuts with a single blade on $3\frac{1}{2}$-inch round steel bars having a high percentage of carbon and manganese; in this case, the average time per cut was $5\frac{1}{2}$ minutes. The machine is intended for cutting material in sizes up to the equivalent of 6-inch round bars. The usual provision is made for automatically lifting the saw from the work on the idle stroke, and the mechanism provided for this purpose is positive in its action.



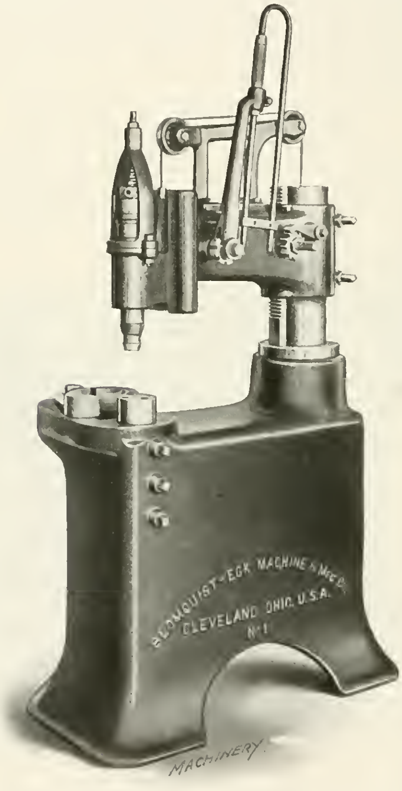
"Sterling" No. 5 Hacksaw Machine made by the Diamond Saw & Stamping Works

BLOMQUIST-ECK PNEUMATIC RIVETER

The machine which forms the subject of the following description was designed by the Blomquist-Eck Machine &

Mfg. Co., Cleveland, Ohio, for the purpose of heading over the ends of hub flange bolts on automobile wheels to prevent the nuts from being loosened by vibration, but it is equally applicable for a variety of other riveting operations. It will be seen that the machine has a heavy base to absorb vibration, and the design has been worked out in such a way that the anvil seat can be changed to suit the requirements of the work; also, it will be noticed that the column is set well back to provide a deep throat. The box section frame which supports the mechanism is raised and lowered by a rack and pinion provided with a ratchet and pawl stop; and it is held in position by two binding screws at the rear, which clamp the frame to the column. Sidewise location is provided by rotating the frame on the column in relation to the anvil.

The hammer is of a standard make; it provides for delivering a heavy blow and is so attached to the slide that the recoil is absorbed by a yoke and spring as shown in the illustration.

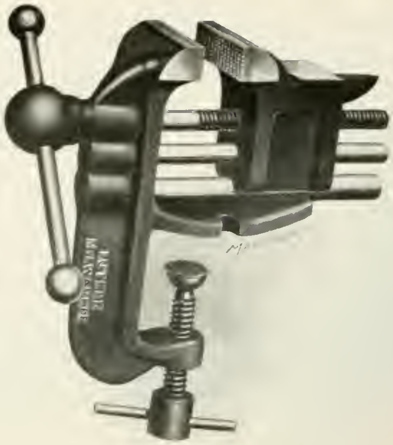


Pneumatic Riveter made by the Blomquist-Eck Machine & Mfg. Co.

The slide is scraped to fit the dovetailed end of the frame, and adjustment for wear is afforded by a tapered gib. The slide is counterbalanced by a weight in the base of the machine, to which it is connected by a wire cable running over pulleys on the frame. The slide is brought down to the work by means of the rack and pinion which are actuated by a handle at the side of the machine. Air is admitted to the hammer cylinder through a looped pipe; and a knurled handle which has an oscillating movement provides for opening and closing the valve. Connection to the pipe line is made through a hose connected to the open end of the looped pipe. Hammer sets and anvils are furnished to suit the work.

LUTHER CLAMP VISES

The Luther Grinder Mfg. Co., Milwaukee, Wis., has recently developed a line of clamp vises provided with guides, screws, jaws and handles made of steel. The movable jaw in these



Clamp Vise made by Luther Grinder Mfg. Co.

vises comes above the steel guides which, in turn, are supported by the bench. This construction makes it practically impossible for the vise to get out of alignment; and the jaws cannot be sprung. It will be apparent by referring to the illustration that an anvil is provided at the back of the movable jaw. This is often a convenience in jobbing shops where a variety of work is handled in the vise.

BAUSH RIFLE BARREL DRILL GRINDER

To meet the special requirements of sharpening drills for rifle barrel drilling machines, the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., has designed and built the grinding machine shown in the accompanying illustration.

Grinder for sharpening Drills used on Baush Rifle Barrel Drilling Machine

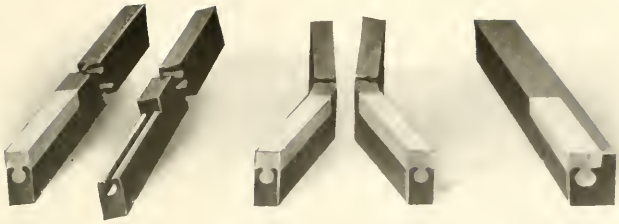


Fig. 1. Examples of "Cast On" Stellite Tools

For this work it is necessary to grind the drill at the point and in the flute at the side to afford a clearance space through which the chips can escape from the hole. On the Baush rifle barrel drill grinder it will be seen that two wheels are provided at opposite ends of the spindle. The wheel *A* is used for grinding the flute in the side of the drill, and reference to the illustration will make it evident that a V-block at *B* affords a convenient means of locating the work in the desired position relative to the grinding wheel; during the grinding operation the drill is clamped down in the vee by means of a strap.

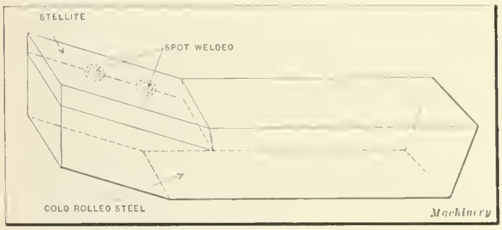


Fig. 2. Tool made from Stellite Cutter spot-welded to Machine Steel Shank

The grinding of the point of the drill is performed by wheel *C* at the opposite end of the spindle, the drill being introduced through bushing *D* to bring its point into contact with the wheel. In order to secure the exact form of point necessary to obtain the best results in grinding rifle barrels, this grinding machine is provided with a cam actuated mechanism which rocks the drill on the surface of the wheel so that the required form of drill point is secured.

"CAST ON" STELLITE TOOLS

For the purpose of effecting an economy in the use of stellite, the Haynes Stellite Co., Kokomo, Ind., has recently developed what are known as "cast on" tools, examples of which are shown in Fig. 1. The shanks are made of heat-treated nickel steel, and it will be evident from this illustration that the way in which the seat is formed to receive the cutter prevents the likelihood of the stellite inlay working loose. As the name implies, the stellite is cast onto the shank, and as the melting point of stellite is considerably higher than that of steel, pouring the molten stellite onto the steel shank results in partially fusing the steel so that the joint is welded together. These tools are only made to special order and practically any kind of tool can be furnished.

Fig. 2 shows a tool made in a different way, but in which the object is the same, namely, to reduce the amount of stellite in the tool to a minimum. In this case the stellite is spot-welded to the machine steel shank, and it will be evident from the illustration that the seat is formed in such a way that ample support is provided. The welding of this stellite cutter onto the shank is being very successfully done with machines built by the Detroit Electric Welder Co.

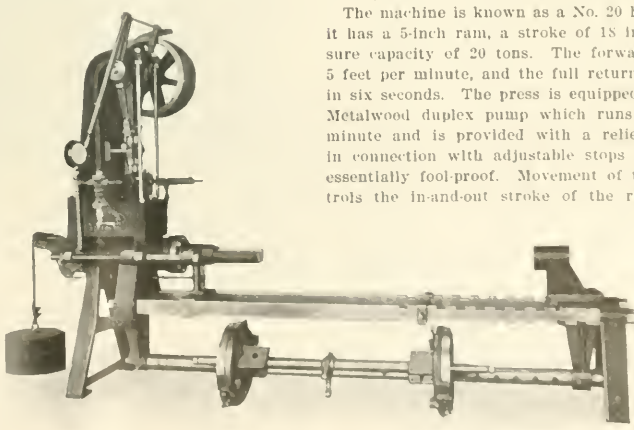
Fig. 3 shows a cross-sectional view of a special type of solid stellite tool which the Haynes Stellite Co. has recently developed for the use of shrapnel manufacturers. The reason for making the tool of this cross-section instead of grinding it from a square bar is that a stellite casting, like castings made from many other metals, is harder and tougher at the surface than at other points of the cross-section. Where it is desirable to secure the maximum strength and hardness, this makes it advisable to remove as little of the outer surface of the metal as possible; hence the practice of casting bars of the exact cross-section which is required, making it only necessary to sharpen the cutting edge of the tool. It is said that this form of tool is giving extremely satisfactory results.

Fig. 3. Solid Stellite Tool for Shell Work

METALWOOD HORIZONTAL FORCING PRESS

The No. 20 horizontal forcing press shown in the accompanying illustration has been developed by the Metalwood Mfg. Co., Leib and Wight Sts., Detroit, Mich., for use in forcing brake drums onto rear axles. It represents one of several styles of the same type of press which have been built by this company to meet special requirements in various lines of manufacture. Alterations in design only affect the length of the bed, the style of resistance head which is employed, the method of attaching fixtures, etc.

The machine is known as a No. 20 horizontal forcing press; it has a 5-inch ram, a stroke of 18 inches, and a rated pressure capacity of 20 tons. The forward speed of the ram is 5 feet per minute, and the full return stroke is accomplished in six seconds. The press is equipped with a five-horsepower Metalwood duplex pump which runs at 200 revolutions per minute and is provided with a relief mechanism operating in connection with adjustable stops which makes the outfit essentially fool-proof. Movement of the operating lever controls the in-and-out stroke of the ram while the pump is running continuously, and adjustable stops insure the forcing being done to exact distance, thus doing away with the necessity of taking measurements in setting up the work or while the forcing operation is in progress.



Metalwood Horizontal Forcing Press for forcing Brake Drums onto Rear Axles

The Metalwood Mfg. Co. is building these machines equipped with belt drive, individual motor drive, accumulator line drive, or for use in connection with an air pressure intensifier. It is claimed that the same accuracy of operation, convenience of control and speed of production are obtained on this press as on modern high-grade machine tools. The principal dimensions of the press are as follows: Distance from floor to center of ram, 34 inches; maximum length of work that can be handled, 7 feet; minimum length of work that can be handled, 3 feet; floor space occupied, 2 feet 10 inches by 13 feet 6 inches, and weight of machine, 4800 pounds.

CORRECTION—CARPENTER THREADING DIE-HOLDERS

In the article on the Carpenter threading die-holders in the February number, the last sentence should have read as follows: "The Acorn die was first brought out by J. M. Carpenter many years ago, and was shown in his patent granted May 12, 1896."

NEW MACHINERY AND TOOLS NOTES

Bench Miller: Miller & Crowningshield, Greenfield, Mass. A plain bench miller developed for handling a variety of light work. The machine is of exceptionally simple design and incorporates the usual features of machines of this type.

Self-centering Shell Chuck: Jenckes Knitting Machine Co., Pawtucket, R. I. A self-centering chuck for holding shells while they are being machined. The chuck has a machine steel body and is at present being made for handling 3-inch shells.

Clipper Belt Lacer: Clipper Belt Lacer Co., 1020 Front Ave., Grand Rapids, Mich. A No. 3 belt lacer which is provided with additional power to enable belts to be laced easily. The power of the tool enables a man to push 6 inches of hooks into a belt at a time.

Lock-nut: Day & Zimmerman, Philadelphia, Pa. A stamped sheet metal lock-nut of simple construction. The two sides of the nut are bent up to serve the double purpose of providing the necessary rigidity and of affording a bearing for the wrench. This nut is screwed down on top of the regular nut to hold it in place.

Grinding Wheel Guard: Ransom Mfg. Co., Oshkosh, Wis. A grinding wheel guard constructed of boiler plate. The outer plate is hinged to give access to the wheel, and a box is provided at the bottom to catch heavy particles of metal or abrasive. The latter feature prevents the exhaust pipe from becoming clogged.

Hydraulic Press: Metalwood Mfg. Co., Detroit, Mich. A vertical press adapted for a wide range of straightening, forcing, and broaching operations. The ram pull back is effected by either air pressure or a counterweight. The general features of the design are the same as those on other machines of this company's manufacture.

Pneumatic Riveter: Vulcan Engineering Sales Co., Chicago, Ill. A riveter designed by the Hanna Engineering Works for use on lattice columns and other structural work of a similar nature. The machine is operated by a toggle joint mechanism combined with levers and guide links which provide a large opening and the required degree of pressure.

Sandblasting Helmet: Multi-Metal Separating Screen Co., 77 East 131st St., New York City. A sandblasting helmet which affords complete protection for the operator and at the same time avoids inconvenience due to weight, impaired vision or difficulty in breathing. Free admission of air is provided by a fine mesh screen in the helmet.

Electric Butt Welder: Detroit Electric Welder Co., Detroit, Mich. A small size butt welding machine which is suitable for portable service; it has a capacity for welding iron, steel, copper, brass and a variety of other metals up to 3/16 inch in diameter. The small size and light weight of the machine make it easy to move about the shop from place to place.

Heavy-duty Lathe: Giddings & Lewis Mfg. Co., Fond du Lac, Wis. A heavy-duty boring lathe provided with a bar that has a single cutting tool. The boring-bar with its housing is moved across the bed by means of a forming attachment at the rear of the machine, which causes the bar to travel in such a way that the required contour is produced on the work.

Engine Lathe: Standard Lathe & Tool Co., Cleveland, Ohio. A heavy pattern engine lathe provided with a geared headstock and single pulley drive. There are two speeds in the head and two in the countershaft; five changes of feed are available which are 0.020, 0.040, 0.060, 0.080 and 0.100 inch per revolution. The machine is built with any length of bed from 8 feet up.

Cutting-off Machines: John Hall & Sons, Brantford, Canada. Two types of high-speed heavy-duty cutting-off lathes designed for the purpose of cutting off and facing shrapnel and high-explosive shells. One is a simple machine designed for cutting off shells. The other is a triple cutting-off machine intended for cutting up ingots for high-explosive shells.

Time Study Watch: M. J. Silberberg, Peoples Gas Building, Chicago, Ill. An improved time study watch for use in obtaining data on time and motion studies, and for readily estimating the production per hour or per day on machining operations. The use of the watch is said to eliminate considerable calculation. The watch is a 17-jewel instrument of Swiss manufacture.

Lubricant Pump: Stevens Mfg. Co., Dayton, Ohio. A feature of this pump is that all parts are manufactured in jigs and fixtures so that they are strictly interchangeable. All gears are made of steel and pack-hardened so that they possess the required durability to give satisfactory service. The pump is made with various sizes of bolting flanges to meet the requirements of different conditions.

Universal Test Indicator: Johnson & Miller, 42 Murray St., New York City. An instrument in which the contact point can be turned to any desired position in relation to the shank in order to facilitate taking readings on a wide range of work. A friction device protects the contact point from being damaged, because if the work is jammed or pressed too hard against the point the latter swings away.

Forced-feed Lubricator: Madison-Kipp Lubricator Co., Madison, Wis. A valveless forced-feed lubricator, designed in such a way that the supply of oil to each bearing can be accurately regulated without loss. Oil is delivered to all bearings from a common reservoir, and all important parts of the lubricator are entirely visible. The feed pipe delivering oil to each bearing has independent adjustment.

Bench Filing and Hacksaw Machine: Extensive Mfg. Co., 90 West St., New York City. A combination hacksaw and filing machine intended for handling those classes of work which are sometimes done by drilling and hand filing. The machine is particularly adapted for die work, although it can also be used to advantage for filing out gages and templets, and for various other operations of a similar nature.

Detachable I-beam Trolley: Chisholm & Moore Mfg. Co., Cleveland, Ohio. This trolley is designed for use on tracks that have no open end, and it is constructed in such a way that it may be quickly placed on the track or removed. This feature is provided by having a hinge at the bottom of the trolley which enables the wheels to be spread so that they may be passed over the lower flange of the I-beam.

Multiple Keyseat Miller: National Machine Tool Co., Cincinnati, Ohio. A tool which has been developed from the regular type of keyseat miller made by this company. The point of difference consists of the addition of a special guide used in connection with the regular guide to obtain the correct spacing for multiple keyways or splines. These tools are made to mill double, triple or quadruple keyseats.

Shell Coating Machine: Spray Engineering Co., Boston, Mass. A painting machine designed for applying an outside coating to shrapnel and high-explosive shells. The machine consists of a table carried by a steel frame, and the operating mechanism is located beneath the table top. The machine may be used for applying such coating materials as varnish, asphaltum, paint, and various special compounds.

Motor-driven Tapping Machine: Poese Machinery & Mfg. Co., Cleveland, Ohio. This company has recently added to its line of automatic tapping machines a tool equipped with individual electric motor drive. This is the automatic tapping and countersinking machine of this company's manufacture provided with a bracket on the column, on which the driving motor is mounted and geared direct to the machine.

Quick-acting Vise: Fisher & Norris, Trenton, N. J. A quick-acting vise which is operated by a foot treadle so that the operator has both hands at liberty for inserting work in the vise and removing it when finished. This is a particularly convenient feature when handling heavy work, as the operator is able to lift the piece in position between the jaws and tighten the vise without requiring the assistance of a helper.

Portable Crane: Brown Hoisting Machinery Co., Cleveland, Ohio. A portable floor crane constructed entirely of steel so that ample strength is provided without making the crane too heavy to be easily handled. A wide wheel-base is provided to allow side pressure without danger of tipping, and the overhead reach is ample for all ordinary requirements. The crane is built in two sizes having capacities of 1½ and 3 tons, respectively.

Electric Shop Truck: Buda Co., Chicago, Ill. A worm-driven storage battery truck on which the transmission mechanism constitutes a simple unit with all wearing parts running in oil. The brake and circuit breaker are operated by a foot-treadle. In driving the truck the operator is only required to depress the treadle to make the circuit and release the brake, these two functions being performed simultaneously.

Tap Driving Chuck: Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill. A tap driving chuck made from a single piece of hardened steel. This chuck is said to be capable of driving a tap of any given size and gives satisfactory service in extreme cases where the variation in the diameter of the shank is as great as 1/32 inch. The tap is held by the body of the shank and does not depend on the square to make it run true.

Storage Battery Truck: Automatic Transportation Co., Buffalo, N. Y. An electric storage battery truck provided with geared drive and a platform that may be raised and lowered by electric power. This truck is particularly adapted for use in machine shops, manufacturing plants and other places where there is a great amount of trucking to be done. It is intended for use in connection with loading platforms on which the work is placed preparatory to moving it.

Driving Wheel Press: Southwark Foundry & Machine Co., Philadelphia, Pa. A 600-ton driving wheel press, the principal dimensions of which are as follows: Vertical space between tie bars, 96 inches; clearance between ram and resistance post, 9 inches; width of opening in resistance post, 14 inches. The press is equipped with a triple plunger air pump connected to a filling supply tank which delivers air at a pressure of 80 pounds per square inch. This press may be equipped with either belt or individual motor drive.

Hand Miller: Standard Engineering Works, Pawtucket, R. I. A hand miller with a box type knee designed to provide rigidity and afford protection for the vertical adjusting screw, thrust bearings and bevel gears. Feed weights are provided to be hung on the handle. The general design and construction follow standard practice in the building of machines of this type. The table can be brought level with the center of the spindle. The hand-lever provides a table feed of 6 inches, and the crank furnishes a feed motion of 14 inches.

Automatic Pipe Wrench: Craftsman Tool Co., Conneaut, Ohio. The automatic adjustment of this wrench is obtained from a hardened steel disk which carries pinions that mesh with a rack on the body of the wrench. The disk, which is the adjustable wrench jaw, is run up into contact with the work, and when the wrench is in use, the tendency of the disk to slip over the work results in turning the pinions, which drives the movable jaw into more intimate contact. The face of this disk or jaw is serrated to give it a secure grip on the work.

Roller Bearing: George Automatic Roller Bearing Co., Winton Place, Cincinnati, Ohio. A line of roller bearings which are capable of carrying an end thrust equal to 50 per cent of the rated radial capacity. The design of these bearings includes several features which represent a departure from standard practice. The tapered rollers are held in pressed steel retainers, and spacing of the rollers is provided for by means of hardened steel balls which engage formed shoulders at the ends of the rollers. This arrangement reduces friction losses to a point where they are practically negligible.

Hydraulic Drawing Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A machine developed for use in drawing the casing of the Prest-O-Lite dissolved acetylene cylinders. The press has a total capacity of 800 tons and is of the inverted type, all the cylinders being located in the head. Between the movable platen and the base there is a plain ring with babbitted bearings which work on the strain-rods. This is called the blank holder and during the initial drawing operation it grips and holds the disks of steel in place in the circular recess in the stationary platen. The lower platen has a hole through its center with a large recess at the top for receiving the female cupping die through which the steel disk is forced.

Turret Screw Machine: Southworth Machine Co., Portland, Me. A hand screw machine provided with a plain head, automatic chuck, bar feed and hand longitudinal feed to the cut-off. The head and bed are cast integral to provide maximum rigidity. The automatic chuck and bar feed are operated by a long lever in front of the head, giving ample leverage for closing the chuck. The turret has six holes and is adapted for holding tools with or without shanks; bolt holes are provided for securing the tools to the faces of the turret. Independent adjustable stops operate automatically for each position of the turret, and these are readily adjusted for the length of each cut. Tapered gibs fitted the whole length of the saddle on each side provide means of making transverse adjustment of the slide. The cut-off saddle is constructed to maintain the alignment by providing a narrow guide and taper adjusting gib. Manning, Maxwell & Moore, 119 West 40th St., New York City, have the selling agency for this machine.

* * *

In the article "Broaching Square Taper Holes in a Brake Lever" appearing on page 474 of the February number of MACHINERY, it was stated that a J. N. Lapointe broaching machine was used. This was an error, as the machine used was made by the Lapointe Machine Tool Co., Hudson, Mass.

OXY-ACETYLENE WELDED PIPE CONNECTIONS

The rapid extension of the use of the oxy-acetylene blowpipe for welding pipe connections and the possibilities of still further adaptations in the future, give particular interest at this time to figures on the cost and efficiency of connections made by this process as compared with those of screwed connections.

During the spring of 1915 some experiments were conducted at the University of Kansas, which had for their purpose the determination of the strength of welded pipe connections. The pipe welds were compared with screwed connections of equal size and with the original pipe material. The detail work of these experiments was performed by three senior students in mechanical engineering under the direction and supervision of F. H. Sibley, director of the Fowler shops of the University.

The specimens were furnished by the Oxweld Acetylene Co. of Chicago. The samples were cut from standard weight "National" black steel pipe, were from the same stock, and hence presumably of uniform quality. The specimens included two pieces of the original pipe, four butt welds, two connections made with malleable iron screwed couplings, three welded tees and two tees made up with malleable iron screwed fittings. The length of the straight samples was 18 inches. The pieces for the butt welds were cut at an angle of about 60 degrees in a pipe cutting machine to give the necessary V groove for welding. The tees were made with an 18-inch run and a 15-inch outlet, the tee welds being made by cutting a hole in the run and butting the outlet against the outside of the run. All the connections were made by the company's operators.

TABLE I. RELATIVE STRENGTH OF WELDED AND SCREWED PIPE CONNECTIONS

Pipe Size (Inches)	Average Maximum Load: Welded Connection (Pounds)	Average Maximum Load: Screwed Connection (Pounds)	Relative Strength of Welded to Screwed Connection (Per Cent)
TENSION TESTS OF BUTT WELDS AND COUPLINGS			
1/2	10,222	9,040	113
3/4	21,367	13,835	154
1	28,330	17,230	164
1 1/2	43,975	31,270	140
COMPRESSION TESTS OF BUTT WELDS AND COUPLINGS			
2	72,500	58,150	125
TENSION TESTS OF WELDED AND SCREWED TEES			
1/2	12,903	8,723	148
3/4	19,763	12,303	160
1	30,007	17,550	171

The straight samples of 1/2-, 3/4-, 1-, and 1 1/2-inch pipe were fitted with plugs in the ends to prevent crushing in by the jaws of the testing machine, and were then tested in tension by the usual method. The 2-inch straight samples were cut off square to lengths of 5 inches and tested in compression. For the tee welds a holder was made to fit the run of the tee at each side of the joint. The end of the holder was then placed in the upper jaws of the testing machine, the outlet of the tee was held in the lower jaws, and the sample was tested in tension.

The action of the welded connections under tension was very much like that of the original pipe specimens. Some of the specimens broke outside of the weld and some broke in the weld. All the screwed connections broke right at the last thread in the fitting. The 2-inch pipe samples tested in compression bulged out on each side of the weld, split along the seam in the pipe as far as the butt weld, which held without splitting. One of the screwed fittings sheared the threads and telescoped, and the other bulged outside of the fitting. In most cases the welded tee connections broke in the outlet and at some distance from the weld. All the screwed tee fittings broke in the casting.

The results of the tension and compression tests of the specimens of butt welded pipe, unwelded pipe, and malleable iron screwed pipe couplings show that the elastic limit of the welded specimens was practically the same as the unwelded pipe. The screwed coupling specimens broke without elongating because of the reduced cross-sectional area at the threads, and so have no elastic limit. The higher strength of the welded connections is at once appreciated from the data given in Table I.

Those who are concerned with the comparative cost of making pipe connections by the two methods will be interested in Table II. The cost of oxygen at the present time varies from 1½ to 2 cents per cubic foot in different parts of the country. The price of 2 cents which has been used in computing these tables is therefore very conservative. The cost of acetylene at 2 cents per cubic foot is the price if supplied in tanks. If the acetylene were generated as used, the cost would be reduced to a little less than 1 cent per cubic foot.

TABLE II. COST OF PIPE CONNECTIONS

Pipe Size, Inches	½	¾	1	1½	2	3	4
WELDED BUTT JOINTS							
Time, minutes	3.00	3.50	4.00	5.00	6.00	10.00	15.00
Oxygen, cubic feet	0.28	0.43	0.76	0.95	1.51	2.51	4.76
Acetylene, cubic feet	0.23	0.41	0.74	0.92	1.47	2.44	4.43
Welding wire, ounces	0.08	0.15	0.20	0.30	0.50	1.60	4.00
COST							
Labor, at 30 cents	$.0150	$.0175	$.0200	$.0250	$.0300	$.0500	$.0750
Oxygen, at 2 cents	.0056	.0086	.0152	.0190	.0302	.0502	.0952
Acetylene, at 2 cents	.0046	.0082	.0148	.0184	.0294	.0488	.0886
Welding wire, at 12 cents	.0006	.0011	.0015	.0023	.0038	.0120	.0300
Total cost	$0.0258	$0.0354	$0.0515	$0.0647	$0.0934	$0.1610	$0.2888
SCREWED COUPLINGS							
Cost of fitting	$0.02	$0.03	$0.04	$0.08	$0.11	$0.27	$0.45
Cost of making up joint	0.02	0.02	0.03	0.03	0.04	0.05	0.07
Total cost	$0.04	$0.05	0.07	$0.11	$0.15	$0.32	$0.52
WELDED TEE JOINTS							
Time, minutes	4.50	5.00	5.50	7.00	9.00	16.00	22.00
Oxygen, cubic feet	0.41	0.61	1.05	1.34	2.26	4.02	6.98
Acetylene, cubic feet	0.35	0.59	1.01	1.29	2.20	3.88	6.50
Welding wire, ounces	0.20	0.40	0.60	1.00	1.40	5.40	9.50
COST							
Labor, at 30 cents	$.0225	$.0250	$.0275	$.0350	$.0450	$.0800	$.1100
Oxygen, at 2 cents	.0082	.0122	.0210	.0268	.0452	.0804	.1396
Acetylene, at 2 cents	.0070	.0118	.0202	.0258	.0440	.0776	.1300
Welding wire, at 12 cents	.0015	.0030	.0045	.0075	.0105	.0405	.0713
Total cost	$0.0392	$0.0520	$0.0732	$0.0951	$0.1447	$0.2785	$0.4509
SCREWED TEES							
Cost of fitting	$0.04	$0.05	$0.08	$0.14	$0.18	$0.51	$1.02
Cost of making up joint	0.03	0.03	0.04	0.04	0.05	0.06	0.09
Total cost	$0.07	$0.08	$0.12	$0.18	$0.23	$0.57	$1.11

Machinery

The cost of the fitting is the principal item in the screwed connections. In most cases the cost of the welded joint is less than the cost of the fitting. As the pipe sizes increase, the lower cost of the welded joint is even more marked. The conclusions that may be drawn from these tests point to the following facts:

> The cost of the welded connections is less than the cost of the screwed connections. The larger the pipe size the greater is the difference.
>
> The time required to make up the screwed connections is about the same as that required to make up the welded connections.
>
> The strength of a welded pipe connection is practically the same as that of an unwelded pipe. By building up the weld it can be made as strong as or even stronger than the rest of the pipe.
>
> The elasticity of the pipe is not much affected by welding.
>
> The strength of the welded pipe connections is greater than that of malleable iron screwed fittings. The strength of the welded specimens was from 113 to 171 per cent of that of the screwed connections.

CUSTOMS INFORMATION

NIPPERS AND PLIERS DUTY—MACHINE TOOLS DEFINED—RELATION OF FINISH TO ULTIMATE CONDITION

BY JULES CHOPAK, JR.*

A decision of the Treasury Department was reported in the February number of MACHINERY, which held that dental tweezers, when imported, are dutiable at 20 per cent and not at 30 per cent as nippers and pliers of all kinds. Since then the United States Court of Customs Appeals at Washington, the final court in such matters, has clearly confirmed this ruling by deciding that various surgical forceps and instruments generally are in no wise nippers and pliers. The decision reverses other decisions previously made by the Board of General Appraisers, holding articles in general having two lever handles working on a pivot and which operate two cutting, gripping or pinching jaws or blades to be nippers and pliers.

The conclusion of the Court was reached by considering several matters which may be briefly stated as follows: In the general understanding of "pliers" and "nippers," dental and obstetrical apparatus are in no sense included. When Congress revised paragraph 168, Act of 1909, the prototype of the present nipper and plier paragraph now 166, it specifically refused to include "surgical and dental instruments or parts thereof" for dutiable purposes with nippers and pliers. Furthermore, such articles are better termed "forceps," according to the authority of Knight's American Mechanical Dictionary, than "nippers and pliers."

The following are customs protests now before the Board of United States General Appraisers, wherein importers have objected to the higher rates exacted by the government. Persons interested may assist in settling by giving such testimony as is of value.

> *Protest:* Power-driven machine for cleaning reeds for looms. *Assessed:* 20 per cent under paragraph 167 as a manufacture of metal. *Claim:* 15 per cent under paragraph 165 as a machine tool.

* Customs Lawyer, 29 Broadway, New York City.

The term "machine tools" has been defined for tariff purposes to apply to such as are operated by power other than hand, and which work on metal, wood or stone. (Gallagher v. U. S. 3 Ct. Customs Appeal, 520) unless wholesale dealers have given the term another meaning. This has been done, as the Board of General Appraisers found in T. W. 34,413. From the trade testimony introduced, the Board defined "machine tools" to be machines driven by other than hand power, working upon metal and employing in their operations cutting tools. It follows that the lower claim of 15 per cent is without merit, since the machine does not cut metal in its operation.

Protest: A combination of a thirteen-needle embroidery machine and a card punching attachment for cutting out the design of the pattern. *Assessed:* 25 per cent under paragraph 165 as an embroidery machine. *Claim:* 20 per cent under paragraph 167 as a manufacture of metal.

The question here is whether the addition of the card punching attachment changes the character of the machine from that of an "embroidery machine." If so, the lower duty will be applicable since there is no other classification in the tariff to be taken. The question turns largely on what are generally considered embroidery machines in the trade. Such combinations as this might very well be embroidery machines of a special type. If, however, the attachment is such as to make a new article not in any sense an "embroidery machine," then the assessment as such cannot stand.

Protest: Circular saw plates containing alloys. *Assessed:* 15 per cent under paragraph 110 as steels by whatever process made, containing alloys. *Claim:* 8 per cent under paragraph 110 as steel sheets not containing alloy, and 12 per cent under paragraph 105 as saw plates cut or sheared to shape or otherwise.

From the government description of the articles, it appears that they contain alloys. Assuming that to be a fact, the 8 per cent claim is at once disposed of. The issue is then narrowed to the provision for "steels containing alloys" as against "saw plates cut or sheared to shape or otherwise." Under well settled customs rules, the classification which is narrower and more specific in its terms is most applicable. Furthermore, a provision which mentions an article by its name usually takes precedence. Applying these rules to this case it would seem that the correct duty should be 12 per cent and not 15 per cent as charged by the government. The merchandise is admitted to be "saw plates" which the 12 per cent classification especially mentions. The classification for "steels containing alloys" takes in a large variety of steel articles in no sense saw plates, while saw plates are limited to a certain class of goods, whose character and use are limited whether or not alloys are used in their manufacture.

Protest: Strainers composed of metal and wire. *Assessed:* 20 per cent under paragraph 167 as a manufacture of metal, metal being the chief value. *Claim:* 15 per cent under paragraph 114 as articles manufactured from wire.

Paragraph 114 exacts 15 per cent duty on "articles manufactured wholly or in chief value of any wire provided for in this section." Under a decision of the Washington Customs courts made May 18, 1915, these strainers would seem to be properly dutiable here. In that case, the merchandise was heavy wire bent in V form as staples. The court held the above quoted classification as controlling. The case would appear to be authority here. On the other hand, the government's assessment is under a clause for metal articles not covered by any other tariff provision, known as the basket or catch-all clause, taking only such articles as fail to find an enumeration elsewhere.

Protest: Steel sheets rolled to such an extent as to constitute planished steel. *Assessed:* 15 per cent under paragraph 109 as planished steel. *Claim:* 8 per cent under paragraph 110 as sheets made by the Siemens-Martin process.

The question raised by this protest is one of fact, namely, if the sheets in their condition as imported, are planished. It has been held as to cold-rolled sheets having a polish incidental to the rolling, that if it was not intentionally done and the polish served no useful purpose but was destroyed in the future operations of manufacture or was not available when a polished surface was ultimately desired that such sheets were not "polished." This may be the rule applicable to these sheets. If not, then the 15 per cent duty must stand as assessed.

FOREIGN TRADE OPPORTUNITIES

A REVIEW OF DEVELOPMENTS ABROAD OF INTEREST TO MANUFACTURERS

At a recent meeting of New York bankers it was said that as the war reaches its climax the nations involved will strain every resource and direct every effort toward the business of winning. This means that productive industries will be even more crippled than at present. Of necessity, therefore, the former customers of the European nations will be obliged to turn to the United States. This is shown by the increase of exports in 1915, when the trade with Europe was doubled and that with Africa, South America, and Asia was increased one-half; an increase not wholly due to munitions of war.

George H. Pickerell, American consul at Para, Brazil, reports that the people in Brazil are taking an immense amount of interest in everything North American, and cannot understand why the people there are not reciprocating to a greater degree. The feeling toward the United States is of the best, and the prospects, on account of the conditions brought about by the European war, were never more favorable for United States trade extension than at this moment. India and Ceylon importers also are eagerly seeking American trade because of their failure to obtain goods in Great Britain.

Russia's dependence upon Germany for goods of all kinds and the opening there for other nations is the subject of an interesting article in *Engineering* (London) which says that there is an almost unlimited demand in Russia for almost all products of the iron industry, and people seem agreed that for a long series of years Russia will be unable herself to cover her requirements, and will have to import a great quantity of goods from abroad. The conditions, however, vary much, both as regards the different classes of goods and the different parts of the vast empire. Generally, it may be said that the finer a machine is, and the more difficult to produce, the greater the chance of exporting it with advantage to the Russian market. On account of the duty, heavy articles and the more simple ones are likely to prove unremunerative, and for some, especially such as are also produced in Russia, the duty is simply prohibitive, reaching or even exceeding, the selling price within Russia of the article in question. Generally speaking, competition is keener in the Western ports, which are nearer Germany.

Internal-combustion motors are certain of a large demand when constructed for using Russian unrefined petroleum, especially in places such as Moscow, Rostoff, Odessa, Kieff, etc., in spite of there being several Russian factories in this branch. There are several manufactories of wood-working machines in the country; still the importation is considerable. Machine tools are for the present in strong demand, and will, no doubt, also meet with a large sale after the war. Electrical apparatus and appliances have hitherto been almost exclusively imported from Germany. The articles under this head are generally imported in unassembled parts, on account of the duty. Several German and Swedish factories have imported a fair number of dynamos and electric motors, but large quantities are made at the Russian manufactories, which have been fully employed during the war. Light motors run at high speeds meet with the readiest sale. Telephones and telegraph material are imported on a large scale. There are some large Swedish telephone exchanges in Russia.

Russians are accustomed to having prices quoted delivered in Russia, duty paid. In the case of more important machinery, purchases may be made F. O. B. shipping port, and during the war this system has had to be generally adopted.

It is quite customary, also, in dealing with very substantial firms, for a credit of six months, twelve months, or even more, to be allowed. Even the Zemstvo organizations want from three to six months credit. Russian wholesale merchants and large commercial houses give long credits, two years or more. Not infrequently, however, payment of one-third of the amount may be obtained on delivery, and as a rule acceptances may be had for the balance of the invoice. For agricultural machinery, the due dates are often arranged to fall immediately after the harvest; during years with unfavorable harvests the seller must be prepared to prolong

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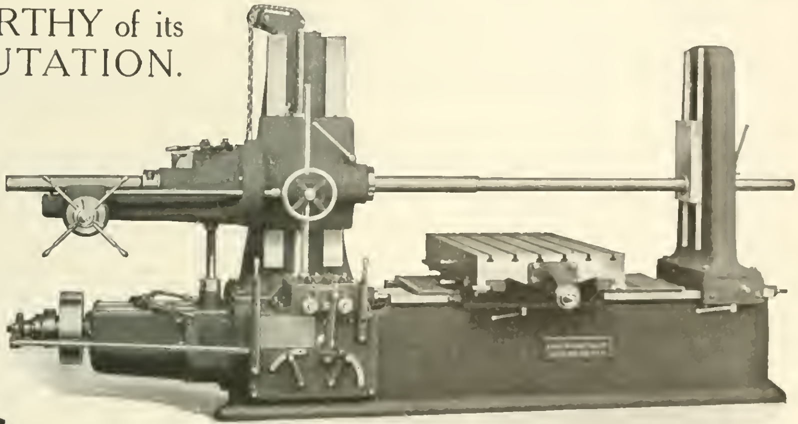

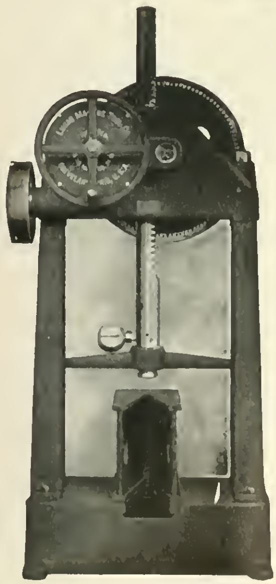

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such bills for another twelve months. The saving deposits in the banks of Russia, during the year ending September, 1915, increased $288,100,000, making the total saving deposits of the nation $1,163,100,000. C. F. Just, the Canadian special trade commissioner, says:

> It is doubtful whether any conceivable scale of waste and destruction of life in the present war, on the side of Russia, will affect the country's economic position for any appreciable period, if the past be a reliable guide in such matters. She has tried with impunity, economic experiments which would have seriously affected most other countries. Wars and political and social upheavals have seemingly had but little effect. Her national resources are very great and of infinite variety and her present population of 171,000,000, however backward and inefficient, is being slowly raised and educated.
>
> There is to be found in Russia, therefore, the unusual conditions of great opportunities for industrial enterprise for which the consuming power is at hand, side by side with opportunities for imports on an extensive scale, with the certainty that the former will rather stimulate than retard the growth of the latter, both in variety and extent; for with the slightest rise in the standard of comfort of such a large population the home industries can hardly expect to meet the demand, at least not for a number of years.

The prospects for immediate trade in various foreign countries are good. Finnish Lapland is now planning to develop its vast deposits of iron ore, which are equal, if not superior, to the deposits of Sweden and Norway; the plans include the building of a railway having a total length of nearly 300 miles. Siam, Bolivia, Chile, and Colombia, too, are planning extensive railway building; while the new Chosen budget gives $4,182,415 for the construction and improvement of its railways, and Russia has recently made great purchases in railway material. The Braden Copper Co. is spending $10,000,000 for steel and machinery for its property at Rancagua, Chile.

The British Board of Trade is confidently stating that Great Britain will hereafter be the world's greatest commercial agent, and British agents are even now seeking to foster such conditions in all countries as will be most favorable to this need. France is seeking to build up a merchant marine and has changed its patent laws so that she now forbids the working in France of patents and trade-marks owned by subjects of *resortissants* of Germany and Austria-Hungary (called here, for convenience, "alien enemies") by those subjects or *resortissants* or their agents. Transfers of or licenses under patents and trade-marks effected by alien enemies are valid only if the transferee can prove that the transfer was made *bona fide* and before the declaration of war, or if a board specially appointed consider the transfer to be in the public interest or for national defense. Moreover, in any case, the state may itself take over the working of patents owned by "alien enemies." The new law provides that patents may not be granted during the war to "alien enemies," but all priority rights under the International Convention are to be kept alive in the case of applicants whose states grant similar advantages to France. Other nations, too, are preparing to seek the world's commerce especially by means of favored-nation treaties. Canada and Australia have already passed tariff laws destined to place American manufacturers at a disadvantage, but United States consuls and other persons familiar with various countries are very urgent that present opportunities to introduce American goods be taken advantage of, claiming that the merits of these goods will secure a large share for them in the later trade. D. E. J.

* * *

PERMANENT MACHINERY HALL

A machinery hall has been established on the fifth floor of the Grand Central Palace, Lexington Ave., 46th to 47th Sts., New York City, for the permanent exhibition of machinery in operation and for demonstration. The area available is 52,000 square feet and it will be sub-divided to suit individual exhibitors' needs. Exhibitors may also rent offices in the building, and electric lighting and all needed facilities will be provided to cover the exhibitors' needs. In the exhibitors' absence, attendants will be provided to hand out literature and otherwise, so far as may be practicable, to represent them. Further information will be furnished by H. D. Benedict, manager of the Merchants & Manufacturers Exchange, Grand Central Palace, New York City.

PERSONALS

A. B. Hazzard has taken the position of engineer of equipment with the Amalgamated Machinery Co., 71 Broadway, New York City.

George B. Morris has taken a position with the Curtiss Aeroplane Co., Buffalo, N. Y., and will have charge of the special organization and production routing work, advising departments, etc.

Charles W. Burrage, formerly of the instructing staff of the Massachusetts Institute of Technology and associated with F. W. Dodge Co. in connection with the preparation of *Sweet's Index*, has joined the staff of Walter B. Snow, Boston, Mass.

Emil Gairing, formerly general superintendent of the Baker & R. & L. Electric Vehicle Co., Cleveland, Ohio, has obtained an interest in the Eclipse Interchangeable Counterbore Co., Detroit, Mich., and has been made vice-president and manager of production.

Frederick E. Koehler, formerly commercial manager of the Central Illinois Utilities Co., has secured an interest in the business of the Racine Tool & Machine Co., Racine, Wis., manufacturer of high-speed metal cutting machines. Mr. Koehler has been made vice-president and acting manager. J. M. Jones, president and general manager, who still retains his interest, is spending the winter in Florida.

* * *

OBITUARIES

Alexander Saunders, president of D. Saunders' Sons, Inc., Yonkers, N. Y., died at his home in Yonkers, February 1, aged seventy-eight years.

John W. Hill, mechanical engineer and sales manager in charge of the Detroit office of the Bantam Anti-Friction Co., Bantam, Conn., died suddenly at his home in Detroit, February 12. Mr. Hill was a member of the American Society of Mechanical Engineers and the Society of Automobile Engineers, and ranked high as a tool designer.

Readers will hear with deep regret of the death of Charles Churchill, head of Charles Churchill & Co., Ltd., London, the oldest concern importing American machine tools into Great Britain. Mr. Churchill died February 14, following the death of his son, Charles Henry Churchill, who died February 8. The business was established in 1865, and besides the London house has four branches in Birmingham, Glasgow, Manchester and Newcastle-on-Tyne. An extended notice will appear later.

Christopher C. Bradley, president of C. C. Bradley & Son, Inc., manufacturers of Bradley power hammers and forgers, died at his home in Syracuse, January 29, aged eighty-one years. Mr. Bradley was born in Syracuse. A few years previous to his birth his father established a foundry under the firm name of Alexander, Bradley & Co., where salt kettles were cast. Mr. Bradley became associated with his father in the foundry business, and as the salt business fell off the firm began the manufacture of farm implements and carriage hardware. In 1855 the firm of C. C. Bradley & Son was established. C. C. Bradley, Jr., entered the business in 1894, and since that time the firm has manufactured power hammers and carriage hardware. Mr. Bradley retired in 1911.

Richard S. Bryant, factory manager of the Standard Welding Co., Cleveland, Ohio, died of cancer at the Post-Graduate Hospital, New York City, January 24, aged forty-six years. Mr. Bryant was widely known as an authority on automobile rims and had invented a number of special types during his career. Most of the detachable rims now in use were designed by him while with the Standard Welding Co. He was the first to design a quick-detachable rim, a type still considerably used. He organized the Bryant Rim Co. of Columbus, Ohio, which was later bought out by the Diamond Rubber Co. of Akron. The good-will and patents of his Columbus Co. were turned in later to the United Rim Co. of Akron, which was a holding company for several rim patents owned by the large rubber companies. He was then made consulting engineer of the United Rim Co. Later he was employed by the Standard Welding Co. as consulting engineer, and quite recently was made its factory manager.

Thomas J. Moore, for the past eight years sales manager of the Philadelphia branch of the Halcomb Steel Co., died at Atlantic City, February 6, after a brief illness, aged fifty-seven years. Mr. Moore was born in Douglas, Isle of Man, and came to America in 1879 after receiving a good education and serving an apprenticeship in the Crewe shops of the London & Northwestern Railway. He held responsible positions successively with the Baldwin Locomotive Works; Pennsylvania R. R. shops at Altoona; Union Switch & Signal Co.; and the New York Shipbuilding Co. He entered the employ of the Halcomb Steel Co. January 1, 1907, as salesman, and within two years became manager of the Philadelphia office, and served with marked success until his death. He leaves a widow and three children, one of whom, Thomas J. Moore, Jr., succeeds him as acting manager of sales.

SOCIETIES, SCHOOLS AND COLLEGES

Grove City College, Grove City, Pa. Catalogue 1915 containing calendar and courses of study for the year 1915-1916.

Stevens Institute of Technology, Hoboken, N. J. Annual catalogue, January-July, 1916, and September, 1916,-July, 1917.

Vocational High School, New London, Conn. Souvenir booklet showing views in the various departments of the school and some of the work done by the students.

American Museum of Safety, 14-18 W. 24th St., New York City. Special bulletin on the award of the Scientific American medal for 1915 to Elmer A. Sperry for his gyroscope compass and stabilizer. The bulletin contains an interesting article on the gyroscope as a safety device, giving the curves showing the performance of the "active" type of gyroscope in stabilizing a pendulum ship model.

Pratt Institute, Brooklyn, N. Y., will open the shops, laboratories and drawing rooms of the school of science and technology to the public on Wednesday evening, March 8, giving an opportunity to all persons interested in industrial education to observe the students at work in the various courses, and to inspect the results and methods as well as the equipment and general facilities for conducting industrial training.

NEW BOOKS AND PAMPHLETS

Examples in Magnetism. By F. E. Austin. 90 pages, 4¾ by 7½ inches. 27 illustrations. Bound in flexible leather. Published by the author, Hanover, N. H. Price, $1.10.

This work by Prof. Austin is treated in the same general style as his "Examples in Alternating Currents," "How to Make Low-pressure Transformers," and "Directions for Designing, Making and Operating High-pressure Transformers." It is intended for students of physics and electrical engineering who are pursuing regular college courses or studying at home, being expressed in a simple style that should be well within the comprehension of every ordinary high-school pupil. It is not merely a book of problems, but a compilation of carefully selected examples that illustrate fundamental principles and embody data useful in actual electrical work.

Mechanical Drafting. By Charles B. Howe. 147 pages, 9 by 10¾ inches. 166 illustrations and 38 plates. Published by John Wiley & Sons, Inc., New York City. Price, $1.75.

This work on mechanical drawing is not intended to be a manual of self-instruction, but is offered rather as an assistant to the teacher to help him in his presentation of the subject, and to supply the conventions, data and problem sheets. The work is comprehensive, dealing with machine drawing, architectural drawing and typical drawing. The contents by chapters follow: Materials and Instruments; Principles of Drafting; Geometry of Drawing; Working Drawings; Machine Drawing; Plan Drawing; Plot and Map Drawing; Pictorial Representation and Sketching; Blueprinting. The work contains many drawings and halftone illustrations of mechanical parts, buildings, etc.

Financing an Enterprise. By Francis Cooper. 524 pages, 5½ by 8 inches. Published by the Ronald Press, New York City. Price, $3.

This book is a manual of information and suggestion for promoters, investors and business men generally. The author observes that the principles of finance do not change, but their application does. The book was first published in 1906, and has now passed into the fourth edition. The purpose of the work, as announced in the first edition, is to set forth the principles of financing business enterprises as clearly as may be, to point out the common mistakes and suggest the best methods of procedure, and to serve generally as a manual of information. The chapter topics are: The Enterprise; Investigation of an Enterprise; Protection of an Enterprise; Capitalization of an Enterprise; Presentation of an Enterprise; and Special Features of Promotion.

Automobile Repairing Made Easy. By Victor W. Page. 1060 pages, 5¼ by 8 inches. 500 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $3.

This book is remarkable for its range, number of illustrations and generally satisfactory treatment of the many varied topics discussed. It describes approved methods of repairing all types of gasoline automobiles, shows late developments based on wide actual repair experience and includes electric starting and lighting system instructions, matter on oxy-acetylene welding, tire repairing, engine and ignition timing, etc. The rapid growth of the automobile industry has resulted in the establishment of many automobile repair shops, and the demand for mechanics skilled in the art of caring for, adjusting and repairing automobiles, has exceeded the supply. This book should meet a general demand for specific instruction by those who have some general mechanical skill and experience. The contents by chapter heads are as follows: The Automobile Repair Shop; Small Tool Equipment for Repair Shops; Overhauling the Gasoline Engine; Cooling, Carburetion and Lubricating System Faults; Location and Remedy of Ignition Troubles; Motor Starting and Lighting Systems; Defects in Clutch and Gear-box; Faults in Chassis Components; The Rear Axle and Driving System; Wheels, Rims and Tires; Miscellaneous Repair Processes; Useful Information for Auto Repairmen; Hints and Kinks. The concluding chapter contains mathematical, mechanical, and miscellaneous tables.

NEW CATALOGUES AND CIRCULARS

Turner Machine Co., Danbury, Conn. Bulletin on the Turner Model F automatic vertical turret lathe.

Allis-Chalmers Mfg. Co., Milwaukee, Wis. Catalogue of centrifugal pumps and centrifugal pumping units.

Wright Mfg. Co., Lisbon, Ohio. Catalogue 7 on Wright high-speed steel chain hoists, steel trolleys and hand cranes.

Link-Belt Co., Philadelphia, Pa. Catalogue 250 on Link-Belt wagon and truck loaders for handling coal, coke, stone, sand and similar loose materials.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Booklet 224 on belt- and motor-driven pneumatic compressors, and "Giant" fuel oil and gas engines.

Sprague Electric Works of the General Electric Co., 527-531 W. 34th St., New York City. Bulletin 49200 treating of electrical theatrical devices, equipment and accessories.

Fort Wayne Electric Works of General Electric Co., Fort Wayne, Ind. Bulletins 46102 and 46103 on Type II demand indicators and Type M-2 demand indicators, respectively.

Mesta Machine Co., Pittsburg, Pa. Bulletin H descriptive of Mesta blowing engines, equipped with automatic plate valves which eliminate the necessity of making adjustments.

Louis Hanssen's Sons, Davenport, Ia. Catalogue 64 on hardware, factory, mill and contractors' supplies and tools. The book contains 1116 pages, 5¾ by 9 inches, and the index covers 18½ pages.

American Spiral Pipe Works, Chicago, Ill. Bulletin 15-9 illustrating lap welded steel pipe made up in any required length, with diameters from 12 to 72 inches and in thicknesses of from ⅛ to 1¼ inch.

General Electric Co., Schenectady, N. Y., has just issued Bulletin 48017 which refers to the application of electricity in the harvesting of natural ice, and illustrates various motors applicable to this work.

Goodell-Pratt Co., Greenfield, Mass., has issued a little pamphlet entitled "The Story of the Stratton Level," which contains a historical sketch of the origin and development of Stratton levels, and an article on the making of these levels.

Chain Belt Co., Milwaukee, Wis. Supplement to general catalogue 56 containing revised price lists of standard detachable chain belts and various changes in Chabelco steel chain belts. The new H type of riveted chain belt is illustrated on pages 8 and 9.

New Departure Mfg. Co., Bristol, Conn. Leaflets on ball bearing application in vertical spindle wood shaping machine; speed reduction gearing for use with marine steam turbine; ball bearing mounting of cylinder mold shaft; and adjustable cylinder mold bearing mounting.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue D containing descriptive matter on electric monorail man trolleys, hand trolleys, tramrail equipment, transfer cranes, jib cranes, overhead traveling cranes, electric hoists, current collectors and motor-driven trolleys.

Tinius Olsen Testing Machine Co., 500 N. 12th St., Philadelphia, Pa. Catalogue of testing machinery exhibited by the company at the Panama-Pacific International Exposition, comprising a variety of testing machines designed for testing metals, fabrics, rubber, etc.

Vanadium-Alloys Steel Co., First Ave. and Ross St., Pittsburg, Pa., is distributing copies of an article on tungsten mining in Colorado, written by the president of the company, Roy C. McKenna. Anyone may obtain a copy of the article by making application to the company.

Link-Belt Co., Chicago, Ill. Booklet entitled "Insuring the Coal Supply," containing an article that describes various coal storage systems designed to accommodate large supplies of coal so as to eliminate delays in business due to strikes, congestion conditions on railways, storms, or other emergencies.

Reliance Engineering & Electric Co., 1056 Ivanhoe Road, Cleveland, Ohio. Bulletin 1013 on the advantages of motor-driven lathes as compared with cone pulley and belt-driven lathes, containing description and specifications of the Reliance all-gear motor drive for application to cone pulley lathes.

D. & W. Fuse Co., Providence, R. I. Catalogue describing the line of Deltabeston wires and insulating materials. Deltabeston wires are covered with asbestos insulation which is claimed to be absolutely fire-proof. All the wires listed in this catalogue are new with the exception of Deltabeston magnet wire.

National Tube Co., Pittsburg, Pa. Booklet entitled "The Whole Kewanee Family," covering the line of Kewanee unions and specialties manufactured by this company. The book contains 72 pages, 5¼ by 7¾ inches, and is printed in three colors. A complete list of the Kewanee specialties is given on page 60.

Strauss & Buegeleisen, 489 5th Ave., New York City. Circular advertising eye protectors made of "Micalite," a substance which has all the properties of celluloid but is incombustible. The protectors are made of clear "Micalite," amber, or combination clear and amber for eliminating the glare from the eyes.

Merchants & Manufacturers Exchange of New York, Lexington Ave., 46th to 47th Sts., New York City. Circular describing the facilities of Machinery Hall that will be opened on the fifth floor of the Grand Central Palace for the permanent exhibition and demonstration of machinery. The available area is 52,000 square feet.

Niles-Bement-Pond Co., 111 Broadway, New York City. Circular 101 illustrating and describing the Niles-Bement-Pond 48-inch car-wheel boring machine; circular 102, describing the Niles center-drive car-wheel lathe; circular 103 on Niles 36-44-inch side-head boring mill; and circular 104 on Niles 90-inch heavy-pattern driving-wheel lathe.

General Electric Co., Schenectady, N. Y. Bulletin 42206 on Curtis steam turbine-generators. The catalogue takes up the general principles and construction of these generators and treats of the advantages of Curtis turbines. Some types of General Electric turbines are shown, as well as some installations of representative Curtis turbines.

Carlisle & Co., 74 Broadway, New York City. Booklet entitled "Tungsten, Its Properties and Uses," describing the characteristics of the metal, uses, sources of supply, etc. An abstract from the United States Geological Survey is included, which gives some interesting facts regarding the physical, chemical and electrical properties of tungsten.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Bulletin 5004 illustrating and describing a 1000-ton hydraulic press for heading brass cartridge cases. Bulletin 5005 illustrating and describing an 800-ton hydraulic drawing press, with examples of work done in drawing dissolved acetylene cylinders for the "Prest-O-Lite" Co.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Bulletin 34 K describing the details of construction of class N-SO fuel oil driven compressors, and their application to the unit system of air power plants. These compressors are made in six standard strokes of 8, 10, 12, 14, 18 and 21 inches, the dimensions, speeds, capacities, etc., being given in the tables.

Cleveland Fabric Belting Co., 1473 W. 110th St., Cleveland, Ohio. Circulars descriptive of the "Clefabco" straight-line belt adjuster for tensioning loose or broken belts. This adjuster is equipped with quick-acting clamps and a positive worm drive, which eliminates slipping. It is made in two styles, for belts from 6 to 12 inches in width and from 16 to 36 inches in width, respectively.

E. C. Atkins & Co., Inc., Indianapolis, Ind. Supplement to catalogue 12, showing new goods and changes since the issuance of this catalogue. This supplement contains data on Atkins hand saws, one-man saws, nests of saws, pruning saws, trowels, web saw frames, butcher saws, spoke shave, protectors for hacksaw frames, hand saw jointer, non-breakable hacksaw blades, saw guards, etc.

Wheeler Condenser & Engineering Co., Carteret, N. J. Circular illustrating and describing horizontal centrifugal pumps for condenser circulation, irrigation, drainage, dry docks, and general mill and power plant service, having a two-part divided casing, with suction and discharge nozzles in the lower half. The impeller is of the enclosed double-suction type, protected by labyrinth wearing rings.

Wm. D. Gibson Co., Huron and Kingsbury Sts., Chicago, Ill. Catalogue 5 of compression, torsion, extension and flat springs made from crucible steel, alloy steel, open hearth steel, music wire, phosphor-bronze and brass. The catalogue contains formulas and data on springs of much value to all designers. A large variety of spring ends and shapes are illustrated which also should be of interest and value.

Nash Engineering Co., South Norwalk, Conn. Bulletin 3 describing Nash hydro-turbine air compressors and vacuum pumps of the single-stage type, and containing table of speeds and capacities; bulletin 4 on turbine vacuum and low-pressure boiler feed pumps for return-line heating systems or any work where air or other gases containing large percentages of liquid have to be handled under a vacuum.

Edwin Harrington Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa. Catalogue L descriptive of Harrington chain hoists, made in three styles: the "Peerless" for fast speed and high efficiency, the "Screw" for simplicity and rough usage, and the "Differential" for occasional use not demanding high efficiency. Harrington travelers are also described; these can be obtained alone or combined with Harrington hoists.

Crescent Tool Co., Jamestown, N. Y. Circular describing the display board for the "Hamr-Handl" screwdrivers which are being placed on the market. This display easel is made of heavy cardboard 10 by 13 inches in size and weighs 2¼ pounds mounted with the tools. It is supplied to dealers without charge with an assortment consisting of one-quarter dozen each of the 4-inch, 5-inch, and 6-inch screwdrivers, and fifty circulars describing the tools.

Imperial Brass Mfg. Co., 1224 W. Harrison St., Chicago, Ill. Catalogue 132 of Imperial oxy-acetylene apparatus for welding and cutting. Examples of broken castings repaired are shown, which indicate some of the possibilities of the process. The cutting of structural steel is also shown and other illustrations which make the catalogue of interest to all concerned with the possible use of oxy-acetylene welding and cutting equipment.

Becker Milling Machine Co., Hyde Park, Boston, Mass. Catalogue on Becker vertical and horizontal millers, containing a detailed description of the belt- and motor-driven vertical millers, of which there are fourteen types and twenty-four sizes. Specifications are also given for Becker profilers, "Lincoln" type millers and plain horizontal millers. The book is illustrated with engravings of a very high grade, the most interesting ones showing close views of continuous milling on Becker machines.

CONTENTS

THE INDUSTRIAL PRESS, Publishers

140-148 Lafayette Street, New York

Seeing the Market Whole—3

The measure of success in selling a product, if it is right, is the measure of acquaintance shop men have with it. If they do not know the product, the market doesn't know it, but doubtless does know competing lines. If these men are with you, you have the market. If they are against you, you are done for.

Shop men are the ultimate market for shop equipment. They are the first to know shop needs and the only ones who know shop methods and equipment. They originate the orders and specify the makes and brands as well as the sizes they prefer. Who else could do it? Office men do the clerical work, purchasing agents make the terms, but the original demand, the definite order—numbers, quantities, sizes, types and brands—necessarily originate with the only men in a works qualified by knowledge and experience to know what is wanted, how much or how many and for what shop needs.

These are not office men, but head machinists, master mechanics, foremen, superintendents and their assistants—many of them have no titles at all. But they have *shop purchasing power and influence* and are constantly specifying shop equipment and materials as part of their regular routine. By whatever means, through whatever channels orders for shop equipment finally reach the desk of the sales manager, they have been sanctioned by these practical shop men. Whether the order comes direct from the buyer, carrying a high-sounding signature, or through a dealer, the fundamental fact remains—that the business was obtained directly or indirectly from the practical men in the shop.

The wise sales manager, realizing the importance of having these men know his line, plans his advertising accordingly. The character and quality of it are more important than the extent of it. Fine-sounding generalities are lost on these men—they are no babes-in-the-wood. Advertising that doesn't give them definite information is largely wasted. Specific information about design, construction, capacity, workability, power, strength, endurance, reliability, etc.—this is what they want and are glad to have. Engineering language is the kind they do business with. Let them have all the facts, and when the salesman calls, whether he represents manufacturer or dealer, he will find the ground cleared and tilled. The one sure way to reach these men is through the technical journals which they read for instruction and business.

THE modern military rifle is an evolution from the musket or shoulder gun, which came into use in Europe in the fifteenth century, displacing the matchlock. The matchlock musket was superseded, in turn, by the wheelock, the snaphance, the flintlock and the percussion gun. The flintlock (see Fig. 1) was the first shoulder firearm to be generally used in warfare. Although the method of firing the charge was crude, it permitted the soldier to aim and fire quickly. The flintlock musket had a smooth bore of comparatively large diameter, and fired spherical bullets. The invention of fulminate of mercury percussion caps for igniting the powder charge in 1799 brought the percussion lock to the front and displaced the clumsy, slow and non-dependable flint lock. All these early guns were muzzle loaders, the powder charge and bullet being inserted into the bore at the muzzle and pushed to the breech by a ram-rod. An improvement in firearms ranking with the percussion cap or primer was the rifled bore which appeared early in the sixteenth century. Little is known of the origin or early development of rifling or helical grooving of the bore to give rotation to the bullet in flight. It has been attributed to several men, one of whom was Gaspard Koller, a gunsmith in Vienna, Austria.

The modern military rifle is the result of five centuries of inventions and developments to which thousands have contributed their best ideas. The manufacture of military rifles requires the highest types of men, machinery, tools and equipment. At present, when millions of rifles are being made in this country for the nations at war, the following articles are of extraordinary interest. The unusual and complicated machining operations are described in detail and illustrated. The organization is outlined and the specifications are tabulated.

Improvements in Military Rifles

The rifled bore improved the accuracy of fire, but difficulty was experienced in expanding the ball so that it would follow the rifling grooves. Various devices were adopted for expanding the ball, such as ramming it onto a pointed projection at the breech end of the barrel, etc., with more or less success. After the adoption of the rifled bore, attention was directed more to the bullet than to the arm itself. The first bullet was of spherical shape similar to that which had been fired from the smooth-bore musket, but for obvious reasons this was not satisfactory. Bullets were then made with bands, "wings," cup-shaped, etc., the development gradually leading up to the design of a bullet of oblong shape. No marked improvements were made, however, until 1849 when Captain Minié devised a hollow base bullet which was expanded by the explosion of the powder charge. This bullet was designed for use in the Thouvenin rifle, and was oblong in shape, with a hollow base in which a hemispherical iron cup was inserted.

The first rifled muskets had seven grooves in the bore with a twist of about one turn in ten feet. The twist of the rifling grooves was increased with improvement in accuracy, and in the Brunswick rifle, brought out in 1836 the twist was made one turn in thirty inches—the length of the barrel. This proved unsatisfactory, however, as it was found that the bullet was driven across the lands instead of following the grooves. The grooves were then made with an increasing depth to assist the bullet in following them, but this made a difficult rifling proposition. An increase in the depth of the grooves also proved unsatisfactory.

For information on rifle manufacture previously published in MACHINERY see "Manufacture of Savage 0.22 Caliber High-power Rifle" in the July and August, 1914, numbers of MACHINERY and articles there referred to.

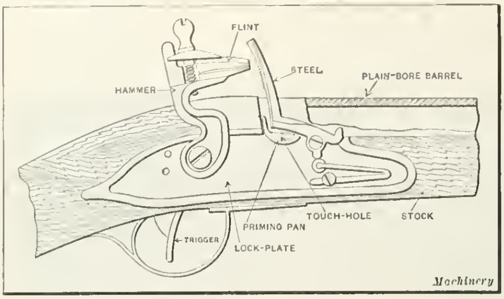


Fig. 1. First Successful Military Shoulder Gun employing a Flintlock

In 1854 Mr. Whitworth brought out a rifle with a hexagonal bore having a twist of one turn in twenty inches and measuring 0.450 inch across the flats. The bullet was also made of hexagonal shape. Other rifles having bores of polygonal shape were tried but discarded. Owing to the difficulty of producing hexagonal and polygonal bores, rifling was again resorted to, and in 1865 Mr. Metford produced a rifle of 0.450 caliber, having five shallow grooves and firing a lead bullet hardened with antimony and wrapped in a thin paper patch. Expansion of the bullet, which was made cup-shaped, was effected by the force of the powder explosion on its base.

Development of Breech-loading Rifles

The disadvantages of the muzzle-loading rifle were early appreciated, and many attempts were made to load at the breech.

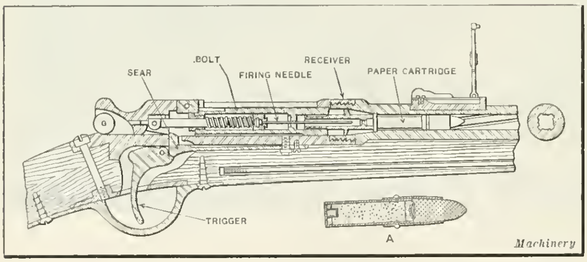


Fig. 2. French Chassepot Rifle of 1866

Even as early as the sixteenth century rifles were designed to load at the breech. One of the first attempts consisted in having a side entrance to the bore at the breech through which the bullet and powder were inserted, the cavity being closed by a screw. The first practical breech-loading rifle was the Prussian needle gun invented by Dreyse in 1838 and adopted by Prussia in 1841. In this rifle the breech was closed by a mechanism resembling the turn-bolt of a door. Ignition was effected by a long needle carried in the bolt, which was driven forward by a spiral spring upon pulling the trigger. The needle, when forced forward, pierced the base of the cartridge and ignited the powder charge by striking a disk of fulminate of mercury contained within it. The escape of gas from the breech proved troublesome, but the gain in rapidity of loading more than compensated for this defect. This rifle, while unsatisfactory in many respects, was an improvement over previous designs and was used by Prussia with marked success in the wars of 1848, 1866 and 1870.

Types of Breech Mechanism

The advantages of the breech-loading rifle were soon recognized by all the leading powers, and many were designed in the first half of the nineteenth century. The majority of breech mechanisms were provided with some sort of a hinged block which was turned over to give access to the chamber in which the charge was placed. The type known as the "Lefaucheux System" had the barrel hinged at the breech end somewhat similar to the present-day shot gun. While this system proved satisfactory for shot guns, it was never considered of practical value for military rifles. Another breech mechanism known as the revolving type, consisted in rotating the barrel eccentrically in relation to the hreech end, but this was soon discarded owing to the difficulty of preserving the correct alignment between the two members, and the leakage of gas between the chamber and the barrel.

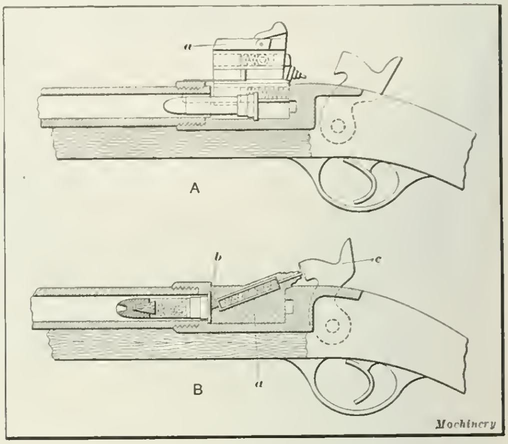


Fig. 3. Breech Mechanism designed by Jacob Snider in 1866

In most of the breech-loading guns invented between 1850 and 1860, the percussion cap was separated from the charge, being located on a nipple. The flame from this cap had to pierce the cartridge and ignite the charge. This system was adopted in the early Sharp, Terry, Greener and Westley-Richards rifles. The Sharp, which was an American rifle, was patented in 1852. The breech end of the barrel was closed by a slide, actuated by a lever forming the trigger guard. To load the rifle, the slide was drawn down to insert the cartridge, and when raised it closed the breech, and at the same time the sharpened top edge cut off the end of the cartridge exposing the powder to the flame of the percussion cap.

In the Terry rifle a tallowed wad was fixed at the

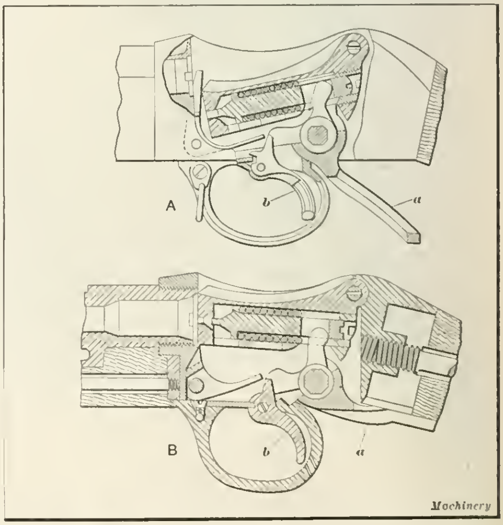


Fig. 4. Martini Bolt Action designed in 1870

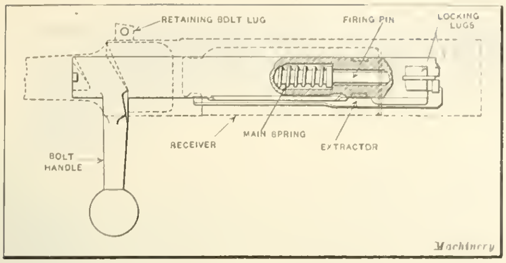


Fig. 5. Diagram illustrating Construction of Mauser Type of Bolt Action

base of the cartridge, and the charge was ignited from the center. The ball was made larger than the bore so that it filled the grooving when forced into the rifling. The Westley-Richards rifle had a hinged block that opened forward, and like the Terry, used a felt wad that served as a gas check. In the Greener carbine, the barrel was unlocked from the breech and slid forward. The escape of gas was prevented by a sliding tube having a tapered ring at its rear end, which acted in the same manner as the obturator used on large caliber guns.

This principle was also taken advantage of in the French Chassepot rifle, designed in 1866 (see Fig. 2), which had a straight-pull bolt, and was arranged to carry a combustible cartridge *A*. This was made with a paper case, and it had a cap in the center of the base; the face of the bolt was provided with a rubber washer to check the escape of gas. About the same time Colonel Boxer devised a cartridge with a case

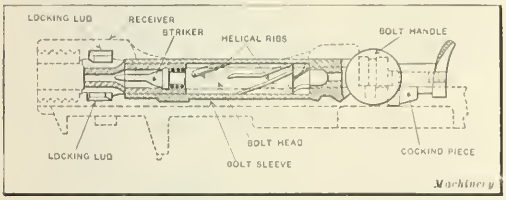


Fig. 6. Diagram illustrating Principle of Construction of Mannlicher Bolt Action

made from coiled brass instead of paper. This was first used in the Snider rifle. The invention of the coiled brass cartridge case gave great impetus to the development of breech-loading rifles. The Boxer case was made from sections of coiled brass; the head, which carried the percussion cap or primer, was attached by solder. Previous to the invention of the brass case, all cartridge cases were made from paper, and consequently were not gas tight. The breech mechanism had to be made so as to prevent the escape of the gases, which was practically impossible. The built-up cartridge case designed by Colonel Boxer was much superior to the paper cartridge case, but it was bulky and not altogether a perfect gas check because of defects in construction. The principle, however, was sound and the later development of the one-piece drawn cartridge case overcame the objections inherent in the Boxer cartridge.

The Snider Breech Mechanism

One of the early breech mechanisms used with considerable success was that designed by Jacob Snider and adopted by the British government in 1867. In this rifle a swinging block was held in a recess in a short receiver screwed to the breech end of the barrel. The block *a*, as shown in Fig. 3, was hinged on the right-hand side of the receiver, which on being opened gave access to a tapered chamber in the breech end of the gun. A projecting spring pin held the block in place when opened. Located on the front end of the block was a hook extractor that engaged the head of the cartridge case to withdraw it after being discharged. In lifting up the block, it also could be withdrawn a short distance; this extracted the cartridge from the chamber, and it could then be thrown out by turning the rifle over. The striker *b* was located diagonally in the block and when struck by hammer *c* was caused to hit the cap in the head of the cartridge. The bullet had a hollow in its base in which a taper plug of wood or clay was inserted to cause it to expand into the rifling grooves. The front end was also made hollow so as to distribute the weight evenly and thus increase the accuracy.

The Martini Breech Mechanism

The Snider breech block had several disadvantages, chief among which was the difficulty experienced in preventing the escape of gas. A considerable improvement in breech mechanism was devised by Mr. Martini in 1870 and finally adopted in 1871. As shown in Fig. 4, this action was designed along the lines of some of the present-day sporting rifles. Instead of the block being hinged to lift up, it was dropped down by operating lever *a*. This gave access to the chamber in the

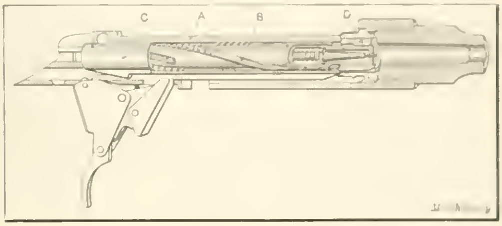


Fig. 7. Ross Straight-pull Bolt Action designed in 1907

barrel and when the block was raised the breech was effectively closed. The firing pin was carried in this block and was released by pulling trigger *b*. This breech mechanism was applied to the Henry barrel, and the combination was known as the Martini-Henry rifle. The barrel was 33.2 inches long, 0.450 inch caliber, and had seven shallow grooves making one turn to the right in 22 inches. The muzzle velocity was 1350 feet per second.

Modern Rifle Bolt Actions

The bolt actions used in modern military rifles may be divided into two groups: (1) those in which the bolt is rotated by raising the bolt lever before the bolt can be withdrawn; (2) those that can be drawn straight back to the rear without any rotary movement of the hand-lever, known as "straight-pull" bolts.

Those in the first group are used by all the principal coun-

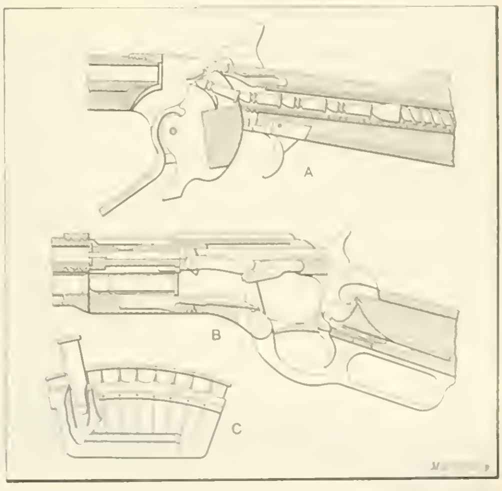


Fig. 8. A One of the First Successful Magazine Rifles known as the "Spencer." B Winchester Magazine Repeater. C Russian Kranka Quick-loader. Forerunner of Present-day Clip and Charger

Fig. 9. French Lebel Military Rifle, Model 1886

tries with the exception of Austria, Switzerland and Canada. These three employ the "straight-pull" bolt action. One of the advantages of a rotating bolt is that a powerful loosening action can be exerted on the fired cartridge case by the bolt handle working on the receiver cam surface. If the bolt is supported by symmetrical lugs as in the Swiss rifle and Austrian pattern of 1895, the lugs have to be rotated to clear them from their seating in the receiver. In the rotating bolt action this is avoided by rotating the bolt by the bolt lever. vibration and affecting the accuracy of fire. When the lugs are on the front end of the bolt, the symmetrical front of the receiver and bolt resist the backward motion of the cartridge on firing, but the recess in which the lugs work is difficult to clean out if sand gets into it, which may happen in hot countries where dust storms occur. The French and Russian rifles have bolt heads which carry the locking lugs and rotate with the bolt. This system appears to have no advantage except for repair purposes. The most desirable bolt is one in which the fore end is solid and is locked in cam shaped grooves in the front end of the receiver, as in the Mauser rifle.

TABLE I. THE PRINCIPAL DIMENSIONS AND SPECIFICATIONS OF MILITARY RIFLES USED BY THE VARIOUS GOVERNMENTS

Country	Model (year)	Designation	Magazine System*	No. of Cartridges in Magazine	Weight in Pounds (without bayonet)	Total Weight, Pounds	Length (without bayonet), Inches	Total Length, Inches	Length of Barrel, Inches	Caliber of Bore, Inches	No. of Rifling Grooves	Depth of Grooves, Inches	Shape of Grooves	Twist of Rifling, Inches	Muzzle Velocity,† Feet per Sec.
Austria and Bulgaria	1895	Mannlicher	Fixed Vert. Box	5	8.34	8.98	50.00	59.50	30.12	0.315	4	0.0080	Concen. Beveled Edge	9.842	2840 2034
Belgium	1898	Mauser	Detach. Vert. Box	5	8.03	9.56	50.25	59.75	30.67	0.301	4	0.0065	Concen.	9.842	1975
Canada	1907	Ross	Fixed Vert. Box	5	8.06	9.08	52.00	58.80	28.00	0.300	4	0.0055	Concen.	10.000	2800
Denmark	1889	Krag-Jorgensen	Fixed Horiz. Box	5	9.73	10.28	52.75	63.00	32.90	0.315	6	0.0075	Metford Segmental	11.811	2535
France	1907-15	Lebel	Fixed Vert. Box	3	6.91	7.83	51.12	71.84	31.49	0.315	4	0.0059	Concen.	9.450	2310
Germany	1898	Mauser	Fixed Vert. Box	5	9.00	9.87	49.40	69.75	29.05	0.311	4	0.0065	Concen.	9.390	2960
Great Britain	1907	Lee-Enfield Mark I	Detach. Vert. Box	10	9.25	8.64	49.50	61.50	30.19	0.303	5	0.0065	Concen.	10.000	2060
Great Britain	1907	Lee-Enfield Mark III	Detach. Vertical Box	10	10.22	9.64	44.50	61.50	25.19	0.303	5	0.0058	Concen.	10.000	2440
Greece	1903	Mannlicher-Schoenauer	Fixed Vert. Box Rotary Platform	5	8.34	9.00	48.37	58.12	28.56	0.256	4	0.0065	Concen. Round Edge	....	2400
Holland	1895	Mannlicher	Fixed Vert. Box	5	9.68	10.42	51.00	60.75	31.12	0.256	4	0.0065	Concen. Round Edge	7.874	2433
Italy	1891	Mannlicher-Carcano	Fixed Vert. Box	6	8.40	9.18	50.75	62.37	30.75	0.256	4	0.0060	Concen.	Increasing from 19¼ to 8¼	2300
Japan	1907	Year 38 Pattern	Fixed Vert. Box	5	8.63	9.56	50.75	65.75	31.30	0.256	4	0.0060	Metford Segmental	7.875	2420
Portugal	1904	Mauser-Verguiero	Vert. Box Mov'bl Box	5	8.81	9.59	48.00	59.25	29.08	0.256	4	0.00575	Concen. Round Edge	7.780	2347
Roumania	1893	Mannlicher	Fixed Vert. Box	5	8.80	9.59	48.50	58.25	28.56	0.256	4	0.0065	Concen. Round Edge	7.874	2430
Russia	1894	Mauser-"3 Line" Nagant	Fixed Vert. Box	5	8.95	9.70	51.87	69.00	31.50	0.300	4	0.0070	Concen. Round Edge	9.500	2886
Spain	1896	Mauser	Fixed Vert. Box	5	9.42	10.34	48.62	58.50	29.03	0.276	4	0.0055	Concen. Round Edge	8.680	2330
Switzerland	1900	Schmidt-Rubin Short Rifle	Detach. Vert. Box	6	8.03	8.64	43.12	58.75	23.33	0.295	3	0.9039	Concen. Round Edge	10.630	2705
Turkey	1893	Mauser	Detach. Vert. Box	5	9.06	10.50	48.60	66.60	29.13	0.301	4	0.0055	Concen. Round Edge	10.000	2140
United States	1903	Springfield	Fixed Vert. Box	5	8.69	9.69	43.21	59.21	24.006	0.300	4	0.0040	Concen.	10.000	2750

Machinery

* In connection with the magazine systems of the various rifles, a charger instead of a clip is used, with the exception of those used by Austria, Bulgaria, Holland, Italy and Roumania; the Canadian rifle uses neither a charger nor clip. Of the rifles listed, only those used by Canada, Denmark, Germany, Great Britain, France, Turkey and United States have cut-offs in the magazine.

† Due to the adoption of improved smokeless powder since the time these data were compiled, some of the muzzle velocities have been increased from 10 to 25 per cent above those given in the table.

There are many forms of rotating bolts. For instance, in some cases the bolt head does not rotate, and the bolt itself is locked at the rear instead of at the front end. In others, there is no separate head and the locking lugs are on the front end of the bolt, no lugs being provided at the rear. Then there are bolts with both a rotating bolt head and locking lugs. One of the rotating bolts, the Lee-Enfield, is the only one with the lugs near the rear part of the bolt. The disadvantage of this arrangement is that upon firing, unsymmetrical stresses are set up in the bolt and receiver, causing lateral vibration and affecting the accuracy of fire.

The Mauser Bolt Action

The Mauser bolt, which is shown diagrammatically in Fig. 5, is of strong and simple construction without a movable bolt head. It can be stripped without the use of tools and is locked by lugs on the front end engaging with cam-shaped grooves cut in the receiver. This form of bolt, which is of the "turn" type, is used with slight modifications on the greater number

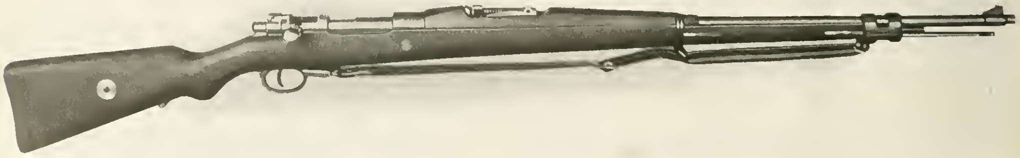


Fig. 10. German Mauser Military Rifle, Model 1898

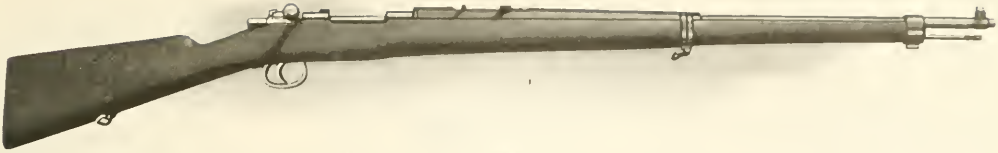


Fig. 11. Spanish Mauser Military Rifle, Model 1896

of military rifles. The Belgian, German, Spanish and Turkish Mauser breech mechanisms vary to a slight extent in the construction of the bolt. Of these four, the Spanish bolt is the simplest, but it has been found to be rather weak as compared with the German bolt. On the German bolt an extra lug engaging in a recess in the cylindrical part of the receiver gives additional support when the cartridge is fired.

The face of the bolt is recessed to receive the head of the rimless cartridge. The lever on the bolt is straight and extends at right angles from the rear end. The left-hand lug has a slot cut in it in which the ejector slides when the bolt is withdrawn to eject the cartridge. The extractor fits on the outside of the bolt and is held in place by a spring collar working freely in a groove cut in the body. On the Spanish Mauser this extractor is exposed and unsupported, except for the retaining ring, whereas on the German Mauser a rib is provided which supports the extractor, giving it greater strength at the time of primary extraction. The operation of this bolt will be more fully described in connection with the description of the Mauser rifle.

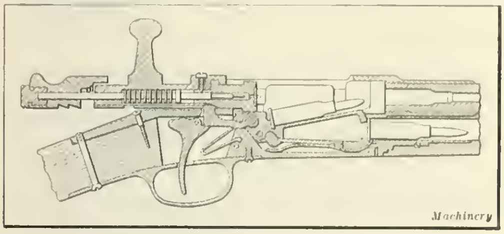


Fig. 12. Diagram showing Breech Action of French Lebel Rifle

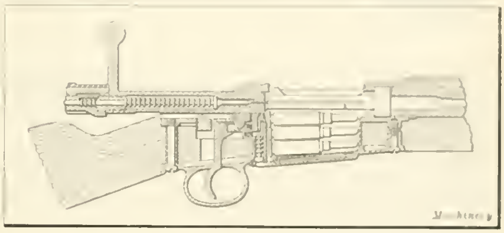


Fig. 13. Diagram showing Breech Action of Spanish Mauser

The Mannlicher Bolt Action

As has been previously mentioned, the Mannlicher bolt action is of the "straight-pull" type. This is diagrammatically shown in Fig. 6. The bolt proper is a hollow cylinder with ribs on each side which work in straight grooves in the receiver. Inside the middle portion of the bolt are two helical feathers or ribs which work in corresponding grooves in the tail of the bolt head and give it a rotary movement in opening and closing the bolt. A groove is cut on the inside of the right rib of the bolt sleeve or cylinder for the extractor.

The bolt consists of the head proper which projects beyond the face of the bolt cylinder, and the tail which enters the cylinder. The bolt head has locking lugs on each side which enter the recesses in the receiver by way of the cam-shaped grooves, and support the bolt head in the firing position. A groove is cut in the head for the ejector. The rear end of the tail has two external helical grooves in which the feather on the cylinder works. The helical grooves have a small groove leading out of them parallel to the axis of the bolt, one to the front and the other to the rear. The one to the front is on top of the tail and that to the rear on the right-hand side when the bolt is open.

This bolt is operated by a pull and push action. When the lever is pulled to the rear, the bolt cylinder cannot revolve because the ribs on it work in the grooves of the receiver and the feathers in the under-cut grooves in the tail. The bolt head, on the other hand, cannot move to the rear until the locking lugs have been disengaged from the recess in the receiver, and this is effected by the turning motion given to the tail of the bolt head by the helical feathers in the inside of the bolt cylinder working in the bolt head tail. Primary extraction is effected by the cam-shaped ends of the grooves in the receiver in which the bolt locking lugs work. The first motion of the bolt to the rear partly compresses the main spring, and as soon as the locking lugs are disengaged from the receiver "cams" they are in line with the ribs on the bolt cylinder and the entire bolt can then be drawn to the rear until arrested by the feathers on the under side of the bolt coming in contact with the horns of the trigger. In closing the bolt, the above movements are reversed, the sear tooth engaging the stud of the cocking-piece and completing the compression of the main spring. The action can be cocked without opening and closing the bolt by pulling back the cocking-piece. At full cock the locking bolt can be used as a safety bolt.

The Ross "Straight-pull" Bolt Action

The Ross "straight-pull" bolt action used in the Canadian military rifle was designed by Sir Charles Ross in 1907. It is a modification of the Mauser bolt coupled with the "straight-pull" feature of the Mannlicher type, and is shown in Fig. 7. It comprises a bolt sleeve A which acts as a carrier for the bolt B and is provided with a handle at the rear. On the exterior bolt surface are two ribs which slide in corresponding grooves in the sides of the receiver. The left rib has a lug engaging with the bolt stop. The extractor is held in an under-cut groove in the top. A slot is cut in the rear end to guide the cocking-piece. The interior is provided with spiral ribs similar to those on the body of the bolt which give the turning movement necessary to lock the bolt. The bolt and the bolt head are made in one piece and are machined to receive the striker and main spring. The lugs D on the front end engage shoulders in the receiver and support the bolt while the cartridge is being fired. The front face of these lugs is cam-shaped to facilitate extraction of the cartridge.

Fig. 14. Austrian Mannlicher Military Rifle, Model 1895

With this bolt mechanism a straight pull back releases the lugs from the shoulder in the receiver, and extracts the cartridge; and a straight push forward inserts the cartridge and cocks the arm ready for firing.

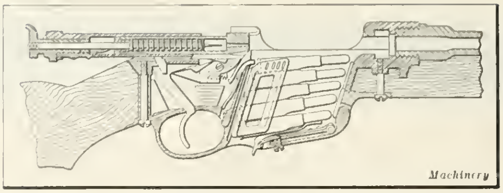


Fig. 15. Diagram showing Breech Mechanism of Austrian Mannlicher Rifle

Development of Magazine Rifles

The first military rifles which were loaded from the breech end were of the single-shot type. The advantages to be gained by increasing the rapidity with which the rifles could be discharged were recognized early in the history of small arms. A great advance in this direction was made by the adoption of breech-loading rifles, when the powder charge, bullet and igniting agent were contained in one case. Weapons known as repeaters were the first really successful rifles that contained a reserve of cartridges. In this class of weapon the cartridges lay nose to base in a tube contained in the butt or in the fore end of the stock. The breech was opened, the empty case extracted and a fresh cartridge introduced in the chamber. The breech was then closed and the weapon cocked ready for firing. The earliest successful weapon of this class was the Spencer rifle shown at A in Fig. 8, which was patented in 1860. This rifle, as the illustration shows, carried the reserve cartridges in a tube in the butt end of the stock, which were followed up by means of a spring controlled plunger.

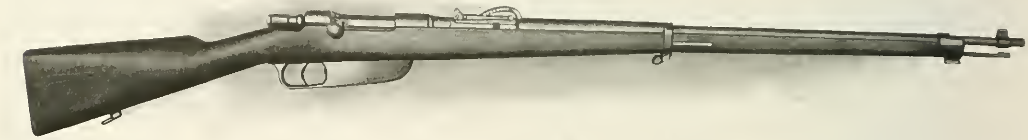


Fig. 16. Italian Mannlicher-Carcano Military Rifle, Model 1891

The Winchester repeater, shown at B in Fig. 8, carried nine cartridges in the magazine, one in the carrier, and one in the chamber. This rifle belonged to that system in which a fixed chamber was closed by a bolt sliding in line with the axis of the barrel and operated by a lever from below. The receiver was divided by a vertical partition into two parts, the carrier occupying the front portion, while the rear contained, with the exception of the breech block lever, the mechanism necessary to operate the breech block and carrier. The breech block was a single piece, the upper end of which had an extractor of the spring hook pattern pinned to it, and at its rear end it supported two side links that formed a knuckle joint.

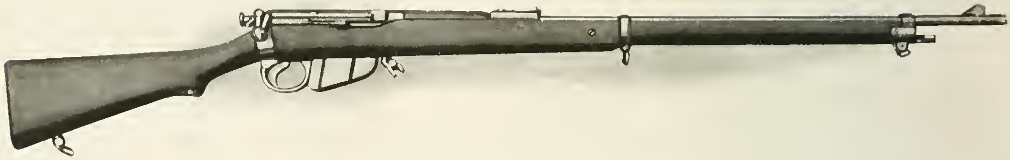


Fig. 17. British Lee-Enfield Military Rifle, Model 1907, Mark I

The hammer was cocked by the end of the firing pin when the breech bolt lever was thrown forward. The rifle was fired by a center lock of the usual pattern. A safety device prevented pulling the trigger when the rifle was cocked. The shells were ejected by the carrier, which lifted up as they were withdrawn, striking them at a distance of about one-third their length from the rear, rotating them about the extractor and throwing them clear of the rifle. The magazine was in the fore end of the stock, and was loaded through a gate in the side cover of the receiver.

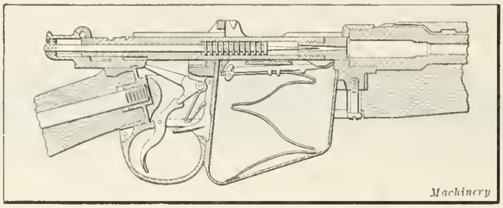


Fig. 18. Diagram showing Breech Action of British Lee-Enfield Rifle

The Kranka Quick-loader

The Winchester repeater just described was used by Turkey in the Russo-Turkish war of 1877-1878 with such striking effect that the Russian government was called upon to adopt a similar method of handling the single-shot gun at that time used by the Russian troops. The defects of the single-loader were partially overcome by the adoption of a quick-loading device known as the "Kranka quick-loader." It consisted, as shown at C in Fig. 8, of a receptacle attached to the side of the rifle, in which there were ten pockets. The cartridges were placed in each pocket in a line, head uppermost, so that they could be quickly withdrawn and forced into the receiver of the rifle in front of the bolt. The rifle was then ready for firing, upon closing the breech mechanism. This quick-loader was the forerunner of the present-day chargers and clips used in connection with a large number of military rifles.

Modern Military Rifles

Following the successful use of the Spencer rifle in 1860, practically all the military powers devoted their attention to the adoption of magazine rifles. The first great power to provide its army with a magazine rifle was the German government. In 1884, it converted the 1871 pattern of the Mauser rifle of 0.433 inch caliber into a magazine rifle, holding eight cartridges in a tube magazine located in the fore end of the stock. All the magazine rifles up to this time were over 0.44 inch caliber, and the French government was the first to reduce the bore below this, when it brought out the Lebel rifle in 1886. This had a bore of 0.315 inch—which is the caliber of the present rifle—and contained eight cartridges located in a tubular magazine in the fore end of the stock. At the beginning of the present war, however, this tubular magazine was dispensed with and a breech magazine holding three cartridges was adopted in its place.

In 1886, the Austrian government adopted the Mannlicher rifle of 0.433 inch bore with a "straight-pull" bolt and at the same time adopted Lee's box magazine, which was patented in 1879 and consisted of a box below the entrance to the chamber, containing the cartridges placed horizontally one above the

other. A platform actuated by a spring pushed the cartridges upward, so that when the bolt was pushed forward it struck the head of the top cartridge and pushed it into the chamber of the barrel. Another important improvement introduced with this rifle was the principle of multiple loading, which was effected by a sheet steel clip containing five cartridges. The clip full of cartridges was pressed into the magazine and retained by a catch until the cartridges were expended, when it fell out through an opening in the bottom of the magazine. In 1888, the bore of the Mannlicher rifle was changed from 0.433 to 0.315 inch, which is also the caliber of the latest or 1895 model. The development in military rifles has been toward a gradual reduction of the bore, the smallest at the present time being 0.256 inch. This caliber has been adopted by Greece, Holland, Italy, Japan, Portugal and Roumania as shown in Table I.

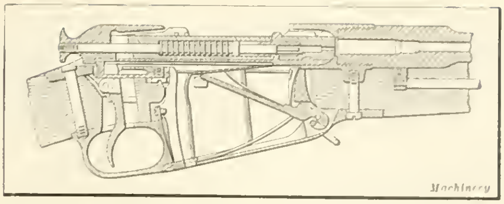


Fig. 19. Diagram showing Breech Action of Russian Three-line Nagant Military Rifle

ceiver. At the same time, the end of the ejector screw strikes behind the left ledge of the cartridge head and ejects the empty cartridge to the right.

Upon pressing the bolt forward, the face of the bottom lug strikes the base of the cartridge in the carrier which has just been raised and pushes it forward into the chamber. As the front of the rib meets the curve on the receiver, the sear engages the cocking-piece and when the bolt lever is turned down, the lugs on the bolt head pass along the curved entrances to the recesses and force the bolt in, completing the compression of the main spring.

The German Mauser Rifle

The German Mauser rifle, shown in Fig. 10, is the model of 1898 and is of the turn-bolt action, after which practically all the modern military rifles have been patterned. This rifle has a bore of 0.311 inch and a muzzle velocity of approximately 2900 feet per second. It fires a nickel-coated steel-cased bullet, weighing approximately 154½ grains. It is supplied with a fixed vertical box magazine and is loaded with a charger containing five cartridges. The bolt is locked in the receiver by lugs on the fore end and is additionally supported by a lug at the rear end. The extractor differs from the one used on the Spanish Mauser in that a lug supports it during primary extraction. The extractor is held to the bolt by means of a split collar. The construction and operation of the bolt has been previously described.

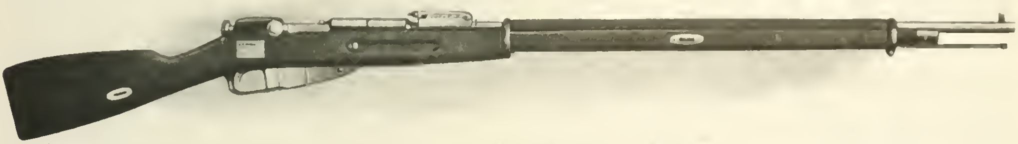


Fig. 20. Russian Three-line Nagant Military Rifle, Model 1894

The French Lebel Military Rifle

The Lebel rifle, shown in Figs. 9 and 12, was the first small-bore rifle to be adopted by any nation, and with it smokeless powder was first used. It is of the turn-bolt type, the bolt being a cylinder bored out from the front end for the main spring, and with a straight lever terminating in a knob near the rear end. It differs from other military rifles in that the stock is made in two pieces, the butt and fore end being joined to the receiver that extends clear down to the bottom of the stock. Some slight modifications have lately been made in this rifle to convert it from a tube magazine rifle to one using a charger that holds three cartridges.

Fig. 21. Japan 38th Year Pattern Military Rifle

The action of the breech mechanism of this rifle is briefly as follows: Upon turning up the bolt lever, the tooth on the cocking-piece rides up on the inclined face of the cam recess on the bolt and the point of the tooth drops into the recess. This compresses the main spring partially. The cocking-piece is prevented from turning with the bolt by the projection being supported by the sides of the receiver. As the bolt is being opened, the lugs on the bolt head are turned in front of their support into a vertical position and the front end of the projection on the bolt is forced back by the curved face of the receiver. The bolt lever and rib are now in line with the openings in the sides of the receiver, so that the bolt and empty cartridge held by the extractor can be drawn back. When the bolt is fully withdrawn it is stopped by the lower lug striking the end of the partition in the re-

The Spanish Mauser

The Spanish Mauser, shown in Figs. 11 and 13, differs very little from the German Mauser. The only modifications aside from the sights and other less important details, are in the bolt and bolt plug. The bolt is made extremely plain, having only two locking lugs on the fore end that fit in corresponding cam grooves in the receiver, and is plain on the rear except for a flat, cocking cam slot, safety bolt lock slot, and a locking slot, for the cocking-piece. The extractor is held by a collar the same as in the German Mauser, but is not supported by a lug during primary extraction. The other important details of this rifle are given in Table I.

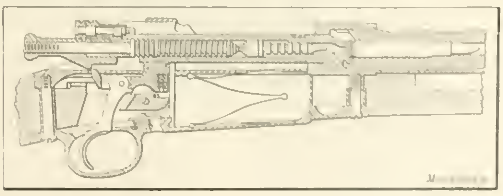


Fig. 22. Diagram showing Breech Action of Springfield Rifle Model 1903

Austrian Mannlicher Rifle

The Austrian Mannlicher rifle, shown in Figs. 14 and 15, is of the "straight-pull" bolt type, as has previously been described. The magazine carries five cartridges which are

held in a clip. As soon as all the cartridges have been removed, the clip drops out of the magazine through an opening in the bottom. The bore of the rifle is 0.315 inch, and it fires a lubricated steel-cased bullet weighing about 244 grains. The "straight-pull" bolt action can be operated slightly faster than the turn-bolt type, but has not the same strength as the latter.

The Italian Mannlicher Carcano Rifle

In this rifle, the Mannlicher type of clip holding six instead of five cartridges is used. The breech mechanism is that introduced by M. Carcano of the Turin Small Arms factory, and is a modified Mauser action. As shown in Fig. 16, the Italian rifle bears a marked resemblance to the Austrian as far as exterior appearance is concerned. The bolt, which is not provided with a separate bolt head, has a lug on each side at the front end. The extractor passes through a slot in the right lug into its seating in the rear. The front end of the bolt is recessed to fit the head of the cartridge, and the rim or recess is cut away at the bottom to allow the cartridges to move up the face of the bolt so that the extractor may enter into the groove, thus avoiding any chance of double loading. The rifling is of the progressive twist type, beginning at the breech end with one turn in 22.9 inches and ending with one turn in 7.5 inches at the muzzle.

The British Lee-Enfield Rifle

In the British Lee-Enfield rifle, shown in Figs. 17 and 18, the bolt is designed on the Mauser principle and the bolt head does not rotate with the bolt proper. The Lee-Enfield is the only one of the rotating bolts which has the locking lug near the rear. The disadvantage of this arrangement in firing is that unequal strains are introduced in the receiver and bolt, which cause lateral vibration and necessitate placing the foresight to one side of the barrel as previously explained. The caliber of this rifle is 0.303, and it fires a nickel-jacketed pointed bullet weighing approximately 150 grains, with a muzzle velocity of 2200 feet per second. Another variation in the British Lee-Enfield is that the magazine, instead of holding five or six cartridges, holds ten and is fed by a charger instead of a clip. A magazine cut-off is provided.

The Russian Three-line Nagant Rifle

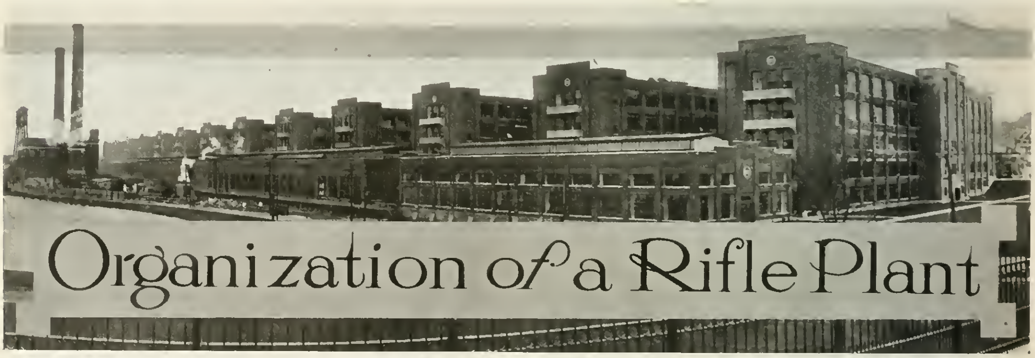
The Russian three-line Nagant rifle, shown in Figs. 19 and 20, is of the turn-bolt type, having a magazine that works on the charger principle. The bolt is provided with a separate head which turns with the bolt and, together with a connecting bar, acts as a guide to the cocking-piece and helps to retain the bolt in the body. To charge the magazine, the charger is placed into the recess cut for it in the bridge of the receiver and the cartridges are forced out by a pressure of the thumb. The charger when empty must be removed by hand. There is no cut-off and the rifle can only be used as a single loader when the magazine is empty. It carries five cartridges.

Japan Year 38th Pattern Rifle

This rifle, which was introduced in 1907 and is shown in Fig. 21, is patterned after the Mauser rifle. The locking lugs of the bolt are on the front end and the extractor is attached to the bolt in the same manner as in the Mauser. The bolt, however, instead of being exposed is covered by a sheet-steel bolt cover, somewhat similar to that used on the Lee-Enfield rifle. The magazine, which holds five cartridges in two columns, is made of sheet steel, the bottom part fitting into an opening made in the front end of the receiver. The bottom of the magazine is closed by a hooked plate. When the magazine is empty, the rear end of the platform prevents the bolt from being closed and thus indicates that the magazine requires refilling. A charger is used instead of a clip.

The American Springfield Rifle

The American Springfield rifle, shown in Figs. 22 and 23, was brought out in 1903 to displace the Krag-Jorgensen formerly employed. This rifle is almost identical with the German Mauser. Of course it has a few modifications, but these are of comparatively minor importance. The extractor is held to the bolt by means of a collar, the same as in the regular Mauser, but in addition it is backed up by a lug, thus reducing the strain on the collar when forcing the extractor over the head of the cartridge. The bolt handle is bent down, as on the Lee-Enfield. The bullet, of the Spitzer type, is 0.303 caliber and has a muzzle velocity of 2750 feet per second.



Organization of a Rifle Plant

THE organization of a plant to turn out a modern military rifle does not differ in essentials from that of any other plant that makes interchangeable parts. The methods of laying out the work, planning the order of operations, and routing the work through the plant, etc., can also be applied to the manufacture of a typewriter, automobile, machine tool, or in fact any other interchangeable product. It is therefore evident that the information on rifle manufacture here given is of wide application. The aim throughout this article has been to deal with fundamental principles, which cover laying out the work, designing the tools and gages, and planning the order of operations. A complete analysis has been given of the most efficient method of machining each component part, and the selection of locating, clamping and gaging points for the various operations. In addition, principles of fixture, gage and tool design have been included to make the analysis complete, but this latter part will be treated in a following number of MACHINERY.

Preparing for the manufacture of military rifles includes the writing of instructions and the compilation of a part and material list. This list gives a part number for every part so as to simplify the routing of the work through the plant. The list also carries a designation that indicates the heat-treating process, finish, etc., to which each part must be subjected. The manner in which these specifications are handled will be explained later.

Personnel of the Organization

In order to make the following discussion clear to those unfamiliar with the organization necessary to manufacture a military rifle, it has been thought advisable to approach this subject from the standpoint of an entirely new organization.

Fig. 23. American Springfield Military Rifle. Model 1903

In this way, the most approved methods of designating and organizing the various departments can be followed. This description is necessarily brief, and is confined to an outline of the departments and their functions.

The entire operation of a plant which is to produce 200 military rifles in eight hours should be under the general direction of a works manager, and affiliated with him should be a chief engineer and production or planning engineer. These two separate heads then control all the manufacturing and engineering activities of the entire organization, reporting to the works manager. In the following is given a short description of the duties of each of the important departments and officials in charge of them. The duties assigned to the various department heads differ, and only a very brief outline of a typical organization is given here.

Works Manager—The works manager has complete charge of the plant, and his assistants are the chief engineer and production engineer.

Chief Engineer—The chief engineer has charge of the issuing of all orders covering the manufacture of tools, parts, assembling of parts, shipping, inspection, etc. Duplicate copies of all purchasing orders are forwarded to the production engineer for his guidance in meeting promises relating to production. The chief engineer, acting through the chief draftsman, has sole charge of the designing and construction of all tools, fixtures, etc., including supervision over the tool department as well as the drafting-room, covering the making, issuing and cancelling of all blueprints, inspection and testing of the finished tools, fixtures and gages. He also has charge, through the chief inspector, of the inspection of all finished arms as well as the inspection of the product as it passes from one machining operation to the next. The inspection department acts as a clearing house, checking up quantities as well as qualities of work, and only on the approval of this department will the work be paid for by the pay-roll department. The chief inspector reports to the chief engineer each day on a form designed for that purpose, the lot number, part number, part name, operation number, pieces received, pieces accepted, pieces rejected, per cent rejected, workman's number, workman's name and department number in which the work was done. The testing of the finished rifle and the adjustment and alignment of the sights are performed under the direction of the chief inspector.

Production Engineer—The production engineer, operating through the planning department, has the sole direction of the work of machining and assembling, the latter of which is divided into two departments, one for assembling the parts into groups, and the other for assembling these groups into the completed rifle. The departments covered under the production engineer's control are: cutting-off, forging, annealing and pickling, profiling, milling, drilling, reaming, rifling, straightening, hand milling, screw machine work, punch press work, bluing, hardening, polishing, filing, burring, stocking, assembling of group parts and assembling of completed rifle. He also has charge, working under the direction of the chief engineer, of the time setting and rate setting for all operations on which tests have been made and on which a piece-rate is established. The planning department controls the manufacture, routing and assembling of the work as follows: The work in the machining and assembling departments is controlled through the planning department by the issue of production orders, which are made out in triplicate, one copy being placed on the central control board, another being sent to the department foreman to be placed on the department control board, and the third being sent to the cost department in order to obtain the cost of each lot of parts which is put through the plant. These production orders have a number to which all time and material consumed in the execution of the order must be charged. The planning department, cooperating with the inspection department, also controls the movement of the work and its transfer from one operation to the next, as well as from one department to another. In addition, it is the function of the planning department to study the machining operations and where possible offer suggestions as to a more satisfactory method of handling the work. These must be approved by the production engineer and the chief engineer before any changes can be made.

Plant Engineer—The plant engineer, who is under the direction of the chief engineer, has charge of the installation, erection and repair of all machinery, and the maintenance and upkeep of the buildings and grounds. This department includes belt men, millwrights, truck men, sweepers, watchmen, teamsters, yard laborers, etc.

Cost Clerk—The cost clerk, under the direction of the chief engineer, has charge of the pay-roll and the factory cost accounting. The time cards are cared for by this department, as well as all records showing the work produced at each operation, by whom it is produced and the amount of money due each employe after deducting cost of spoiled work.

Chief Inspector—The chief inspector, working under the direction of the chief engineer, has full charge of the material from the time it comes into the plant until it is completely machined and assembled, as far as specifications for machining are concerned. No work is passed which does not come up to the specifications and drawings. The inspector is distinctly a functional foreman and a representative of the planning department, and in his special capacity is over every man in the shop. His word is final and his decisions can be set aside by the chief engineer only. The chief inspector should see that rough material such as forgings are examined to be sure that they will finish up to the dimensions given on the drawings. The parts in process are inspected after each operation and before they are moved.

Shop Superintendent—The shop superintendent is in direct charge of the foremen of the manufacturing departments. All department heads under him should have proper written instructions which must be strictly followed. Any improvements that can be made by the planning department in the handling of work should be taken up first with the superintendent and then with the chief engineer. The superintendent should devote his entire attention to the manufacturing departments.

Department Foremen—The department foremen have complete charge of the work under their supervision and their duties are to see that the machines, jigs and fixtures, are kept in proper repair, and that the production department fulfills its duties in removing and passing the work along.

Sub-foremen—It has been found a good plan in large manufacturing departments to install a number of sub-foremen sometimes known as tool-setters. The function of these men, who should be expert operators of the machines over which they have charge, is to set up the various machines on every new job. After the machine has been set up, a completed part is turned out and this is passed upon by the inspector before the operator is allowed to take charge of the machine. The greatest efficiency can be obtained by having a specialist set the machine and then training the operator to handle it in the proper way.

No attempt has been made in the foregoing to cover fully the duties of each of the officials, the object being only to give a general classification of the principal ones.

THE specifications for a military rifle, when turned over to the manufacturer by the war department of the government for whom the rifle is to be manufactured, should be carefully scrutinized by the engineering and production department heads. The requirements on this work are so stringent that it is necessary for the engineering department to give the specifications a great amount of study, before designing any fixtures, tools or special machinery for manufacturing the various parts.

In order to give some idea of the necessary requirements, a brief abstract is given of the specifications required for the Spanish Mauser rifle, caliber 7 millimeters, model 1896.

1. The rifle shall be finished in every respect to the satisfaction of the inspector appointed for that purpose. He shall be at liberty to inspect personally or by deputy the work during its progress, and to reject any unsuitable or defective material that does not agree with the standards set in the specifications.

2. The quality of the material specified shall conform to the instructions given in all cases, and no advantage shall be taken of any omission of detail in these specifications. Full explanation of any part of the work not fully shown or understood can be obtained upon application to the war department.

3. The rifle must conform to the pattern and standard gages, subject to the usual limits and the dimensions as laid down on the working drawings.

4. The inspection shall be carried on in the contractor's or sub-contractor's premises. Suitable accommodations must be provided for by the contractor.

5. If one-fourth of any delivery of any component part be found inferior to the pattern or model or contrary to the terms of this specification, the whole consignment will be liable to rejection.

Specifications for Manufacture of Material

The chemical and physical specifications covering the various materials used in rifle manufacture are given in Tables II and III, respectively. These tables also contain the symbols used to indicate the carbon and manganese content of the material. The chemical and physical requirements of these materials are as follows:

C Steel.—This material has a medium carbon content of about 0.35 per cent, and a high manganese content of 1.20 to 1.30 per cent, low in phosphorus, silicon, and sulphur. It has been used in the manufacture of certain parts for the Springfield rifle, such as the bolt, receiver, bolt plug, cocking-piece, etc. This material, when properly annealed after rolling or forging, machines easily, and when pack-hardened a very hard exterior surface is secured with a soft core. The high manganese content improves the physical qualities and at the same time neutralizes the harmful effect of the phosphorus and sulphur. It also makes the crystals of the steel smaller, and forms a stronger and more homogeneous forging. It is necessary to anneal this steel before performing any operations upon it; for annealing, the steel must be heated to a temperature of from 10 to 20 degrees above the lowest absorption point of the steel, or to about 1285 degrees F. This makes the steel easy to work, and keeps the grains as small as possible. It has been found that by increasing the carbon content of this material, an unsatisfactory material is obtained. It is not only more difficult to machine, but receivers made from it have been found to develop cracks during firing tests. The carbon content should not be above that given in Table II. The method of heat-treating is given under the heading "Pack-harden."

Gun Steel.—This steel, which should be low in carbon and medium in manganese content, is used in the manufacture of such parts as the sight bases, sights, trigger, retaining bolt, etc. In fact, it is used for all parts where the wear is not excessive and where cyanide hardening is satisfactory. Materials covered under these specifications must be manufactured by the crucible or open-hearth process, and must be delivered in the annealed condition. All slabs, blooms, billets, bars or forgings must be rolled or forged from ingots, the cross-section of which is at least four times that of the finished bar or billet, and from which an amount equal to at least 5 per cent of the total weight has been taken from the bottom and 30 per cent from the top if top-poured; and 5 per cent from the bottom and 20 per cent from the top of the ingot if bottom-poured or fluid-compressed. The billet, ingots or forgings must be free from cracks, seams, slivers, flaws or other injurious imperfections, and must have a workmanlike finish and conform to the dimensions given on the drawings. When cold-rolled or cold-drawn materials of these chemical specifications are required, the requirements outlined under the heading "Screw Stock" must be observed.

TABLE II. CHEMICAL CONSTITUENTS OF MATERIALS USED IN MILITARY RIFLE PARTS

Trade Name of Material	Specification Symbol	Limits in Chemical Composition, Per Cent							
		Carbon	Manganese	Silicon	Phosphorus	Sulphur	Chromium	Vanadium	Nickel
C steel	32-120	0.30-0.35	1.20-1.30	0.05-0.10	0.06 max.	0.06 max.	....	....	....
Gun steel	15-72	0.10-0.20	0.55-0.90	0.03-0.08	0.12 max.	0.10 max.	....	....	....
Crucible or lockwork steel	75-35	0.70-0.80	0.30-0.40	0.08-0.20	0.03-0.06	0.02-0.04	....	....	....
Best grade tool steel	118-28	1.10-1.25	0.20-0.30	0.08-0.20	0.03 max.	0.03 max.	....	....	....
Spring steel, carbon	100-32	1.00-1.05	0.30-0.35	0.02-0.10	0.03 max.	0.03 max.	....	....	....
Drill rod	120-22	1.15-1.25	0.15-0.30	0.10-0.40	0.015 max.	0.02 max.	....	....	....
Screw rod	15-45	0.10-0.20	0.30-0.60	0.04-0.10	0.12 max.	0.12 max.	....	....	....
Cold-rolled steel	14-45	0.10-0.18	0.30-0.60	0.05-0.10	0.045 max.	0.05 max.	....	....	....
Smokeless barrel steel	45-120	0.40-0.50	1.15-1.30	0.18-0.25	0.08 max.	0.06 max.	....	....	....
Vanadium, Type D, mild	39-80	0.35-0.43	0.70-0.90	0.20 max.	0.04 max.	0.04 max.	0.80-1.10	0.16 min.	....
Nickel barrel steel	35-65	0.30-0.40	0.50-0.80	0.10-0.20	0.04 max.	0.04 max.	....	....	3.25-3.75
Music wire	57-45	0.55-0.60	0.40-0.50	0.09	0.018	0.011	....	....	....

Machinery

Crucible or Lockwork Steel.—This steel is used in the manufacture of such parts as the safety lock and band spring catch. It is a medium carbon steel capable of being hardened. It must be manufactured by the crucible or open-hearth process and delivered in the annealed condition. The remarks regarding the process of manufacture of gun steel apply also here. The hardening and tempering consist first, in heating the parts to 1450 degrees F. and cooling in oil; second, placing in a wire basket and immersing in a niter bath kept at a constant temperature of 600 degrees F. The parts are kept immersed until they reach the temperature of the bath, the time required varying with the size of the part.

Tool Steel.—Tool steel of the best grade is used in the striker, which is subject to considerable wear. It can be manufactured either by the open-hearth, crucible or electric furnace process. From each lot of twenty bars or a fraction thereof of the same size, made from the same open-hearth melt or furnace charge, three bars are selected at random and subjected to physical tests. Bars that do not vary in their cross-sectional dimensions more than 1/8 inch will be considered one size. The material is subjected to a chemical analysis to determine the percentage of the chemical constituents, especially the carbon content. The front end of the striker only is hardened. This part is heated to 1450 degrees F., immersed in oil, and then drawn in a niter bath to 450 degrees F.

Spring Steel, Carbon.—This material is used in the manufacture of the flat springs, which are not subjected to excessive wear or severe stress. Carbon spring steel does not give as good results for rifle parts as vanadium type D steel, and consequently carbon spring steel is only used where the service is not severe. The specifications on this material permit it to be manufactured by the open-hearth, crucible, or electric furnace process. The chemical constituents must agree with those given in Table II. The percentage of vanadium or other elements may vary so long as the necessary physical requirements are maintained, in which case only the percentage of phosphorus and sulphur need conform closely to that given in the table. The nick test and deflection test shall be made with a full size specimen. Tensile tests shall be made with a full size specimen when practicable. Each test specimen must be taken from a different bar. For the tensile test, a specimen bar after being tempered shall have an ultimate tensile strength of at least 150,000 pounds per square inch, with an elastic limit of at least 85 per cent of the ultimate tensile strength. For the nick test, a specimen shall present a fine uniform grain when nicked and broken. For the deflection test, a specimen bar after being tempered, and resting upon supports 24 inches between centers, shall not take a permanent set of more than 0.05 inch after the first application of a load corresponding to a fiber stress of 115,000 pounds per square inch; nor a permanent set of more than 7.5 per cent of the total deflection on a load producing a fiber stress of 140,000 pounds per square inch; nor any further set after five additional applications of the load giving a fiber stress of 130,000 pounds per square inch. This steel must be free from all defects. The bars shall be thoroughly cleansed by pickling or other approved methods, and when cleansed by pickling they must be thoroughly washed in limewater and rinsed with fresh water to remove all traces of the pickling bath. In the case of round bars a variation of 0.02 inch in diameter is allowed on bars over 7/16 inch diameter; and in the case of rectangular bars a variation of 0.02 inch in thickness and 0.03 inch in width is allowed on bars over 3/16 inch in thickness and 7/16 inch in width.

Drill Rod.—This material is used in the manufacture of such parts as pins, etc., and when these parts are subjected to wear, they are hardened and tempered, as specified in Table IV. The material known as drill rod must conform to the chemical analysis given in Table II and to the physical specifications given in Table III. The rods shall be smooth and polished, and cut to lengths as ordered, and shall have smooth ends and be in strict accordance with the sizes called for. A variation of not more than 0.0005 inch is allowed on all sizes under 7/16 inch diameter.

Screw Rod.—This material is used in the manufacture of such parts as screws, bushings, butt plate, etc., and is used in its natural condition without casehardening. The material may be cold-rolled or cold-drawn at the option of the manufacturer, but must be free from defects and have a smooth and workmanlike finish. For rods or bars up to 1/2 inch diameter or thickness, the cold reduction must not be less than 1/32 inch, and for rods or bars greater than 1/2 inch the cold reduction must not be less than 1/16 inch. The limits on the diameter or thickness of the finished material are as follows: For bars up to and including 1 inch, 0.003 inch; above 1 inch and including 2 1/2 inches, 0.004 inch, above 2 1/2 inches

TABLE III. PHYSICAL PROPERTIES OF MATERIALS USED IN MILITARY RIFLE PARTS*

Trade Name of Material	Specification Symbol	Tensile Strength, Pounds per Square Inch	Elastic Limit, Pounds per Square Inch	Reduction of Area, Per Cent	Elongation in Two Inches, Per Cent	Scleroscope Hardness Numeral
C steel	32-120	85,000-100,000	56,000-65,000	35-60	25-35	34-37
Gun steel	15-72	60,000-80,000	40,000-55,000	40-60	20-35	[illegible]
Crucible or lockwork steel	75-35	80,000-95,000	46,000-54,000	45-55	25-35	[illegible]
Best grade tool steel	118-28	95,000-105,000	50,000-60,000	20-30	15-20	[illegible]
Spring steel, carbon—untreated	100-32	100,000-110,000	54,000-65,000	20-30	5-8	[illegible]
Spring steel, carbon—heat-treated	100-32	150,000-160,000	130,000-150,000	....	....	[illegible]
Drill rod	120-22	120,000-130,000	100,000-120,000	25-35	5	[illegible]
Screw rod	15-45	85,000-100,000	68,000-85,000	45-60	25-35	[illegible]
Cold-rolled steel	14-45	65,000-85,000	45,000-75,000	45-60	30-40	[illegible]
Smokeless barrel steel	45-120	100,000-120,000	60,000-75,000	40-55	20-30	[illegible]-41
Vanadium, Type D, mild—untreated	39-80	85,000-110,000	65,000-85,000	45-60	20-25	[illegible]
Vanadium, Type D, mild—heat-treated	39-80	150,000-200,000	135,000-180,000	45-55	8-15	[illegible]
Nickel barrel steel—untreated	35-65	85,000-100,000	52,000-68,000	[illegible]	20-25	[illegible]
Nickel barrel steel—heat-treated	35-65	115,000-175,000	90,000-160,000	[illegible]	10-20	45-60
Music wire	57-45	275,000-340,000			....	[illegible]†
Walnut, English or American	W	......	......		....	....
Gum wood	W	......	......	....	....	....

Machinery

*Courtesy of the Henry Souther Engineering Co.

† Music wire cannot be compared with ordinary heat-treated steel because of the peculiar mechanical working that it is subjected to during the process of manufacture.—Shore Instrument Co.

0.005 inch. The limits for the chemical and physical requirements are given in Tables II and III, respectively. For testing this material, it is divided into four groups as follows: The dimensions given refer to the diameter of round rods and the thickness of rectangular bars. Group 1: 1/4 inch; group 2: 1/4 inch and up to 1/2 inch; group 3: over 1/2 inch and up to 1 1/2 inch, inclusive; group 4: over 1 1/2 inch. For groups 1, 2 and 3 the elastic limit must not be under 75,000 pounds per square inch and for group 4, not under 70,000 pounds per square inch. The phosphorus or sulphur content must not exceed 0.06 per cent. The bending test specimen must be taken at a distance of one-fourth the diameter of the bar from the longitudinal axis. When bent cold to 180 degrees, the inside diameter of the bend must not be greater than three times the diameter of the bar being tested. The allowable variations in thickness, width or diameter are up to and including 1 inch, 0.003 inch; above 1 inch and including 2 1/2 inches, 0.004 inch; above 2 1/2 inches, 0.005 inch.

Cold-rolled Steel.—Cold-rolled steel is used in the manufacture of such parts as the stock mortise band and upper band nose plate. It must be a flanging, cupping and drawing steel and must be made by the open-hearth process. It must also be soft and ductile, of low-carbon content, with a bright finish, and must be flat and of uniform thickness. It must stand blanking, cupping and drawing to a depth of four inches in four drawings. After cutting or trimming to length, it must stand forming by having the open end reversed, turning it inside out as tinners do when wiring cans. All this work must be done with punches and dies. The material must be made of such ductility that it can pass from one drawing operation to the next without annealing and with losses that do not exceed 2 1/2 per cent.

Smokeless Barrel Steel.—The greater number of rifle barrels made at the present time are produced from a special material known as smokeless barrel steel, the chemical and physical properties of which are given in Tables II and III, respectively. This steel is generally used in the untreated condition, as it has been found by numerous experiments that heat-treating does not improve it, but seems to make it more subject to corrosion. Corrosion in a rifle barrel always starts about 1/2 to 1 inch from the point where the end of the cartridge case terminates in the breech of the barrel, and continues on toward the muzzle. Corrosion sometimes takes place gradually, or it may skip the center of the barrel and start in again at the muzzle. Smokeless barrel steel seems to be the least affected by the corrosive action of nitro powders of any of the steels thus far used. It is manufactured by the crucible or open-hearth process in a similar manner to other carbon steels. Stock for rifle barrels is generally 1.35 or 1 5/16 inch diameter. The chemical and physical requirements must be closely adhered to.

Vanadium Type D Mild.—This alloy steel has been found to give excellent results in springs subjected to severe duty. It is manufactured either by the electric, crucible or open-hearth process, and the remarks regarding manufacture made in reference to best grade tool steel also apply here. The maker is requested to specify the heat-treatment necessary to obtain the best physical condition in order that it may resist tensile, crushing or vibratory stresses, and also the heat-treatment necessary to produce a high degree of hardness when required. This steel is recommended for use in the extractor, retaining bolt spring, rear sight leaf spring, extractor collar, etc. These parts are all hardened at the same temperature but are drawn to different temperatures, as they have different functions to fill. For hardening, the pieces are heated and quenched in oil at about 1600 degrees F. They are then drawn at temperatures varying between 750 and 840 degrees F.

Nickel Barrel Steel.—The great demand for smokeless barrel steel has made it necessary for some manufacturers to substitute 3 1/2 per cent nickel steel. The chemical and physical requirements necessary are given in Tables II and III, respectively, and the manufacture is either by the open-hearth or crucible process, the crucible process generally being used for rifle barrels. This steel is used in the heat-treated condition. A few degrees variation in the temperature at which the steel is heat-treated makes a great variation in the resulting physical properties, and hence great care must be taken in heating the pieces thoroughly and uniformly throughout. For rifle barrels, the material is generally heat-treated by first being heated to 1425 to 1440 degrees F., at which temperature it is held for 1 1/2 hour, and then quenched in oil. When cold, it is reheated to 1020 to 1045 degrees F. for 1 1/2 hour, and then allowed to cool off in the furnace.

Music Wire.—Music wire is used for all coil springs and especially for the main spring, sear spring, etc. For rifle springs the treatment consists in immersing the parts in a niter bath heated to 470 degrees F. until they reach a straw color, when they are removed and cleansed in water.

Specifications for Machining Operations on Rifle Parts

The specifications covering the machining of the steel parts deal principally with the tolerances or limits allowed; these vary from ± 0.0025 inch for some parts to ± 0.00025 inch for other parts where good fits are necessary. There are also a few other important points such as hardened surfaces, location of holes, etc., that must receive careful attention. In the following is given a brief outline of the requirements for the principal parts.

The receiver is gaged for size and shape, position of thread and locking shoulder from the barrel seating, positions of slots, ejector hole, sear pin hole, charger guide, sear nose slot, cocking-piece slot, and tang. The bolt is gaged for size and shape, and tested for straightness and concentricity of bore, also for position of lever, locking shoulder, and cams, and all hardened surfaces are tested. The striker is gaged for size and shape of point and position of collar. The striker is tested for temper by placing the point in a hole and applying a pull of seven pounds immediately above the collar, after which it is spun to be certain that it runs true. The cocking-piece is gaged for diameter, width, shape, position and diameter of cam. The magazine spring is compressed for a period of not less than fourteen hours slightly in excess of the amount of compression to which it is subjected in the magazine, after which it must lift the plunger to the stop with a weight slightly greater than the weight of five loaded cartridges. The main spring is compressed for a period of not less than fourteen hours slightly in excess of the amount of compression to which it is subjected in the rifle.

Treatment and Finish of Parts

One of the first duties of the engineering department after studying the specifications is to designate part numbers for the various components of the rifle. This is generally done according to the group system, dividing the rifle up into four or more units, such as the barrel and assembly, receiver and assembly, bolt and assembly, magazine and trigger guard and assembly, stock and miscellaneous parts. The parts are then given consecutive numbers in this order. This simplifies the ordering of material and the routing of the work. Symbols are also used for the chemical constituents of the material. The usual manner in which this is done is to take the highest content of the two principal ingredients. For instance, in a 50-point carbon, 60-point manganese steel, the symbol would be 50-60. Thus instead of specifying the entire chemical constituents of the steel in the shop order, these symbols alone are given. In some manufacturing plants letters are used instead of numbers to refer to the chemical constituents, but this is not as satisfactory, as the numbers are practically self-explanatory. In Table IV, which gives a complete list of the parts with their part numbers, is also included a column giving the kind of material used for the various parts, the specification symbol, treatment and finish. In designating the various heat-treatments and finishing operations, the first two letters of the word are used as a symbol. When a compound word, such as pack-hardening, designates the operation, the first letters of each part of the compound are used, such as PH or ST for special tempering.

In the following are given a list of the symbols for the heat-treatments and finishing operations, and a description of each process. The operations described are referred to by the symbols given in Table IV.

An	Anneal	Oi	Oil
Bg	Blue (Gas Furnace Process)	PH	Pack-harden
Bn	Blue (Niter Bath Process)	Pi	Pickle
Br	Browning (Rusting)	Po	Polish
CH	Caseharden	ST	Special Tempering
Cl	Clean	Te	Temper
Ha	Harden	Tu	Tumble

Symbol An: Anneal.—This treatment is given to parts that are rough-formed to shape by forging. Rifle parts, such as the receiver, bolt, trigger guard, and other smaller parts, after forging and trimming, are packed in cast-iron boxes containing charred bone, and the cover is luted with fireclay. The box and contents are heated in the furnace at a temperature slightly above the critical point, which varies with the chemical constituents in the steel. Parts containing from 0.50 to 0.80 per cent carbon should be heated to a temperature varying from 1250 to 1300 degrees F., then taken out and allowed to cool off in the boxes. The barrel is annealed by packing in an annealing furnace and heating to about 1300 degrees F. It is then removed and placed in a sand box where it is allowed to cool off gradually.

Symbol Bg: Blue (Gas Furnace Process).—This process makes use of the special gas furnace developed by the American Gas Furnace Co., in which the work is placed on special racks and then loaded in the rotating cylindrical retort. The retort is rotated at a speed of from 2 to 5 R. P. M., depending upon the size of the work. The capacity of this drum is for 125 pounds of work and sixteen quarts of granulated charred bone in sizes of from 1/8 to 1/4 inch granules. Before the work is put into the retort, the torch should be lit and adjusted so as to produce a soft blue flame about 1 1/4 inch long with a slightly green core at each burner tip. In about one hour's time the thermometer should read from 625 to 700 degrees F., which is the proper heat at which most work should be blued. The work is now inserted with eight quarts of charred bone, but without the "carbonia oil." After the articles have been thoroughly oxidized, which requires about one hour, eight quarts of charred bone are thoroughly mixed with one pint of "carbonia oil," thus making a total of sixteen quarts of bone in the retort. It is important that the bone and carbonia be thoroughly mixed, and to facilitate this they should first be warmed. If this precaution is not taken the work is likely to become spotted. The retort is now rotated, and the work exposed to the action of this mixture with the thermometer registering about 625 degrees F. for a time varying from one-half to three hours, depending on the shape and surface finish of the pieces. In order to determine the correct color, a few pieces should be taken out of the retort and examined. When first removed they appear gray, but when dipped in oil and wiped off or tumbled in oily cork, they show deep black or carbonia finish. The pieces should be examined every half hour for each new batch of work, so that the bluing operation need not be carried on any longer than necessary to get the desired color. The total time required for each charge is about five hours.

When discharging the retort, the bone is sifted from the work and the latter dumped, if small parts, into wire baskets and submerged in sperm oil. For work having small grooves, holes, etc., it is preferable instead of dipping the work in the oil to tumble it in cork which has been saturated with sperm oil. After the work is sufficiently cool, the basket should be raised from the tank, and the oil allowed to drip off. The finish-drying is then done in sawdust or in any suitable manner for the work in hand. The drying may also be done in the retort of the machine with sawdust or ground cork; ground cork is preferable, but if sawdust is employed it should be free from very fine dust, as this forms a paste which clogs up the screw threads, slots, small holes, etc. Heavy articles which demand the very best finish should not be removed from the retort until the heat has been allowed to decrease sufficiently to prevent oxidization of the carbonia finish. It should also be understood that firearm parts should not be tumbled loose in the retort but should be held on fixtures or racks. The retort of this furnace will hold approximately eighty pieces of the size of the receiver, magazine or trigger guard, to each charge, and one operator can attend to about six furnaces. The fuel used is illuminating gas, and the consumption per hour for the No. 64 heating furnace is between 90 and 100 cubic feet.

Symbol Bn: Blue (Niter Process). This treatment is given all small parts or those of minor importance. The nitrate of potassium (saltpeter) is melted in an iron tank and heated to about 600 degrees F. The parts to be blued are cleansed and placed in a wire basket, after which they are immersed in the molten niter until a uniform color of the desired shade is obtained. This immersion requires only a few seconds. The articles are then removed and cleansed in water, after which linseed oil is applied to prevent them from rusting.

TABLE IV. LIST OF RIFLE PARTS GIVING SYMBOLS USED IN SPECIFYING MATERIAL, TREATMENT AND FINISH

No. of Part	Name of Part	Kind of Material	Specification Symbol	Treatment and Finish
1	Barrel	Steel Forging	45-120	An Pi Po Br
2	Front Sight	Steel	15-72	Po-Bn
3	Front Sight Base	Steel	15-72	Po-Bn
4	Front Sight Base Screw	Steel	15-45	Po-Bn
5	Rear Sight Base	Steel Forging	15-72	An Pi Po Bn
6	Cleaning Rod	Steel	15-45	Use as machined
7	Rear Sight Leaf	Steel	15-72	Po-Bn
8	Rear Sight Leaf Spring	Steel	39-80	Ha-Po Te 750° F.
9	Rear Sight Leaf Spring Screw	Steel	15-45	Po Bn
10	Rear Sight Leaf Pin	Steel	120-22	Po-Bn
11	Rear Sight Slide	Steel	15-72	Po Bn
12	Rear Sight Slide Catch	Steel	15-72	Po Bn
13	Rear Sight Slide Catch Pin	Steel	120-22	Ha Po Te 600° F.
14	Rear Sight Slide Catch Spring	Music Wire	57-45	ST
15	Rear Sight Slide Catch Stop Screw	Steel	15-45	Po Bn
16	Receiver	Steel Forging	32-120	An Pi-PH Po Bg
17	Retaining Bolt	Steel	15-72	CH Po Bn
18	Retaining Bolt Spring	Steel	39-80	Ha-Po Te 750° F.
19	Ejector	Sheet Steel	100-32	Ha-Te 600° F
20	Ejector Fulcrum Screw	Steel	120-22	Ha Te 600° F
21	Bolt	Steel Forging	32-120	An Pi PH Po Bg Po
22	Bolt Plug	Steel Forging	32-120	An Pi PH Po-Bn
23	Cocking Piece	Steel	32-120	PH Po-Bn
24	Striker	Steel	118-28	Ha Te 450° Po
25	Extractor	Steel	39-80	Ha Te 750° Po
26	Extractor Collar	Steel	39-80	Ha Te 750° Po
27	Main Spring	Music Wire	57-45	ST
28	Safety Lock	Steel Forging	75-35	An Pi Ha Te 600° Po-Bn
29	Magazine and Trigger Guard	Steel Forging	15-72	An-Pi Po-Bg
30	Magazine Floor Plate	Steel Forging	15-72	An Pi Po-Bn
31	Floor Plate Catch	Steel	15-72	CH
32	Floor Plate Pin	Steel	120-22	Ha Te 600° F
33	Floor Plate Spring	Music Wire	57-45	ST
34	Magazine Platform	Steel Forging	15-72	An-Pi Po Bn
35	Magazine Spring	Steel Ribbon	100-72	Ha-ST 740° Cl
36	Stock	Wood	W	Oi
37	Hand Guard	Wood	W	Oi
38	Butt Plate	Steel Forging	15-72	Po Bn
39	Sear	Steel	75-35	Ha Tu Te 600° F.
40	Trigger	Sheet Steel	15-72	CH Po Bn
41	Sear Pin	Steel	120-22	Ha Po Te 600° F.
42	Sear Spring	Music Wire	57-45	ST
43	Trigger Pin	Steel	120-22	Ha Po Te 600° F
44	Stock Mortice Band	Sheet Steel	14-45	Po Bn
45	Guard Screw, Front	Steel	15-45	Po Bn
46	Guard Screw, Rear	Steel	15-45	Po Bn
47	Guard Screw Bushing	Steel	15-45	Use as machined
48	Butt Plate Screw, Lower	Steel	15-45	Po Bn
49	Butt Plate, Screw Upper	Steel	15-45	Po-Bn
50	Butt Sling Swivel	Steel	15-45	Po Bn
51	Butt Sling Swivel Block	Steel	15-72	Po Bn
52	Butt Sling Swivel Pin	Steel	120-22	Ha-Te 600° F
53	Butt Sling Swivel Block Screws (two)	Steel	15-45	Po-Bn
54	Lower Band	Steel Forging	15-72	An-Pi Po-Bn
55	Lower Band Spring Catch	Steel	75-35	Ha-Te 600° F Po Bn
56	Lower Band Swivel	Steel	15-45	Po Bn
57	Lower Band Swivel Screw	Steel	15-45	Po-Bn
58	Lower Band Swivel Screw Nut	Steel	15-45	Po-Bn
59	Upper Band	Steel Forging	15-72	An Pi Po Bn
60	Upper Band Spring Catch	Steel	75-35	Ha-Te 600° F Po Bn
61	Upper Band Nose Plate	Sheet Steel*	14-45	Po-Bn
62	Upper Band Nose Plate Pin	Steel	120-22	Ha Te 600° F

* Electrically welded.

Symbol Br: Browning.—The browning process is applied to parts that cannot be heated after being finished. It consists in cleaning the work thoroughly in boiling limewater, after which the residue of lime is removed by a hand brush. The browning fluid is applied with a sponge, after which the parts are allowed to "rust" by being placed in an oven, the air of which is moistened by the escape of steam through perforations in the steam pipes. Care is taken to see that all sections of the work where browning is not desired are protected by wood plugs. After the parts are thoroughly rusted, they are

scratch-brushed, and the rusting and scratch-brushing operations are repeated until three or four coats of rust have been applied. As a final treatment, oil is applied to prevent further rusting of the parts. A satisfactory browning fluid comprises the following constituents:

Constituent	Part by Ounces
Spirits of wine (grain alcohol)	1½
Tincture of iron	1½
Corrosive sublimate (mercury chloride)	1½
Spirits of niter (nitrous ether)	1½
Blue vitriol (copper sulphate)	1
Nitric acid	¾

Dissolve the corrosive sublimate in one quart of warm water and add the blue vitriol; then add the alcohol, tincture of iron, spirits of niter, and finally the nitric acid.

Symbol CH: Caseharden.—This treatment is given parts that require a surface hardness and in which strength and resiliency are minor considerations. The work is immersed in a bath of molten cyanide of potassium, and heated to a temperature of from 1450 to 1500 degrees F. for from one to five minutes, depending on the character of the work being treated. The work is then removed and cleansed in water.

Symbol Cl: Clean.—This treatment is given to parts after machining to remove the oil and fine chips. The solution used is known as a hot soda bath, and is kept in iron kettles. A satisfactory cleaning solution is composed of one-half pound sal-soda to each gallon of water. The solution is heated to the boiling point before immersing the parts to be cleansed. Small parts are usually held in wire baskets for immersing. The time required for cleaning depends upon the condition of the work. When thoroughly cleansed, the work is removed and allowed to dry off, the soda deposit preventing the parts from rusting. As caustic soda is a strong alkali, care should be taken to prevent it from getting onto the hands.

Symbol Ha: Harden.—This treatment is given where called for and is applied only to parts having a carbon content of over 0.65 per cent. It consists of heating the parts to be hardened above the recalescence point and immersing in water or oil, depending on the cross-sectional area of the part and the possibility of its warping out of shape.

Symbol Oi: Oil.—This treatment consists of the application of raw linseed oil to the finished stock and hand-guard in as many coats as are required to produce the finish desired. The oil is allowed to penetrate into the wood after each coat before the following coat is applied.

Symbol PH: Pack-harden.—This treatment is given to parts that have a severe duty to perform but cannot be subjected to the treatment given under symbol Ha, owing to their carbon content. The treatment consists in packing the work in casks or wrought iron boxes, using a mixture of charcoal and charred leather. Care should be taken to see that the pieces of work do not touch the surfaces of the container or each other. Bone should not be used, as it contains a high percentage of phosphorus, which tends to make the steel weak and brittle. These boxes are then placed in the furnace and heated to about 1500 degrees F., after which they are removed, the work is taken out and immersed in water or oil. Great care should be exercised in heating, not to allow the temperature to exceed that specified, as a higher heat coarsens the grain and necessitates reheating.

Symbol Pi: Pickle.—This treatment is given to forged parts previous to machining to remove the scale, and is also given to some parts after hardening. The pickling solution, which is composed of one part sulphuric acid to ten parts water, is contained in wood or lead-lined tanks. The acid should be poured into the water while stirring, but the water should never be added to the acid, as this may cause an explosion. The sulphuric acid bath does not attack the sand or black oxide of iron which forms the scale, but soaks through and attacks the iron beneath the scale, dissolving it sufficiently to loosen it. The best and quickest results are obtained by heating the pickling solution, but in no case should the temperature exceed 150 degrees F., as a higher temperature than this causes noxious fumes. After the scale is loosened sufficiently, which generally requires from thirty minutes to an hour, the parts should be immersed in the hot soda solution used for cleaning to remove all traces of acid. The best results are obtained by heating both the pickling and soda baths.

Symbol Po: Polish.—This operation follows machining and in some cases heat-treatment of the parts. The object of polishing is to obtain a smooth finished surface on the work. The number of polishing operations given the work depends upon the condition of the surface left by machining, and also to some extent on the size and shape of the part. Some parts, such as screws and other small parts, are rough- and finish-polished; others slightly larger or of medium size are given three polishes, whereas parts such as the receiver pass through as many as four polishing operations. The polishing wheels vary in diameter from 1 to 18 inches, depending upon the size and shape of the work. Small wheels of 1 or 2 inches diameter are made from walrus hide turned to the form required, but larger ones are made with wooden cores to the periphery of which leather or walrus hide is glued. Leather used for covering wood core wheels is oak-tanned triple ply leather belting of the best grade. Walrus hide is used for wheels of small diameter on which a form is turned that would cause trouble if made from belt leather. The speeds of the wheels vary from 4500 to 5000 surface feet per minute, depending upon the size of the wheel and the character and shape of the work being polished.

The grades of emery used for polishing operations vary with the condition of the work. If the machining has been properly done, using cutters which have been carefully sharpened, the polishing operation is accomplished with the minimum of labor, and a finer grade of emery can be used. The polishing operation on the large parts, such as the receiver, comprise the following: roughing, first fining, second fining and finishing. In general, the rough-polishing is done with No. 90 emery; the first fining with No. 120 emery; the second fining with the wheel used for the first fining, which has been worn down smooth, or with a new wheel charged with No. FF emery; and the finishing with wheels charged with No. FF emery, after being stoned down to a smooth surface to avoid scratching the work. For finishing, the face of the revolving wheel is oiled with oil-soaked waste held in thin cloth covers. Light machine oil is generally used for this purpose. The stones used for smoothing the surface of the wheel are common hard white pebbles.

Symbol ST: Special Tempering (Springs).—This treatment is given such parts as coil springs, including the main spring, sear spring, etc. It consists in immersing the work in a niter (saltpeter) bath which has been heated to 470 degrees F., in which the parts are allowed to remain until they reach a "straw" color; they are then removed and cleansed in water. The special heat-treatment of coil springs made of music wire is peculiar to the firearms industry.

Symbol Te: Temper.—This treatment is given all hardened parts in order to relieve the strain set up in the hardening operation. It consists in placing the parts in a wire basket and immersing them in a niter bath kept at the required temperature. In using this symbol, the required temperature is noted as a part of the symbol itself. For example, the retaining bolt spring, made of vanadium type D mild steel, is tempered to 750 degrees F.

Symbol Tu: Tumble.—This treatment is given to the smaller parts in order to remove the hardening scale and sharp edges, and consists in placing the parts in a tumbling barrel together with a quantity of steel balls of various sizes in the proportion of one peck of work to two pecks of steel balls. Soapy water is then poured into the barrel until it rises about one inch above the surface of the work. The amount of burnishing soap chips used for each charge is about four ounces, and this should be dissolved before the water is poured in. The barrel is then rotated at about 15 R. P. M. for a period of from one to five hours, depending on the condition of the work when placed in the barrel and the results required. After tumbling, the contents are removed by emptying onto a screen through which the balls pass; then the work is washed in a hot soda solution, after which it is ready for the succeeding operations.

Machining Barrels and Sight Parts

PREVIOUS to the advent of smokeless powder, military rifle barrels were made from low-carbon steel, and were not heat-treated. Round stock turned to the required external size and shape, and drilled, reamed and rifled was generally used. Soft steel was found unsuitable for use with smokeless powders, and other steels containing higher percentages of carbon and manganese were used to better withstand the erosive effects; thus a special steel known as "smokeless barrel steel" has come into prominence. It is recommended for this barrel, and stock ⅞ inch in diameter is used. These special steels are more difficult to work than cold-rolled steel, and various methods have been adopted, not only to save material, but also to reduce the machining time. One method is to upset the end of the barrel at the breech, so that smaller diameter stock can be used. Another is to roll the barrel tapering in a taper-rolling machine of either the continuous or half-roll type.

There are two methods used in taper-rolling rifle barrels, employing two distinct types of machines. The older type, which was first used in the Springfield armory about the time of the Civil War, comprises two rolls, shown by the diagram in Fig. 24, with a series of eleven grooves on their periphery. These rolls are about 20 inches in diameter, and the grooves are tapering, being practically the diameter of the rough stock at the beginning and gradually tapering down to the end. The rolling starts, of course, at the deepest part of the groove. Seven passes of the bar through the rolls are required to finish it. The bar is heated in an oil furnace to a temperature of about 1380 degrees F., a low temperature being found to be best. When the bar has reached the correct temperature, it is quickly removed from the furnace and placed in the rolling machine. It requires two men to operate this rolling machine; one feeds the bar in at the front and the other catches it at the rear and passes it back again. One man has charge of the furnace and one operates the drop-hammer for straightening the barrels. Straightening is done by using an upper and lower die, each of which has a half groove in its surface, which is slightly longer than the barrel and made to a similar taper. The barrel is laid in the lower groove and the hammer dropped while the bar is being rotated; this acts as a rough outside straightening operation. The production from one rolling machine is about 400 barrels in eight hours, requiring the services of four men.

This method of rolling, while in general use, has several disadvantages. First, it requires a skilled operator to accomplish the work satisfactorily. Second, it is difficult to roll a barrel straight because the heated bar is easily twisted while being entered between the grooves in the rolls. Again, the barrel rolls away from instead of toward the operator, making it difficult for him to keep it straight when passing through the rolls; in addition, the machine cannot be worked at its full capacity because of the difficulty of catching the roll each time it turns around. The production, therefore, is not as great as that which is obtained by the half-roll machine, which is described in the following.

An improved method of rolling rifle barrels has been developed by the Ajax Mfg. Co., Cleveland, Ohio. The chief advantage of this method is that the barrel is rolled toward the operator instead of away from him, and the machine can be operated by one man. Another advantage is that the work can be easily placed in position, and the operator has no difficulty in "catching the rolls." Placing the work against the stop also makes it easier for the operator to produce a straight barrel. Fig. 25 shows how this is accomplished. The method of operating this machine is to place the heated barrel in the guide and against the stop when the half rolls are furthest apart. Then as the rolls rotate they drive the bar out in the direction indicated by the arrow, presenting it to the operator, who simply supports it and prevents it from dropping down. The most convenient method is to use a bar of sufficient length to make two barrels, and taper it down at each end, cutting it apart in the center. The rolls are operated at 30 R. P. M., and for an average barrel are provided with seven grooves which are of practically the same diameter as the rough bar and gradually decrease to the smallest section of the barrel.

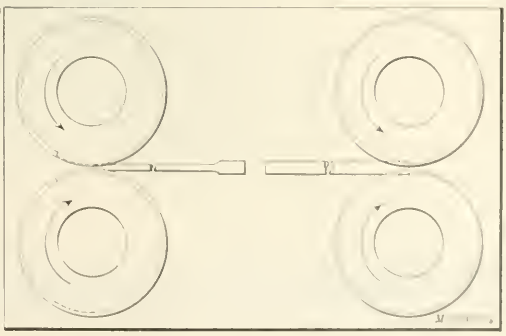


Fig. 24. Continuous Roll Method of rolling Rifle Barrels

The rolls used on this machine are provided with both single- and double-adjustment roll-holders. The former have a vertical adjustment to allow for rolling different diameters of stock and to permit finishing the rolling dies when they become worn. The latter have both vertical and eccentric adjustment. The eccentric adjustment is accomplished by loosening the set-screws on one side of the shaft and tightening those on the other so as to shift the roll into an eccentric position. Thus, straight annular grooves may be used for rolling tapers by setting the dies eccentrically as shown by the diagram. The back-stop provided with the machine regulates the length to which the stock is inserted between the dies, thus securing accuracy in handling. On the average rifle barrel, the production obtained from this machine is about 800 in eight hours, two men being employed, one to attend to the furnace and the other to the rolling machine.

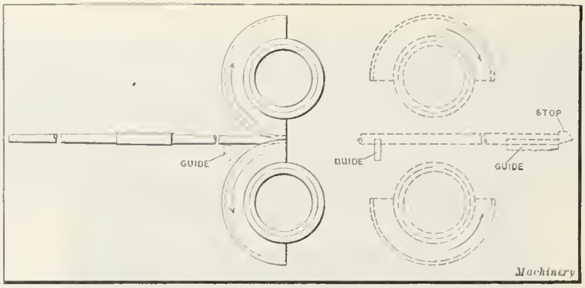


Fig. 25. Ajax Method of rolling Rifle Barrels

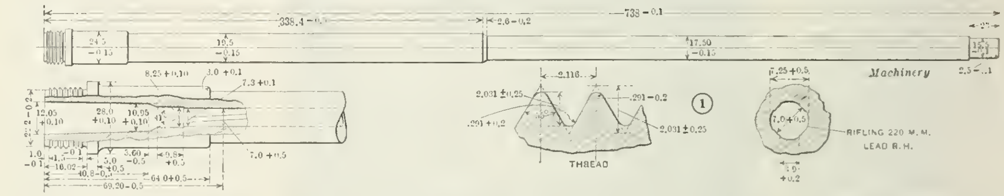
Upsetting Rifle Barrels

Another method of making rifle barrels which applies particularly to the barrel used on the Spanish Mauser rifle is to upset the breech end. This is accomplished in an upsetting and forging machine and is usually done in one blow. Unless the operation is handled carefully, however, one blow is not sufficient to give a homogeneous upset, and it is recommended that in all cases two blows be used. The method of accomplishing this is simple and is described briefly in the order of machining operations on the barrel. All barrels are annealed after rolling and then pickled. These operations have been covered separately.

Operations on Barrel

The barrel is considered by military experts to be the most vital part of a rifle, and as such receives very careful attention during the process of manufacture. Aside from the character of the material used, the two most important points are the concentricity and straightness of bore. The most satisfactory method of machining is to start with the bore and then locate from the bore for all subsequent external machining operations. The following description, in connection with Table V and Figs. 27 to 31, gives a complete outline of all the important operations on this rifle barrel.

TABLE V. OPERATIONS ON BARREL—PART NO. 1



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off	Cold sawing mach.	Higley saws	31	0.075	60	3
2	Upset breech end	2-inch power forg. mach.	Dies and plunger	70 strokes	Hand	135	1
3	Anneal and pickle	Annealing furnace	See text	..	..	30	1
4	Turn, face and center breech end	Turret lathe	Air chuck and tools	65	Hand	25	1
5	Straighten outside	..	Hand fixture	..	..	20	..
6	Drill	Gun barrel drill. mach.	0.265 gun barrel drill	100	0.00057	3	4
7	Ream bore, rough	Gun barrel ream. mach.	0.269 barrel reamer	15	0.040	15	2
8	Countersink each end	Whiton double-head centering mach.	60 deg. countersink	75	Hand	50	1
9	Spot-turn	Engine lathe	..	120	Hand	25	1
10	Rough-turn	Gun barrel turn. lathe	Steadyrest and tools	120	0.002	4	6
11	Straighten (interior)	..	Hand oper.	..	..	15	1
12	Ream bore, first finish	Gun barrel ream. mach.	0.273 barrel reamer	16	0.040	15	2
13	Turn breech end	Engine lathe	..	120	Hand	35	1
14	Grind shoulder on muzzle	Cylindrical grind. mach.	Grinding wheel	Wheel 5000 Work 35	Hand	40	1
15	Grind, second setting	Cylindrical grind. mach.	Grinding wheel	Wheel 5500 Work 40	Power	25	1
16	Grind, finish	Cylindrical grind. mach.	Grinding wheel	Wheel 5500 Work 42	Power	20	1
17	Ream bore, finish	Gun barrel ream. mach.	0.2756 sq. reamer	15	0.040	15	2
18	Straighten (interior)	..	Hand oper.	..	..	15	1
19	Rifle	Gun barrel rifling mach.	Hook cutter "Intra" steel	30	0.0005 per trav.	1½	4
20	Counterbore and ream chamber	Gun barrel chambering mach.	1 counterbore 4 reamers	20	Hand	4	1
21	Finish muzzle end	Chambering machine	Spec. fixt.	30	Hand	30	1
22	Mill thread for receiver	Thread mill. mach.	Spec. fixt.	60	..	30–40	3
23	Mark inscriptions	Noble & Westbrook mark. mach.	Roll stamp	..	Hand	30	1
24	Polish	Polishing lathe	Leather covered wheels	3500 R.P.M.	Hand	5 to 6	1
25	Brown	Browning oven	Circular trucks	..	..	25	4 men
26	Polish muzzle	Screw shav. mach.	Emery cloth	150–200	Hand	60	1

Machinery

Fig. 26. Spanish Mauser Rifle Barrel and Sight Bases

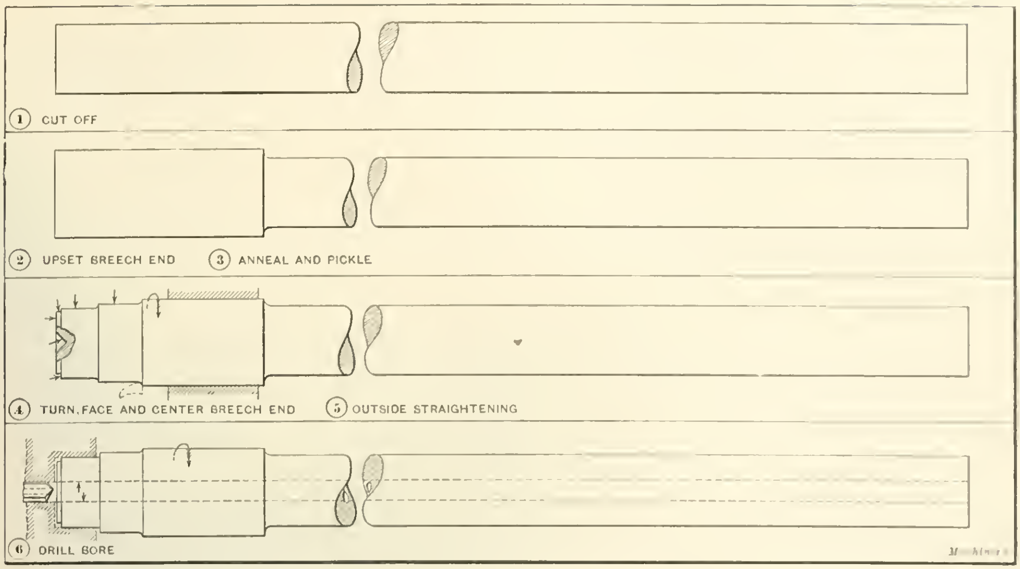


Fig. 27. Operations on Spanish Mauser Rifle Barrel

Operation 1: Cut Off.—This operation is accomplished in a cold-sawing machine in which six bars are held at one setting. A high-speed steel inserted-tooth saw should be used.

Operation 2: Upset Breech End.—This operation is accomplished in a two-inch upsetting and forging machine. The bars of stock are placed in a gas furnace and heated on one end for a distance of about six to eight inches, to approximately 1500 to 1600 degrees F. One operator is required to attend to the furnace and the other to operate the forging machine. On this size of upset one blow is generally sufficient, but in order to secure a more homogeneous structure, it is advisable to give the work two blows. The hourly production, employing two men, one furnace and one machine, is about 135 pieces.

Operation 3: Anneal and Pickle.—Annealing of the rifle barrels is done in a muffle furnace. The barrels are heated in the furnace until they reach a uniform temperature of from 1200 to 1300 degrees F. throughout, and are then removed and placed in a sand box to cool off slowly. (See also "Anneal.") The pickling is necessary to remove the scale formed in annealing and facilitate machining. (See "Pickle.")

Operation 4: Turn, Face and Center Breech End.—This is a preparatory machining operation. The end of the barrel is turned down at the breech so that it can be held in the bushing in the barrel drilling machine. The centering is done to facilitate starting the oil-tube drill. The work is gripped in an air chuck and the machining operations are performed from the turret and cross-slides.

Operation 5: Straighten Outside.—In order to reduce the amount of subsequent straightening, it is advisable, previous to drilling the bore, to straighten the outside surface of the barrel. This is accomplished in the usual manner by placing

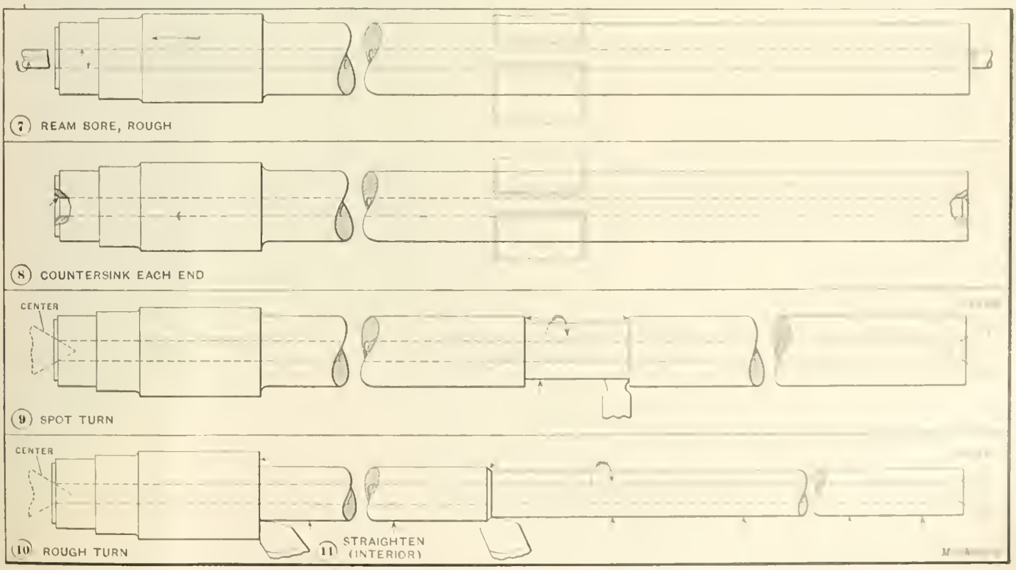


Fig. 28. Operations on Spanish Mauser Rifle Barrel (Continued)

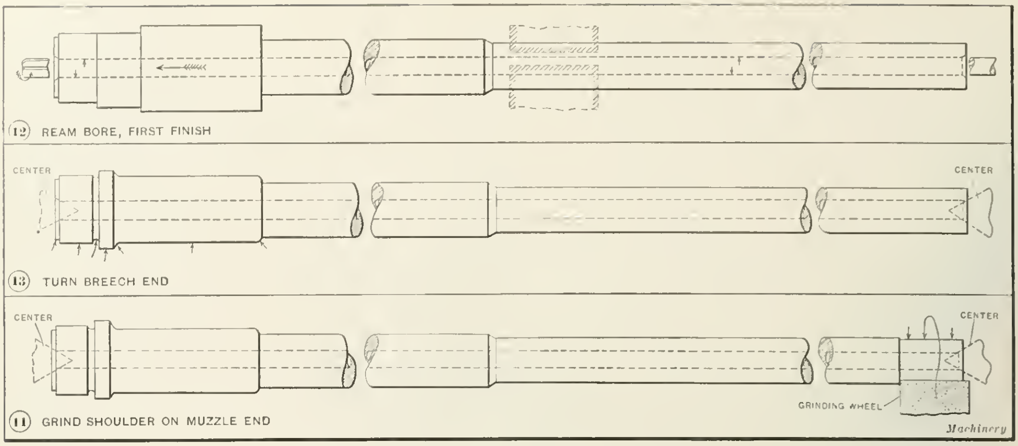


Fig. 29. Operations on Spanish Mauser Rifle Barrel (Continued)

the bar on a support and striking it where crooked with a hammer. It is then rolled on parallel strips to determine whether it is straight or not.

Operation 6: Drill.—This operation is performed on a standard barrel drilling machine, the barrel rotating instead of the drill. The barrel is rotated at a high rate of speed—about 1760 R. P. M.—and the forward feed of the drill is about 0.00057 inch per revolution of the work. Good lard oil or other effective cooling lubricants are forced through the drill at a pressure of about 450 pounds. This high pressure is necessary in order to force the chips back through the groove in the drill.

Operation 7: Ream Bore, Rough.—This operation is performed in a regular gun barrel reaming machine which differs from the drilling machine in that the work is held stationary and the reamer rotated. The most satisfactory method of reaming a gun barrel is to hold the barrel in a "floating" fixture, and then draw instead of push the reamer through. This facilitates reaming and reduces the liability of producing a bore with reamer rings in it. The reamer is held in a chuck, and is generally of the four-fluted type, with teeth having a negative rake.

Operation 8: Countersink Each End.—This operation is generally accomplished on a double-head centering machine of the "Whiton" type. The work is held in a "floating" fixture in the center, and a countersinking tool in each spindle countersinks the bore to provide centers for turning.

Operation 9: Spot-turn.—This operation is accomplished in an engine lathe, and the object is to provide a center point by which the barrel can be supported by a steadyrest when rough-turning. Owing to the flexibility of the barrel, this operation cannot be accomplished very readily, and care should be taken to see that all barrels are turned to the correct diameter.

Operation 10: Rough-turn.—This is done in a regular gun barrel turning lathe, in which the barrel is held on centers, and supported by a steadyrest at the center. Two cross-slides carry the turning tools. One operates at the muzzle end, and the other on the opposite side of the steadyrest, working toward the breech end.

Operation 11: Straighten Interior.—This operation is accomplished by hand by a barrel straightener. There are two methods in general use. The first known as the "line shadow" method is the older, but is still used in many rifle barrel plants. A strip of wood nailed across a ground glass placed over the window casts two shadows down the bore of the

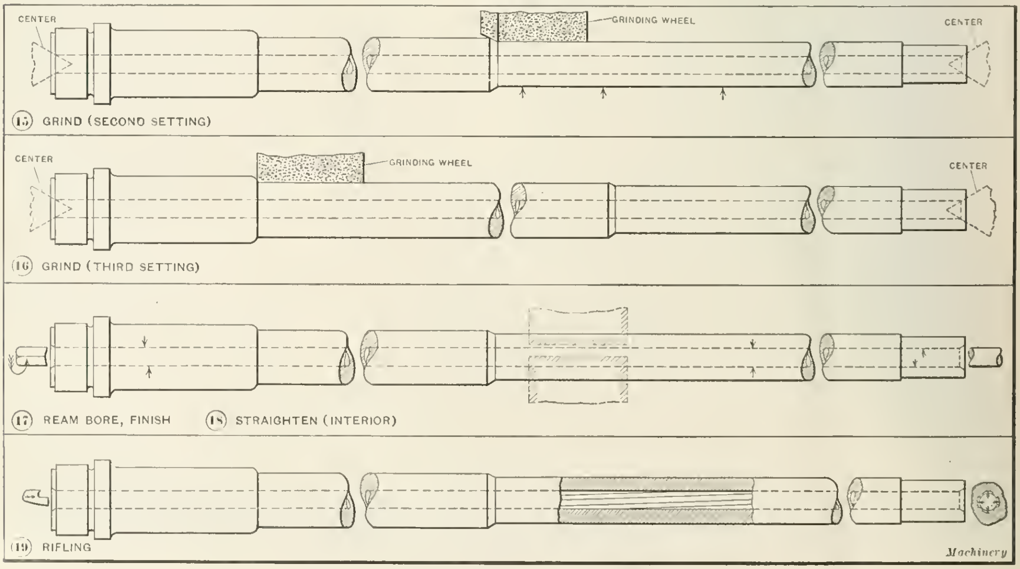


Fig. 30. Operations on Spanish Mauser Rifle Barrel (Continued)

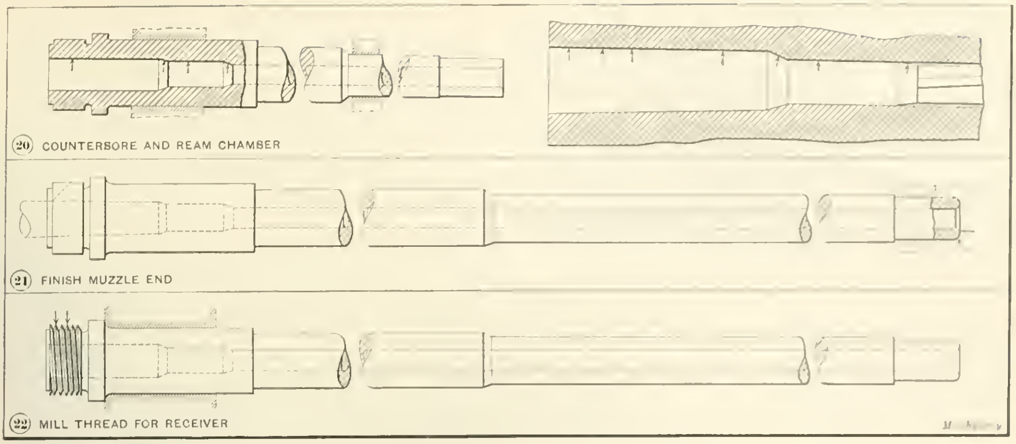


Fig. 31. Operations on Spanish Mauser Rifle Barrel (Continued)

barrel. Any bend or curvature in these line shadows indicates a corresponding lack of straightness at that point in the bore. The barrel is then straightened until the shadows are parallel. This method requires the barrel to be reversed, because the shadows diffuse at a distance a little beyond the center of the barrel. The more modern method is that known as the "concentric ring" method. In this, a lens is placed in the muzzle of the barrel, which is covered with cement through which a circle is scratched to the glass. When the barrel is held up to the light, a series of rings appears in the bore of the barrel. By suitable regulation of the amount of light permitted to strike the muzzle, this can be made an extremely delicate test, and the slightest want of concentricity is an indication that some correction is needed. For further information on this subject, see article entitled "Drilling, Reaming and Straightening Rifle Barrels" in another part of this number.

Operation 12: Ream Bore, First Finish.—This operation is accomplished in a similar manner to Operation 7.

Operation 13: Turn Breech End.—This operation consists in reducing the diameter at the breech end which is subsequently to be threaded, facing the end, under-cutting at the shoulder, and turning that portion not turned in the previous operations.

Operation 14: Grind Shoulder on Muzzle.—This operation is performed in a plain cylindrical grinding machine and consists in grinding that portion of the muzzle end on which the front sight base is to be soldered. This diameter is ground by feeding the wheel straight in on the work without any lateral traverse.

Operation 15: Grind, Second Setting.—This operation is also performed in a plain cylindrical grinding machine, and consists in grinding the portion extending from the shoulder at the muzzle end up to the first increase in diameter. This operation is done by traverse grinding.

Operation 16: Grind, Finish.—This is also done in a plain cylindrical grinding machine and consists in finish-grinding the last long shoulder on the barrel.

Operation 17: Ream Bore, Finish. This operation is performed in a similar manner to Operation 7, except that a square reamer is used. Oil is placed on the reamer, and a rosewood shim is held in one of the grooves by a washer. This shim backs up the reamer and keeps the cutting edge at all times in contact with the work. The square type of reamer is one of the oldest reamers used for this operation, and is conceded to be the most satisfactory. This operation should be very carefully handled. The gaging is done by dropping a plug 0.275 inch diameter, and six inches long, through the entire length of the barrel. The gage must not be forced through, but must drop through freely from its own weight.

Operation 18: Straighten Interior.—This is handled in the same manner as Operation 11, but must be much more carefully done, as it is the final straightening operation.

Operation 19: Rifle.—This operation is accomplished in a regular barrel rifling machine. Two different types of cutters are used for this work—one known as the "scrape," and the other as the "hook" cutter. Some authorities claim that the scrape cutter gives the best results, but this is not agreed upon. It is certain, however, that the hook cutter works much better than the scrape type. The former works on the return stroke, and the latter works on both forward and return strokes, but takes much lighter cuts.

Operation 20: Counterbore and Ream Chamber.—This operation is accomplished in a barrel chambering machine, using counterbores and reamers. The usual practice is to use one counterbore of the eccentrically relieved type, having three diameters, and then finish the bore by using four reamers, each slightly larger than the foregoing, the final one covering all diameters. This operation must be very carefully handled, to make the chamber concentric with the bore and also to prevent throwing up burrs into the rifling grooves, which would necessitate lapping. The most satisfactory gun barrel is one that has a machine-finished bore—not lapped.

Operation 21: Finish Muzzle End.—This operation, performed in a gun barrel chambering machine, consists in using an eccentrically relieved cutter, which chamfers the inside and outside of the muzzle end, in order to prevent the formation of burrs.

Operation 22: Mill Thread for Receiver.—This operation is accomplished in a thread milling machine employing a special fixture.

Operation 23: Mark Inscriptions.—This is done in a Noble & Westbrook marking machine, using a roll stamp on which the required inscriptions are cut in relief.

Operation 24: Polish.—This operation is accomplished on a polishing lathe and consists in using two different grain sizes of emery glued to a leather-faced wheel. For the roughing operation, No. 60 emery is used, and for the finishing, No. 90. The speed of the wheel is about 3500 revolutions per minute.

Operation 25: Brown.—See "Brown."

Operation 26: Polish Muzzle—This operation is accomplished by gripping the barrel in a screw shaving machine and using No. 120 emery cloth to brighten up the muzzle.

OPERATIONS ON FRONT SIGHT

The front sight (see Fig. 32), which is subjected to very little wear, is made from a bar of gun steel, and for the preliminary operations is cut off into lengths of five inches. These bars, which should preferably be of cold-rolled, rectangular stock, 1/2 by 11/32 inch, are ground all over preparatory to milling. After rough-milling to form the blade, the bar is cut up into ten parts and at the same time the dovetail is rough-milled. The previously ground surfaces act as locating and gaging surfaces in the subsequent operations. For additional details, such as feeds, speed and production, see Table VI

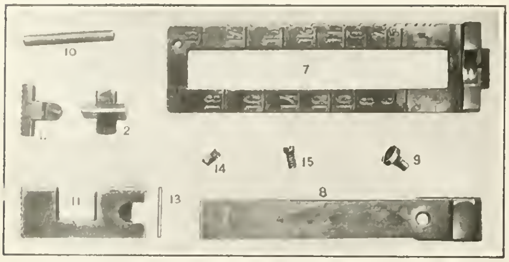
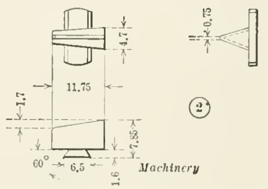


Fig. 32. Rear and Front Sight Parts

Operation 1: Cut into Lengths of 5 Inches.—This operation is accomplished on a cutting-off machine that holds six bars at once, using a high-speed steel inserted-tooth saw.

Operation 2: Grind Top and Bottom.—This is done on a Blanchard vertical surface grinder, using a magnetic chuck that has an outside retaining ring and holds eighty pieces. 0.010 to 0.015 inch is removed from each side, the limit being 0.002 inch. The wheel used is silicate, corundum, grain 30, grade 3/4, 16 inches diameter, 1 1/2 inch width of rim. The table feed is roughing, 17 R. P. M.; finishing, 5 R. P. M. The depth of cut per revolution of work-table is 0.001 inch; production, 400 to 500 per hour, for each side.

TABLE VI. OPERATIONS ON FRONT SIGHT—PART NO. 2



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut into lengths of 5 in.	Cutting-off mach.	Insert. tooth H. S. steel saw	40	0.20	1000	2
2	Grind top and bottom	Blanchard surf. grinder	Magnetic chuck	See text		2000	1
3	Grind right- and left-hand sides	Blanchard surf. grinder	Magnetic chuck	See text		2000	1
4	Mill blade and top	Lincoln type mill. mach.	Spec. fixt. holds two strips	70	0.015	200	3
5	Cut off from bar and mill dovetail, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.010	150	2
6	Mill front and rear ends	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	25	2
7	Mill angles of dovetail projection	Hand mill. mach.	Spec. indexing fixt.	75	Hand	45	1
8	Mill angle on top	Hand mill. machine	Spec. vise jaws	75	Hand	50	1
9	Mill right-hand angular side	Hand mill. machine	Spec. vise jaws	75	Hand	45	1
10	Mill left-hand angular side	Hand mill. machine	Spec. vise jaws	75	Hand	45	1
11	Mill dovetail corners	Hand mill. mach.	Spec. rotary fixt. with former	75	Hand	60	1
12	File corners and burr	..	Files	..	..	40	1
13	Polish	Polishing lathe	Leather covered wheels	4500	Hand	80	1
14	Blue	Niter bath	....	..	..	See text	

Operation 3: Grind Right- and Left-hand Sides.—This operation is also accomplished on a Blanchard vertical surface grinder, under the same conditions as Operation 2.

Operation 4: Mill Blade and Top.—This operation is done on a Lincoln type milling machine, using a special fixture that holds two 5-inch strips. A gang of three form cutters is used which rough-mills the tapered sides, top and shoulder.

Operation 5: Cut Off from Bar and Mill Dovetail, Rough.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces. In the clamping jaws of the fixture are slots through which the cutting-off saws pass.

Operation 6: Mill Front and Rear Ends.—This is accomplished on a Lincoln type milling machine, using a fixture that holds two pieces. The ends are milled by straddle-milling.

Operation 7: Mill Angles of Dovetail Projection.—This operation is accomplished in a hand milling machine, using a special indexing fixture in which the work can be indexed so that both sides of the dovetail can be milled at one clamping of the work.

Operation 8: Mill Angle on Top.—This is accomplished in a hand milling machine, using special vise jaws in which the work is held at an angle to the travel of the table; one piece is milled at a time.

Operation 9: Mill Right-hand Angular Side.—This operation is done in a hand milling machine, in which the work is held in special vise jaws at an angle to the surface of the table.

Operation 10: Mill Left-hand Angular Side.—This operation is handled in the same manner as Operation 9.

Operation 11: Mill Dovetail Corners.—This is done in a hand milling machine, using a special rotary fixture with a former on the table for controlling the movement of the cutter-head.

Operation 12: File Corners and Burr.—This is a hand operation.

Operation 13: Polish.—See "Polish."

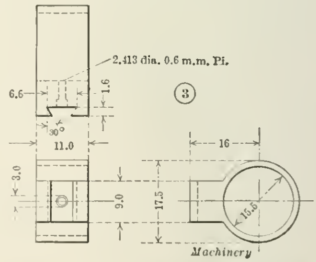
Operation 14: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON FRONT SIGHT BASE

The front sight base (see Fig. 26) is made from a 1 1/8-inch round bar of gun steel stock, the first operation being accomplished in an automatic screw machine of the multiple-spindle type. The hole and one end are then used as locating and gaging points in subsequent operations. For milling the dovetail slot in the top, however, a third location point is necessary, the right-hand side being used for this purpose. For additional details, such as feeds, speeds and production, see Table VII.

Operation 1: Drill, Ream, Face and Cut Off.—This operation is accomplished in a multiple-spindle automatic screw ma-

TABLE VII. OPERATIONS ON FRONT SIGHT BASE—PART NO. 3



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drill, ream, face and cut off	Mult. spin. auto. screw mach.	Spec. tools	30 to 85	0.0015 to 0.010	60	3
2	Face opposite end to length	Blanchard surface grinder	Mag. chuck	See text		800	1
3	Mill right- and left-hand outline and top	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.020	45	2
4	Mill sight slot, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.020	100	1
5	Mill sight slot dovetail, finish	Hand mill. mach.	Spec. fixt.	75	Hand	45	1
6	File corners and burr	..	Files	..	..	45	1
7	Polish	Polishing lathe	Leather covered wheels	4500	..	65	1
8	Blue	Niter bath	..	..	See text		

chine, in which the work is held by eccentric chucks. A straight-blade type of cut-off tool is used.

Operation 2: Face Opposite End to Length.—This operation is accomplished in a Blanchard vertical surface grinder, using a magnetic chuck which has a retaining ring that surrounds the work. Four hundred pieces can be held at one time on the chuck; the amount removed from one side is 0.010 inch and the limit is —0.002 inch. A corundum wheel, grain 30, grade 3/4, silicate, 1 1/2 inch face, 16 inches in diameter, is used. The table speed, roughing, is 17 R. P. M.; finishing, 5 R. P. M. The depth of cut per revolution of work is 0.001 inch.

Operation 3: Mill Right- and Left-hand Outline and Top.—This operation is accomplished in a Lincoln type milling machine, using a special fixture that holds two pieces. The right-hand side, top, and half of the circular section is milled on one side of the fixture and the left-hand side and the remainder of the circular section is machined on the opposite side of the fixture, one piece being completed at each traverse of the table. The fixture used is made with one side adjustable so as to take care of variations in diameter of the cutters. High-speed steel, eccentrically relieved, interlocking form-milling cutters are used.

Operation 4: Mill Sight Slot, Rough.—This operation is also accomplished in a Lincoln type milling machine, using a fixture that holds two pieces. The work is done by an ordinary plain cutter without any teeth on the sides. The same type of fixture is used as for Operation 3.

Operation 5: Mill Sight Slot Dovetail, Finish.—This operation is accomplished in a hand milling machine, using a special fixture and a T-shape dovetail cutter.

Operation 6: File Corners and Burr.—This is a hand operation.

Operation 7: Polish.—See "Polish."

Operation 8: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON REAR SIGHT BASE

The rear sight base (see Fig. 26) is a drop-forging made from a 1 1/8-inch diameter round bar of hot-rolled gun steel. After drop-forging, trimming, annealing and pickling, the first machining operation consists in drilling and reaming the hole and facing the large end in a hand screw machine. In all subsequent operations, the hole and the large end act as locating and gaging points, except when machining the slot, when the right-hand side also serves as a third locating point. For additional details, such as feeds, speeds and production, see Table VIII.

Operation 1: Drop-forge and Trim.—This operation is performed under an 800-pound drop-hammer, a roughing or breaking-down and finishing impression being necessary. The forging is trimmed while hot and cut off the bar.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Drill, Ream and Face.—This operation is accomplished in a hand screw machine, the work being gripped in an air chuck provided with special shaped jaws to grip the piece securely.

Operation 4: Face Front End to Length.—This operation is accomplished in a screw shaving machine, the work being held on a hardened and ground expanding mandrel and forced up against the shoulder; the facing is done by a tool on the cross-slide.

Operation 5: Mill Top Face.—This operation is performed in a Lincoln type power milling machine, provided with a special fixture for holding two pieces.

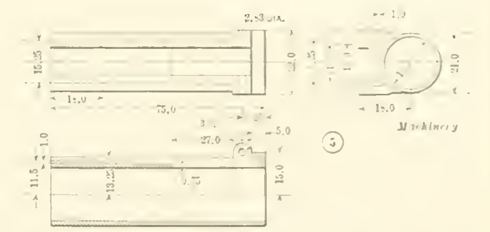
Operation 6: Sweep-mill Outside of Body.—This is done in a Lincoln type milling machine, the fixture being designed to hold two pieces and rotated by a rack on the bed.

Operation 7: Sweep-mill Rear End of Body.—The same remarks apply here as in Operation 6.

Operation 8: Mill Sight Leaf Hinge Lugs and Sides.—This operation is accomplished in a Lincoln type milling machine, a fixture being provided that holds two pieces.

Operation 9: Profile Clearance Cut for Sight Leaf Spring Groove, Rough.—This operation is done in a single-spindle profiling machine provided with a former for controlling the movement of the end-mill. This former is provided with a shoulder, enabling two depths of milling cuts to be made.

TABLE VIII. OPERATIONS ON REAR SIGHT BASE—PART NO. 5



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800 lb. drop-hammer	Forging and trimming dies	..	..	60	1
2	Anneal and pickle	Anneal furn. pickling bath	......			100	.
3	Drill, ream and face	Hand screw mach.	Spec. chuck and tools	30 60	0.010 0.015	20	1
4	Face front end to length	Screw shav. mach.	Spec. chuck	60	0.002	60	1
5	Mill top face	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.020	60	2
6	Sweep-mill outside of body	Lincoln type mill. mach.	Spec. rotary fixt. holds two pieces	75	0.010	30	2
7	Sweep-mill rear end of body	Lincoln type mill. mach.	Spec. rotary fixt. holds two pieces	75	0.010	30	2
8	Mill sight leaf hinge lugs and sides	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.015	45	2
9	Profile clearance cut for sight leaf spring groove, rough	One-spindle profiling mach.	Spec. fixt.	75	Hand	25	1
10	Shave clearance cut for sight leaf	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	Hand	25	1
11	Profile sight leaf spring groove, finish	Single-spindle profiling mach.	Spec. fixt.	75	Hand	30	1
12	Mill sight leaf retaining slots	Hand mill. machine	Spec. fixt.	80	Hand	40	1
13	Drill and ream sight leaf pin hole	Two-spindle drill. mach.	Spec. jig	30 75	Hand	85	1
14	File and burr	......	Files	..	..	35	1
15	Stamp	......	Hand stamps	..	.	250	1
16	Polish	Polishing lathe	Leather covered wheels	4500	Hand	35	1
17	Blue	Niter bath	......	See text	..	..	..

Operation 10: Shave Clearance Cut for Sight Leaf.—This operation is accomplished in a Pratt & Whitney vertical bench shaving machine, using a special fixture for holding the work.

Operation 11: Profile Sight Leaf Spring Groove, Finish.—This operation is performed on a single-spindle profiling machine.

Operation 12: Mill Sight Leaf Retaining Slots.—This operation is accomplished in a hand milling machine, using a special fixture for holding the work. The milling is done with a T-shaped cutter.

Operation 13: Drill and Ream Sight Leaf Pin Hole.—This is accomplished in a two-spindle sensitive drilling machine, the work being held in a special jig so that the drilling can be accomplished from one side and the reaming from the other.

Operation 14: File and Burr.—This is a hand operation.

Operation 15: Stamp.—This operation consists in stamping the part number on the work by hand stamps.

Operation 16: Polish.—See "Polish."

Operation 17: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON REAR SIGHT LEAF

The rear sight leaf (see Fig. 32) is made from a rectangular bar of cold-rolled gun steel, 1/2 by 15/16 inch. The first operation, which is cutting these strips into pieces of the desired length, can be accomplished either in a punch press or in a cutting-off machine. In this case a punch press is specified. The following operations consist in grinding the right- and left-hand edges, which is done on a Blanchard vertical surface grinder. These finish-ground surfaces act as locating points

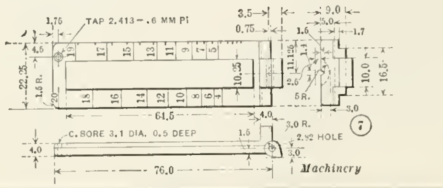
for the subsequent milling operations. For additional details, such as feeds, speeds and production, see Table IX.

Operation 1: Cut Off to Length.—This operation is accomplished in a punch press, using a shearing punch and die.

Operation 2: Grind Right- and Left-hand Edges.—This is done in a Blanchard vertical surface grinder by holding the work on a magnetic chuck. About eighty pieces are held on the chuck at one time, and the grinding is done with a silicate, corundum wheel, grain 30, grade ¾, 16 inches in diameter by 1½ inch rim. The table speed is roughing, 17 R. P. M.; finishing, 5 R. P. M. The down feed of the wheel is 0.0012 inch per revolution of the table, and from 0.010 to 0.015 inch is ground from each side.

Operation 3: Mill Top Face, Ends and Sight Lug, Rough.—This operation is accomplished in a Lincoln type milling machine, using special vise jaws that hold two pieces.

TABLE IX. OPERATIONS ON REAR SIGHT LEAF—PART NO. 7



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off to length	Punch press	Shearing punch and die	60 st'k's	Hand	40	1
2	Grind right- and left-hand edges	Blanchard surf. grinder	Magnetic chuck	See text		225	1
3	Mill top face, ends and sight lug, rough	Lincoln type mill. mach.	Spec. vise jaws	70	0.020	50	2
4	Mill bottom face and ends, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	50	2
5	Mill top face, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	40	2
6	Mill joint cut on lower end	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	45	2
7	Mill spring and sighting opening	Hand mill. mach.	Spec. fixt. holds one piece	70	Hand	30	1
8	Shave spring and sighting opening	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	0.002 per stroke	20	1
9	Shave spring angle on lower end	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	0.002 per stroke	40	1
10	Drill and ream joint pin hole and drill stop screw hole	3-spindle sensitive drill. mach.	Spec. jig	D., 75 R. 30	0.003 0.010	35	1
11	Tap stop screw hole	Bench tapping mach.	Spec. fixt.	20	..	100	1
12	Mill clearance cut for sight	Hand milling mach.	Spec. fixture and tool	80	Hand	50	1
13	Mill sight notch	Hand milling mach.	Spec. fixture	80	Hand	100	1
14	Mill notches in right-hand side	Hand mill. mach.	Spec. fixt.	70	0.005	35	1
15	Mill graduations in left-hand side	Hand milling mach.	Spec. fixture gang cutters	75	Hand	45	1
16	Mill graduations in right-hand side	Hand milling mach.	Spec. fixt. gang cutters	75	Hand	45	1
17	Engrave figures	Gorton No. 1A engraving machine	Spec. fixture	125	Hand	15	1
18	File corners and burr	...	Files	..	..	25	1
19	Polish	Polishing lathe	Leather covered wheels	4500	..	60	1
20	Blue	Niter bath	...	..	..	See text	

Operation 4: Mill Bottom Face and Ends, Rough.—This is accomplished on a Lincoln type milling machine, using a special fixture fitted up with vise jaws for holding two pieces at one setting. One side of the fixture is made adjustable.

Operation 5: Mill Top Face, Finish.—This operation is accomplished in a similar manner to Operation 4, a special fixture with one adjustable side being used.

Operation 6: Mill Joint Cut on Lower End.—This is done in a Lincoln type milling machine, using a special fixture with jaws that hold two pieces. The hinge joint is straddle-milled.

Operation 7: Mill Spring and Sighting Opening.—This operation is accomplished in a hand milling machine provided with a fixture that has special jaws holding one piece. An end-milling cutter is used for making the cut, and a former on the fixture controls its movement.

Operation 8: Shave Spring and Sighting Opening.—This operation is accomplished in a Pratt & Whitney vertical bench shaving machine provided with a special fixture for holding one piece.

Operation 9: Shave Spring Angle on Lower End.—This is accomplished in a similar manner to Operation 8.

Operation 10: Drill and Ream Joint Pin Hole and Drill Stop Screw Hole.—These operations are accomplished on a three-spindle sensitive drilling machine, using a special jig for holding the work.

Operation 11: Tap Stop Screw Hole.—This is done in a bench tapping machine, using a simple jig.

Operation 12: Mill Clearance Cut for Sight.—This operation is accomplished in a hand milling machine, using a fixture provided with special vise jaws, holding one piece. An end-milling cutter is used to take the cut.

Operation 13: Mill Sight Notch.—This is done in a hand milling machine, using special jaws for holding the work.

Operation 14: Mill Notches in Right-hand Side.—This operation is accomplished in a hand milling machine, using special jaws for holding one piece and a gang of slitting cutters on the arbor.

Operation 15: Mill Graduations in Left-hand Side.—This operation is accomplished in a hand milling machine, in a similar manner to Operation 14, with the exception that the work is held with the flat instead of the edge up.

Operation 16: Mill Graduations in Right-hand Side.—This operation is similar to Operation 15.

Operation 17: Engrave Figures.—This is accomplished in a Gorton No. 1A engraving machine, using a special fixture for holding the work.

Operation 18: File Corners and Burr.—This is a hand operation.

Operation 19: Polish.—See "Polish."

Operation 20: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON REAR SIGHT LEAF SPRING

The rear sight leaf spring is made from a hot-rolled ½ by ⅜ inch bar of vanadium type D steel. (See Fig. 32.) The first operation is cutting off to approximate length in a punch press with a shearing punch and die. The next operation is to grind the right- and left-hand sides to bring the piece to the required width. The piece is then milled to shape, using the previously ground sides as locating points. See Table X for feeds, etc.

Operation 1: Cut Off to Length.—This operation is accomplished in a punch press, using a shearing punch and die, the press operating at 60 strokes per minute. A stop in the die controls the length of the piece.

Operation 2: Grind Right-hand Side.—This operation is done on a Blanchard vertical surface grinder, holding 150 pieces on the chuck inside of a retaining ring. The wheel used for this purpose is 16 inches in diameter, rotating at 4190 surface feet per minute, 1½ inch rim, grain 58-24, grade 1, corundum, silicate. The down feed of the cutter-head is 0.0012 inch per revolution of the table. The table speeds are 17 R. P. M., roughing; 5 R. P. M. finishing.

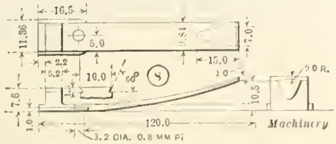
Operation 3: Grind Left-hand Side.—This operation is accomplished in a similar manner to Operation 2.

Operation 4: Mill Bottom and Face Ends to Length.—This is accomplished in a Lincoln type milling machine with a quick-acting vise provided with special jaws in which two pieces are held side by side. High-speed steel milling cutters are used.

Operation 5: Mill Top Faces and Sides of Boss, Rough.—This operation is performed in a Lincoln type milling machine carrying a quick-acting vise provided with special jaws that hold two pieces. This cut leaves about 1/32 to 3/64 inch to be removed by the finishing cut.

Operation 6: Mill Top Faces and Sides of Boss, Finish.—This operation is similar to Operation 5, with the exception that the cutter for the top of the spring is made to cut the desired angle on the top.

TABLE X. OPERATIONS ON REAR SIGHT LEAF SPRING—PART NO. 8



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off to length	Punch press	Shearing punch and die	60 st'k's	Hand	1200	1
2	Grind right-hand side	Blanchard surf. grinder	Mag. chuck	See text		500	1
3	Grind left-hand side	Blanchard surf. grinder	Mag. chuck	See text		500	1
4	Mill bottom and face ends to length	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	50	0.020	50	2
5	Mill top faces and sides of boss, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	50	0.015	48	2
6	Mill top faces and sides of boss, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	55	0.010	40	2
7	Straddle-mill sides of boss	Hand mill. mach.	Spec. vise jaws	55	0.010	40	1
8	Mill dovetail slots in right- and left-hand sides of boss	Hand mill. mach.	Spec. index. fixt.	55	Hand	30	1
9	Mill clearance cut on right-hand side of tang	Hand mill. mach.	Spec. vise jaws	55	Hand	50	1
10	Mill clearance cut on left-hand side of tang	Hand mill. mach.	Spec. vise jaws	55	Hand	50	1
11	Mill clearance cut in lower face of tang	Hand mill. mach.	Spec. vise jaws	50	Hand	50	1
12	Drill and countersink screw hole	One-spin. drill. mach.	Spec. jig comb. drill and c. s.	60	Hand	300	1
13	Tap screw hole	Tapping mach.	Spec. jig	20	Hand	250	1
14	Bend to shape	Punch press	Bend. punch and die	60 st'k's	Hand	200	1
15	Stamp	......	Hand stamp	..	..	250	1
16	File and burr	......	Files	..	..	50	1
17	Polish	Polishing lathe	Leather covered wheels	4500	..	65	1
18	Harden and temper	Hard. furn. tempering bath	......	..	..	150	1

Operation 7: Straddle-mill Sides of Boss.—This operation is accomplished in a hand milling machine, one piece being held at a time in special vise jaws.

Operation 8: Mill Dovetail Slots in Right- and Left-hand Sides of Boss.—This operation is accomplished in a hand milling machine provided with an index milling fixture.

Operation 9: Mill Clearance Cut on Right-hand Side of Tang.—This is accomplished in a hand milling machine, using special vise jaws for holding the work.

Operation 10: Mill Clearance Cut on Left-hand Side of Tang.—This is similar to Operation 9.

Operation 11: Mill Clearance Cut in Lower Face of Tang.—This operation is accomplished in a hand milling machine, using special vise jaws that hold the work at the required angle.

Operation 12: Drill and Countersink Screw Hole.—This is done in a one-spindle drilling machine, holding the work in a simple jig and using a combination drill and countersink.

Operation 13: Tap Screw Hole.—This operation is accomplished in a one-spindle tapping machine.

Operation 14: Bend to Shape.—This operation is accomplished in a punch press, using a bending punch and die.

Operation 15: Stamp.—This consists in stamping the number on the part.

Operation 16: File and Burr.—This is a hand operation.

Operation 17: Polish.—See "Polish."

Operation 18: Harden and Temper.—See "Harden" and "Temper."

OPERATIONS ON REAR SIGHT SLIDE

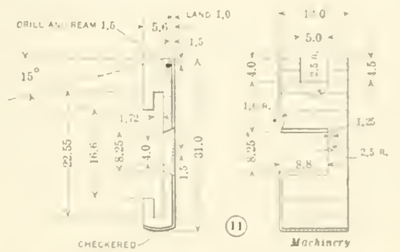
The rear sight slide is made from a 1 3/8 by 5/16 inch bar of hot-drawn gun steel (see Fig. 32), which is cut up into lengths of 3 inches, sufficient to make five pieces. The next operation consists in milling one edge to facilitate clamping, after which the large slot and bottom surface are rough-milled. In the subsequent operations, the slot and the lower edge act as locating points for performing the various milling operations. On some of the operations, however, the bottom surface, one edge, and one end are used as locating and gaging points.

Operation 1: Cut Off into 3-inch Lengths.—This operation is performed in a punch press, using a shearing punch and die.

Operation 2: Mill One Edge.—This is accomplished in a Lincoln type milling machine, using special vise jaws that hold six pieces in group formation.

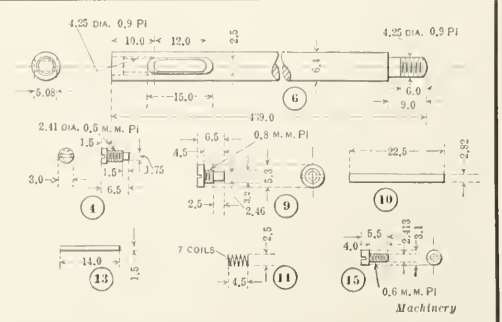
Operation 3: Mill Bottom Surface and Slot, Rough.—This operation is done in a Lincoln type milling machine, using a special vise that holds two pieces. This vise is designed with two adjustable clamping jaws and one center stationary jaw.

TABLE XI. OPERATIONS ON REAR SIGHT SLIDE—PART NO. 11



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off into 3-inch lengths	Punch press	Shearing punch and die	60 st'k's	Hand	2500	1
2	Mill one edge	Lincoln type mill. mach.	Vise jaws, hold six pieces	70	0.020	1000	2
3	Mill bottom surf. and slot, rough	Lincoln type mill. mach.	Spec. vise; holds two pieces	70	0.015	150	3
4	Grind top surface	Blanchard surf. grinder	Magnetic chuck	See text		700	1
5	Cut off to length	Lincoln type mill. mach.	Spec. vise holds two pieces	70	0.020	200	2
6	Mill bottom edge	Lincoln type mill. mach.	Vise jaws; hold six pieces	70	0.020	150	2
7	Mill bottom surf. and slot, finish	Lincoln type mill. mach.	Spec. vise; holds two pieces	70	0.015	35	2
8	Mill T-slot, finish	Hand mill. mach.	Spec. vise jaws, hold one piece	75	Hand	40	1
9	Mill hinge slot and right-hand end	Hand mill. mach.	Spec. vise jaws; hold two pieces	70	Hand	100	1
10	Mill seat for slide catch	Hand mill. mach.	Spec. vise jaws, hold one piece	75	Hand	60	1
11	Mill large sight slot and top edge	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	70	0.015	40	2
12	Mill bevel edges on left- and right-hand sides of large slot	Hand mill. mach.	Index. fixt.	70	Hand	50	1
13	Mill sight notch	Hand mill. mach.	Spec. vise jaws, hold one piece	70	Hand	100	1
14	Mill clearance for sight notch	Hand mill. mach.	Spec. vise jaws, hold one piece	75	Hand	75	1
15	Mill angular clearance on right hand side	Hand mill. mach.	Spec. vise jaws, hold one piece	70	Hand	60	1
16	Mill radius on top front edge	Hand mill. mach.	Spec. vise jaws, hold one piece	70	Hand	60	[illegible]
17	Mill serrations on left-hand end, first setting	Hand mill. mach.	Spec. vise jaws, spe[illegible]	70	Hand	50	[illegible]
18	Mill serrations on left-hand end, second setting	Hand mill. mach.	Spec. rotary fixt. spec. hol[illegible]	70	Hand	[illegible]	1
19	Drill and ream pin hole	Two-spindle drill. mach.	Drill jig	[illegible]	Hand	60	1
20	Stamp	......	Hand stamps	..	..	250	1
21	File and burr	......	Files	..	..	60	1
22	Polish	Polishing lathe	Leather cov. wheels	[illegible]	Hand	45	1
23	Blue	Niter bath	......	See text		..	..

TABLE XII. OPERATIONS ON MISCELLANEOUS SIGHT PARTS AND CLEANING ROD



Part No.	Operation	Machine Used	Hourly Product per Mach.	Machs. per Operator
4	Form thread cut off and slot	Aut. screw mach. with slotting attachment	270	3
4	Polish	Polishing lathe, leather covered wheels	500	1
4	Blue	See text	...	...
6	Cut off to length	Punch press	1200	1
6	Form and thread	Hand screw machine	45	1
6	Face, counterbore, drill and tap	Hand screw machine	40	1
6	Mill flat on sides	Hand mill. mach. index fixture	45	1
6	Spline mill slot	P. & W. spline mill. mach.	30	2
9	Form, thread cut off and slot	Aut. screw mach. with slotting attachment	270	3
10	Form, cut off and burr	Auto. form. mach. with burring attach.	400	3
10	Harden and temper	Harden and temp. bath	250	1
13	Form, cut off and burr	Auto. form. mach. with burring attach.	1000	3
13	Harden and temper	Harden and temp. bath	500	1
14	Wind, set and cut off	No. 1 spring coiling mach.	6000	2
14	Spring temper	Tempering bath	500	1
15	Form, thread cut off and slot	Auto. screw mach. with slotting attachment	320	3
15	Polish	Polishing lathe, leather covered wheels	500	1
15	Blue	See text	...	...

Operation 4: Grind Top Surface.—This is accomplished on a Blanchard vertical surface grinder by holding eighty pieces on the magnetic chuck inside of a retaining ring. The wheel used is 16 inches diameter, 1½ inch rim, and runs at 4190 surface feet per minute. The wheel used is corundum, silicate, grain 24, grade 1. The depth of cut is 0.0012 inch per revolution of the work-table. The speed of the work-table is 13 R. P. M., roughing; 5 R. P. M., finishing.

Operation 5: Cut Off to Length.—This operation is performed on a Lincoln type milling machine, using special vise jaws that hold two pieces. Four saws 1/16 inch wide are used to cut off these pieces, and at the same time two milling cutters at each end face off the rough ends of the bars. The jaws are slotted to clear the saws.

Operation 6: Mill Bottom Edge.—This operation is accomplished in a Lincoln type milling machine, using vise jaws that hold six pieces. The bottom edge is milled to act as a locating point in subsequent operations.

Operation 7: Mill Bottom Surface and Slot, Finish.—This is accomplished in a Lincoln type milling machine, using the same type of vise as for Operation 3. The work is held by the sides instead of from the ends, so as not to spring it.

Operation 8: Mill T-slot, Finish.—This operation is accomplished in a hand milling machine, using a T-cutter. Special vise jaws are provided for holding the piece.

Operation 9: Mill Hinge Slot and Right-hand End.—This is done in a hand milling machine, using special vise jaws that hold two pieces.

Operation 10: Mill Seat for Slide Catch.—This operation is accomplished in a hand milling machine, using special vise jaws and an end-milling cutter.

Operation 11: Mill Large Sight Slot and Top Edge.—This is accomplished in a Lincoln type milling machine, using special vise jaws that hold two pieces.

Operation 12: Mill Bevel Edges on Left- and Right-hand Sides of Large Slot.—This operation is accomplished in a hand milling machine, using a side milling cutter and a special indexing fixture for indexing the piece in position for milling both edges.

Operation 13: Mill Sight Notch.—This is done in a hand milling machine, using a bevel cutter and special vise jaws.

Operation 14: Mill Clearance for Sight Notch.—This operation is accomplished in a hand milling machine, using an end-milling cutter and special vise jaws.

Operation 15: Mill Angular Clearance on Right-hand Side.—This operation is accomplished in a hand milling machine, using special vise jaws.

Operation 16: Mill Radius on Top Front Edge.—This is accomplished in a hand milling machine, using a radius cutter.

Operation 17: Mill Serrations on Left-hand End, First Setting.—This operation is accomplished in a hand milling machine, using special vise jaws for holding the work and a formed hob.

Operation 18: Mill Serrations on Left-hand End, Second Setting.—This is done on a hand milling machine, using a special hob and a rotary fixture.

Operation 19: Drill and Ream Pin Hole.—This operation is accomplished on a two-spindle sensitive drilling machine.

Operation 20: Stamp.—This consists in stamping a number on the parts with hand stamps.

Operation 21: File and Burr.—In this operation all sharp corners and burrs are removed.

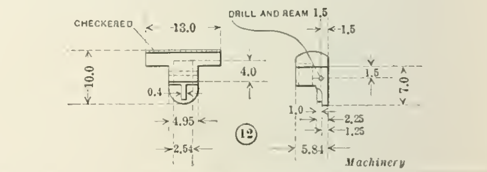
Operation 22: Polish.—See "Polish."

Operation 23: Blue.—See "Blue—Niter Bath Process."

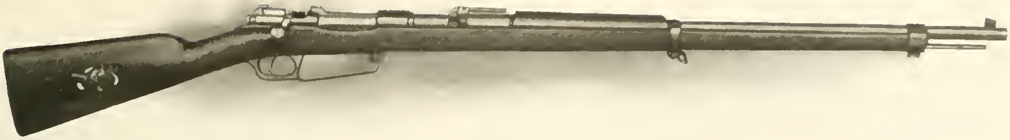
OPERATIONS ON REAR SIGHT SLIDE CATCH

The rear sight slide catch (see Fig. 32) is made from hot-rolled gun steel, and the most satisfactory method is to shear off pieces 3⅜ inches in length from ⅝ by ½ inch stock. These strips are then ground on the right- and left-hand edges on a Blanchard vertical surface grinder, held in special vise jaws, two at a time and milled, rough-forming the extended

TABLE XIII. OPERATIONS ON REAR SIGHT SLIDE CATCH—PART NO. 12



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off into 3⅜-inch lengths	Punch press	Shearing punch and die	60 st'k's	Hand	1500	1
2	Grind right- and left-hand edges	Blanchard surf. grinder	Mag. chuck	See text		2500	1
3	Mill bottom surface	Lincoln type mill. mach.	Spec. vise jaws; hold four strips	60	0.020	800	2
4	Mill top surf. and lug, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	60	0.020	400	2
5	Mill locking step and cut off to length	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	60	0.015	500	1
6	Grind front and rear surfaces	Blanchard surf. grinder	Mag. chuck	See text		1000	1
7	Mill clearance radius	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
8	Mill locking step	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
9	Drill and c. bore spring hole and drill and ream pin hole	4-spindle drill. mach.	Spec. jig	30-60	Hand	45	1
10	Mill serrations—first setting	Hand mill. mach.	Spec. vise jaws. Spec. hob	70	Hand	50	1
11	Mill serrations—second setting	Hand mill. mach.	Spec. rotary fixt. Spec. hob	70	Hand	50	1
12	Stamp	......	Stamps	..	..	250	1
13	File and burr	......	Files	..	..	120	1
14	Polish	Polishing lathe	Leather covered wheels	5000	Hand	50	1
15	Blue	Niter bath	See text	..	..	..	..



Argentine Mauser—Modified German Mauser Bolt Action, Model 1896

piece. The previously ground surfaces act as locating and gaging points. For additional details, such as feeds, speeds and production, see Table XIII.

Operation 1: Cut Off into 3⅜-inch Lengths.—This operation is accomplished on a punch press, using a shearing punch and die.

Operation 2: Grind Right- and Left-hand Edges.—This operation is accomplished on a Blanchard vertical surface grinder, on which about eighty strips are held on the magnetic chuck inside of a retaining ring. 0.010 to 0.015 inch of material is ground from each surface, and the limits are ± 0.002 inch. The wheel used is 16-inch diameter, 1½-inch face, grain 30, grade ¾, silicate, corundum. The wheel speed is 4190 surface feet per minute. The table feed is 17 R. P. M., roughing; 5 R. P. M. finishing. The depth of cut per revolution is 0.0012 inch.

Operation 3: Mill Bottom Surface.—This is done on a Lincoln type milling machine, using special vise jaws that hold four strips. A high-speed steel serrated milling cutter is used.

Operation 4: Mill Top Surface and Lug, Rough.—This operation is accomplished on a Lincoln type milling machine, provided with a special pair of vise jaws that hold two strips. Three milling cutters of the interlocking type are used.

Operation 5: Mill Locking Step and Cut Off to Length.—This operation is performed on a Lincoln type milling machine, using special vise jaws that hold two strips, and saws and cutters equally spaced along the arbor. In this operation the milled strips are cut up into ten pieces each.

Operation 6: Grind Front and Rear Surfaces.—This operation is accomplished on a Blanchard vertical surface grinder, and is similar to Operation 2, except that 500 pieces are held on the magnetic chuck at one time.

Operation 7: Mill Clearance Radius.—This operation is done on a hand milling machine of the Whitney type, using straddle-milling cutters, the cutter being dropped down onto the work to form the radius. A special pair of vise jaws is used, holding one piece.

Operation 8: Mill Locking Step.—This operation is accomplished on a hand milling machine, using special vise jaws and a special formed straddle-milling cutter.

Operation 9: Drill and Counterbore Spring Hole, and Drill and Ream Pin Hole.—These operations are accomplished on a four-spindle sensitive drilling machine, using a special jig for holding the work.

Operation 10: Mill Serrations—First Setting.—This is done on a hand milling machine, using a hob type of cutter and special vise jaws for holding the piece.

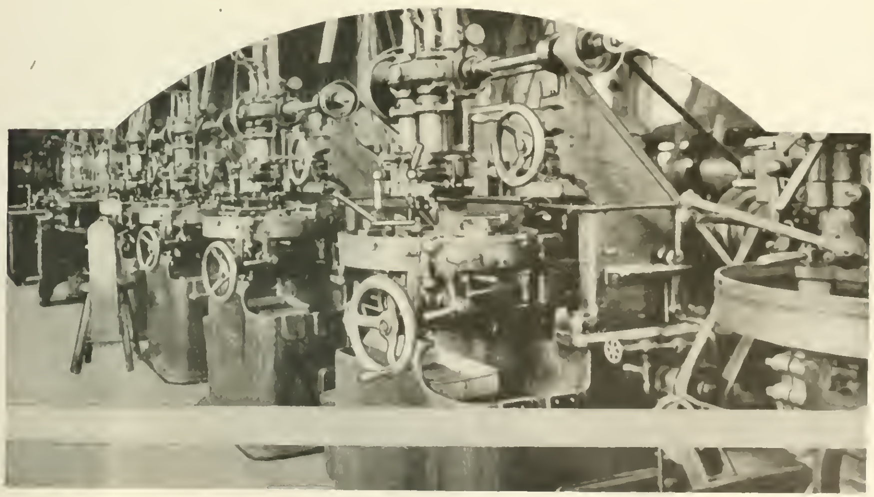
Operation 11: Mill Serrations—Second Setting.—This operation is accomplished on a hand milling machine, using a special rotary fixture and a special hob.

Operation 12: Stamp. This is a hand operation.

Operation 13: File and Burr.—This is also a hand operation.

Operation 14: Polish.—See "Polish."

Operation 15: Blue.—See "Blue—Niter Bath Process."



Machining Receiver and Parts

THE receiver, which must be capable of withstanding severe shocks and also have a hard surface to resist wear, is made from a special carbon steel known as C steel. This material, when properly annealed, machines easily. The board type of drop-hammer has been recommended for forging in this article because it has been practically universally used in forging rifle parts. Of late, however, the steam type of drop-hammer has come into use and has proved to be superior in many respects to the board type of drop-hammer. The chief advantage of the steam drop-hammer is that it can be operated much more rapidly. The first operation on the receiver is drop-forging and trimming, and after annealing and pickling, the part is ready for machining. Owing to the importance of this part, great care must be exercised in the selection of locating and clamping points. For the various operations, these points have been indicated on the operation sheet, Figs. 34 to 37. Wherever possible, however, the hole and front end of the receiver should be used for locating and gaging points. In some cases the bottom surface is also used, and this is indicated in the illustrations referred to. For additional information on feeds, speeds, and production, see Table XIV.

Operation 1: Drop-forge and Trim.—This operation is accomplished in a 1200-pound drop-hammer, one man attending to the furnace, trimming press, and drop-hammer.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Mill Bottom, Rough.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces. High-speed steel milling cutters of the eccentrically relieved interlocking type are used.

Operation 4: Spot, Drill, Recess, Ream, Chamfer, and Face.—This is accomplished on a turret lathe, using a special chuck for holding the rough forgings and locating the work from the previously machined face.

Operation 5: Straddle-mill Both Sides.—This operation is accomplished on a Lincoln type milling machine, using high-speed steel eccentrically relieved milling cutters, and a special fixture that holds two pieces. The fixture is made with one side adjustable to compensate for wear of the cutters.

Operation 6: Mill Bottom, Finish.—This is similar to Operation 3, but is handled in a different manner. In this case the work is located from the previously drilled and reamed center hole.

Operation 7: Sweep-mill Top.—This operation is accomplished on a Lincoln type milling machine, using a special type of rotary fixture, operated through a special gearing device.

Operation 8: Profile Top for Cartridge Ejector, Rough and Finish.—This is done on a two-spindle profiling machine, using a roughing and finishing former and a roughing and finishing cutter.

Operation 9: Sweep-mill Top at Rear End.—This operation is accomplished on a Lincoln type milling machine in a similar manner to Operation 7.

Operation 10: Mill Cartridge Clearance, Rough.—This is accomplished on a hand milling machine, using a special fixture for holding the work that locates it from the previously drilled and reamed hole.

Operation 11: Mill Radius on Left-hand Top Side.—This operation is performed on a hand milling machine, using a relieved cutter, formed to the desired radius.

Operation 12: Sweep-mill Bottom Circular Surfaces.—This is accomplished on a Lincoln type milling machine in a similar manner to Operation 7.

Operation 13: Spline-mill Magazine Opening.—This operation is accomplished on a Pratt & Whitney spline milling machine, using a special fixture that holds two pieces, operated upon at the same time from the two opposing spindles.

Operation 14: Broach Sides of Magazine Opening and Cartridge Clearance.—This is done on a Lapointe broaching machine, using a special fixture for holding the work. The work is held at the desired angle and one broach finishes the slot.

Operation 15: Shave Taper End of Magazine Opening.—This operation is accomplished on a Pratt & Whitney vertical bench shaving machine, using a special fixture for holding the work at an angle.

Operation 16: Profile Clearance Cut in Front End of Magazine Opening.—This operation is accomplished on a one-spindle profiling machine, using a special fixture for holding the work.

Operation 17: Profile Clearance Cut in Rear End of Magazine Opening.—This is done on a one-spindle profiling machine, using a special fixture for holding the work.

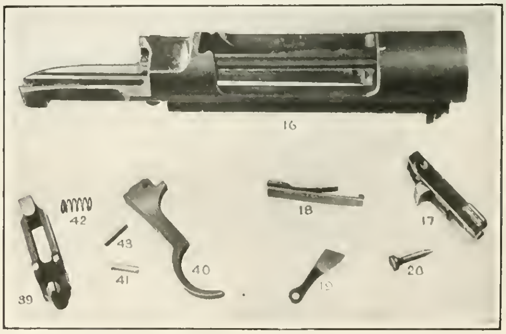


Fig. 33. Spanish Mauser Receiver, Retaining Bolt, Trigger and Sear Parts

Operation 18: Profile Magazine Platform Stop Pocket, Rough and Finish.—This operation is accomplished on a two-spindle profiling machine, using a tapered cutter and roughing and finishing former guides.

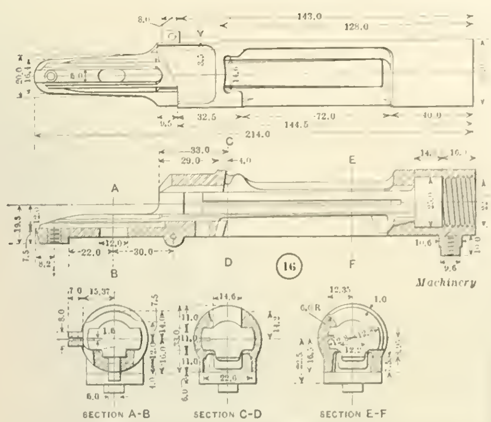
Operation 19: Profile Clearance Cuts in Rear End of Cartridge Opening.—This is accomplished on a one-spindle profiling machine, using a tapered cutter, and the work is set at an angle in a special fixture.

Operation 20: Shave Clearance Cuts in Rear End and

Sides of Cartridge Opening.—This operation is accomplished on a Pratt & Whitney vertical bench shaving machine.

Operation 21: Mill Top Surface of Tang.—This is done on

TABLE XIV. OPERATIONS ON RECEIVER—PART NO. 16



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	1200-lb. drop-hammer	Forging dies trim. punch and die	..	..	40	1
2	Anneal and pickle	Annealing furnace pickling bath	......	..	..	25	See text
3	Mill bottom, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.062	40	2
4	Spot, drill, recess, ream, chamfer and face	Turret lathe	Spec. chuck	30-60	0.010 0.040	10	1
5	Straddle-mill both sides	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.062	30	3
6	Mill bottom, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.040	40	2
7	Sweep-mill top	Lincoln type mill. mach.	Spec. rotary fixt.	50	0.032	20	2
8	Profile top for cartridge ejector, rough and finish	Two-spindle profiling mach.	Spec. fixt.	70	Hand	15	1
9	Sweep-mill top at rear end	Lincoln type mill. mach.	Spec. rotary fixt.	50	0.032	20	2
10	Mill cartridge clearance, rough	Hand mill. mach.	Spec. fixt.	70	Hand	30	1
11	Mill radius on left-hand top side	Hand mill. mach.	Spec. fixt.	70	Hand	40	1
12	Sweep-mill bottom circular surfaces	Lincoln type mill. mach.	Spec. rotary fixt.	50	0.032	25	2
13	Spline-mill magazine opening	P. & W. spline mill. mach.	Spec. fixt. holds two pieces	70	0.010	12	4
14	Broach sides of magazine opening and cartridge clearance	Lapointe broaching mach.	Spec. fixt. broach	..	..	30	1
15	Shave taper end of magazine opening	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	Hand	45	1
16	Profile clearance cut in front end of magazine opening	One-spindle profiling mach.	Spec. fixt.	70	Hand	60	1
17	Profile clearance cut in rear end of magazine opening	One-spindle profiling mach.	Spec. fixt.	70	Hand	60	1
18	Profile magazine platform stop pocket, rough and finish	Two-spindle profiling mach.	Spec. fixt.	70	Hand	30	1
19	Profile clearance cuts in rear end of cartridge opening	One-spindle profiling mach.	Spec. fixt.	70	Hand	60	1
20	Shave clearance cuts in rear end and sides of cartridge opening	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	Hand	45	1
21	Mill top surface of tang	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.032	45	2
22	Mill bolt slide clearance in tang, rough and finish	No. 1 Rockford radial drill. mach.	Spec. fixt. two cutters	60	0.015 0.020	35	2
23	Profile outline on tang, rough and finish	Two spindle profiling mach.	Spec. fixt.	70	Hand	35	1
24	Profile extractor cam surface, rough	One-spindle profiling mach.	Spec. fixt.	70	Hand	40	1
25	Mill extractor cam surface and bolt lever clearance, finish	One-spindle profiling mach.	Spec. rotary fixt.	65	Hand	30	1
26	Mill cocking-piece clearance slot in tang	Hand mill. mach.	Spec. fixt.	70	Hand	20	1
27	Mill clearance for extractor slot in front end	Hand mill. mach.	Spec. fixt.	70	Hand	40	1
28	Shave guide slot for bolt head	P. & W. horiz. splining mach.	Spec. fixt's hold two pieces Spec. cutter bars	30	0.002	30	2
29	Shave right side of bolt lug slot	P. & W. horiz. splining mach.	Spec. fixt's. hold two pieces Spec. cutter bars	30	0.002	20	2
30	Shave left side of bolt lug slot	P. & W. horiz. splining mach.	Spec. fixt's. hold two pieces Spec. cutter bars	30	0.002	20	2
31	Mill cartridge clearance, finish	Hand mill. mach.	Spec. fixt.	70	Hand	35	1
32	Mill lower cartridge entrance	Hand mill. mach.	Spec. fixt.	70	Hand	40	1
33	Mill upper cartridge entrance	Hand mill. mach.	Spec. fixt.	70	Hand	40	1
34	Cut bolt locking cam lugs	Engine lathe	Spec. relieving device	..		20	2
35	Mill thread for barrel	Thread mill. mach.	Spec. fixt. Spec. hob	60	..	35	2
36	Hand tap thread for barrel	Spec. hand tap. mach.	Tapping fixt. and tap	Hand	Hand	35	1
37	Straddle-mill retaining bolt lug	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.010	35	2
38	Mill top and bottom of retaining bolt lug	Hand mill. mach.	Spec. fixt.	60	Hand	45	1
39	Drill, ream, and counterbore sear pin hole and retaining bolt stop hole	Four-spindle drill. mach.	Spec. jig	35-60	Hand	45	1
40	Mill slot for retaining bolt finger	Hand mill. mach.	Spec. fixt.	60	Hand	40	1
41	Shave opening for retaining bolt finger	Vertical bench shav. mach.	Spec. fixt.	100 st'k's	Hand	45	1
42	Mill off and bevel bolt guide rib	Knee type plain mill. mach.	Spec. fixt.	50	0.020	30	1
43	Hollow-mill front guard screw boss	Upright drill. mach.	Spec. jig	30	Hand	50	1
44	Drill and counterbore guard screw holes, and drill hole for front sear tooth	Five spindle drill. mach.	Spec. jig	35-60	Hand	35	1
45	Spline mill elongated sear opening in tang	P. & W. spline mill. mach.	Spec. fixt. holds two pieces	70	0.005	60	2
46	Profile lightening cut on front base end	One spindle profiling mach.	Spec. fixt.	70	Hand	40	1
47	Mill remainder of bottom circular surface on tang	Hand mill. mach.	Spec. rotary fixt.	65	Hand	40	1
48	Mill chamfer on top rear end of chamber	Hand mill. mach.	Spec. rotary fixt.	70	Hand	60	1
49	Tap guard screw holes	Single spindle drill. mach.	Tap attach.	25	Hand	45	1
50	Roll inscriptions on side	N. & W. marking mach.	Spec. fixt. Spec. roll	.	Hand	50	1
51	Stamp		Hand stamp	..	..	250	1
52	File and burr	....	Files	..	..	20	1
53	Pack harden	Heating furnace	Oil bath tanks	..	..	25	1
54	Polish	Polishing lathe	Leather covered wheels	5000		6.8	1
55	Blue	American "bluing" gas furnace	Spec. racks	..	..	120 6 m'chs	6

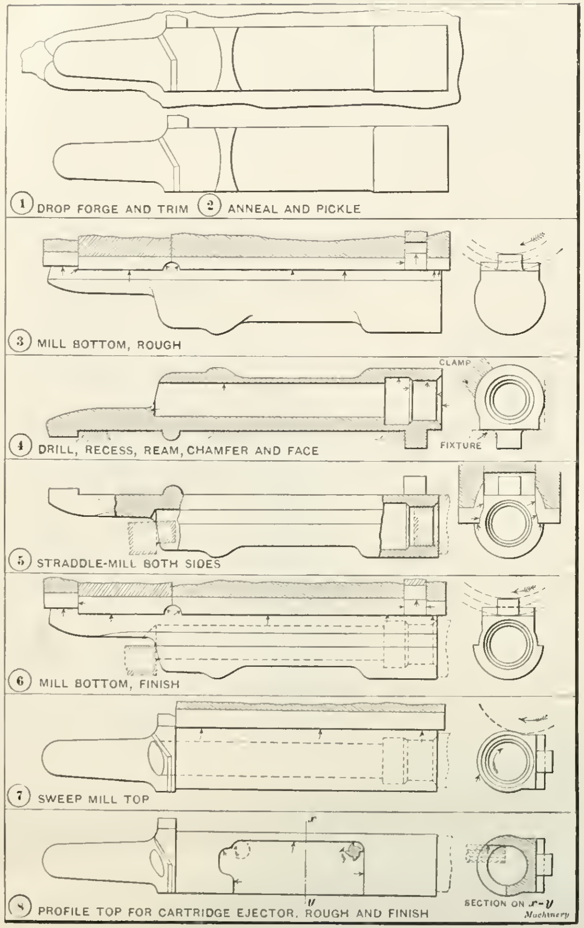


Fig. 34. Machining Operations on Spanish Mauser Receiver

a Lincoln type milling machine, using a special fixture that holds two pieces, and eccentrically relieved high-speed steel milling cutters. One side of the fixture is adjustable for height to compensate for variation in the diameters of the two sets of cutters.

Operation 22: Mill Bolt Slide Clearance in Tang, Rough and Finish.—This operation is accomplished on a No. 1 Rockford radial drilling machine, using a special fixture for holding the work. A roughing and a finishing cutter are used. These cutters are provided with pilots and are fed in from the end, being supported by a bushing in the fixture.

Operation 23: Profile Outline on Tang, Rough and Finish.—This operation is performed on a two-spindle profiling machine, using roughing and finishing guide forming blocks and taper milling cutters. The work is held at a slight angle so that the end is at right angles to the bottom surface of the receiver and the sides are milled in an angular position.

Operation 24: Profile Extractor Cam Surface, Rough.—This operation is accomplished on a one-spindle profiling machine, using a special fixture for holding the work.

Operation 25: Mill Extractor Cam Surface and Bolt Lever Clearance, Finish.—This is done on a single-spindle profiling machine, using a special rotary fixture that guides the cutter in a cam path.

Operation 26: Mill Cocking-piece Clearance Slot in Tang.—This operation is accomplished on a hand milling machine, using a special fixture for holding the work.

Operation 27: Mill Clearance for Extractor Slot in Front End.—This is accomplished on a hand milling machine, using a T-type of milling cutter and a special fixture for holding the work. The cutter is dropped down to the required depth.

Operation 28: Shave Guide Slot for Bolt Head.—This operation is performed on a Pratt & Whitney horizontal splining machine, of the double head type, using a special fixture for holding the work, and special cutter-bars designed on the principle of the hook type of rifling tool. In this machine, the work is held in fixtures fastened to a table that is traversed back and forth, and two pieces of work are held on the table at one time so that a cut is taken at each traverse. The hook type of cutter is fed in the same way as in the Pratt & Whitney rifling machine.

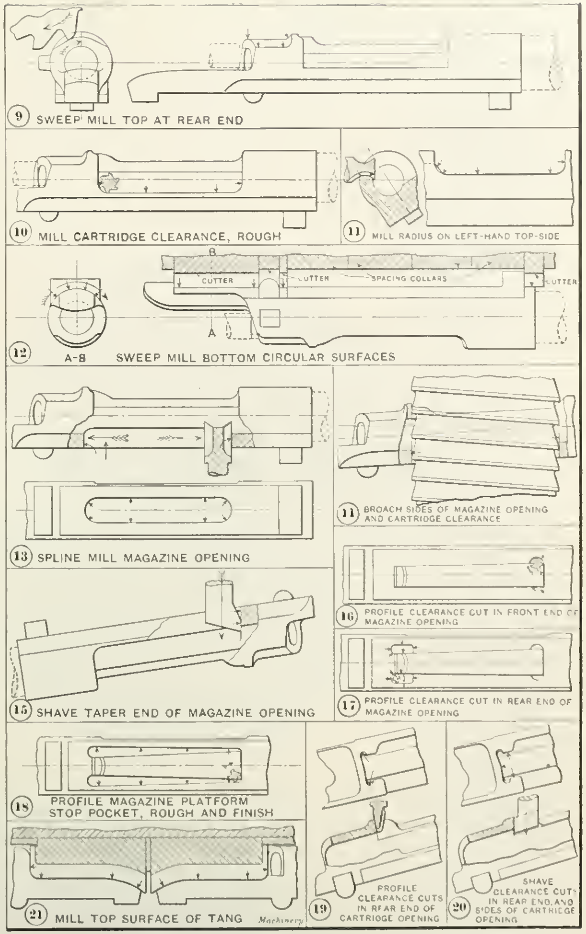


Fig. 35. Machining Operations on Spanish Mauser Receiver (Continued)

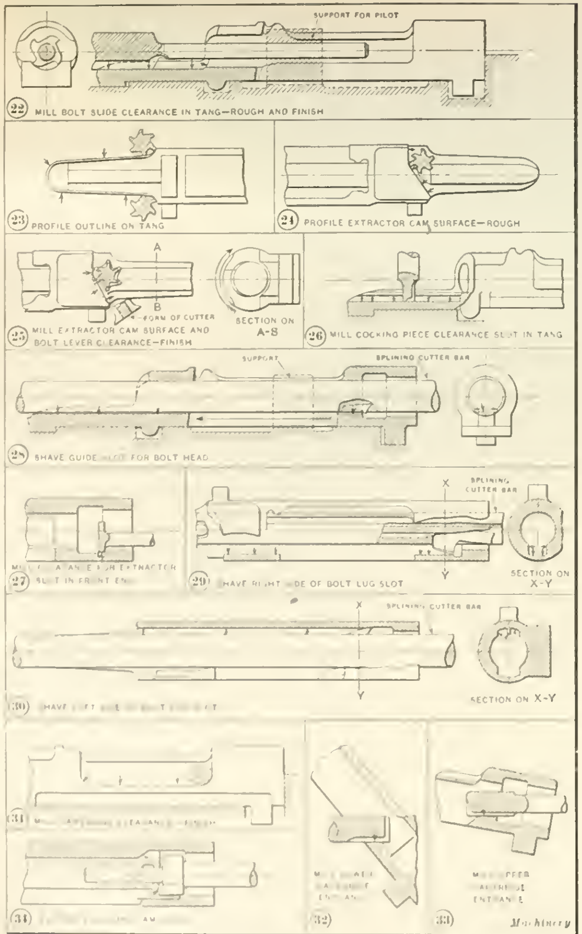


Fig. 36. Machining Operations on Spanish Mauser Receiver (Continued)

Operation 29: Shave Right Side of Bolt Lug Slot.—This operation is accomplished on a Pratt & Whitney horizontal splining machine, using a special fixture and special cutters as in the case of Operation 28.

Operation 30: Shave Left Side of Bolt Lug Slot.—This is done on a Pratt & Whitney horizontal spline milling machine in a similar manner to Operation 28.

Operation 31: Mill Cartridge Clearance, Finish.—This operation is accomplished on a hand milling machine, using an end-milling cutter, the work being held in a special fixture.

Operation 32: Mill Lower Cartridge Entrance.—This is accomplished on a hand milling machine, using a special fixture for holding the work at an angle.

Operation 33: Mill Upper Cartridge Entrance.—This operation is accomplished on a hand milling machine, using a special fixture that holds the work at an angle to the axis of the milling cutter.

Operation 34: Cut Bolt Locking Cam Lugs.—This operation is performed on an engine lathe that has been fitted up with a special fixture and a cam type of relieving device.

Operation 35: Mill Thread for Barrel.—This is done on a thread milling machine, using a special fixture for holding the work and a special hob. At the time that the thread is being milled, the work is also marked to indicate the starting point of the thread.

Operation 36: Hand Tap Thread for Barrel.—This operation is accomplished on a special hand tapping machine, using a special tap that is started from the correct point.

Operation 37: Straddle-mill Retaining Bolt Lug.—This operation is performed on a Lincoln type milling machine, using a special fixture, one side of which is made adjustable, that holds two pieces.

Operation 38: Mill Top and Bottom of Retaining Bolt Lug.—This is done on a hand milling machine, using a special fixture.

Operation 39: Drill, Ream, and Counterbore Sear Pin Hole and Retaining Bolt Stop Hole.—These operations are accomplished on a four-spindle drilling machine, using a special jig for holding the work.

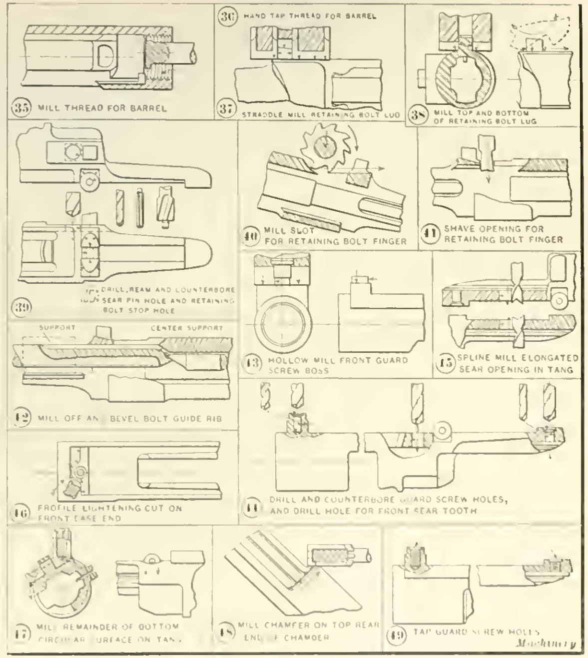


Fig. 37. Machining Operations on Spanish Mauser Receiver (Continued)

Operation 40: Mill Slot for Retaining Bolt Finger.—This operation is accomplished on a hand milling machine, using a special fixture and a slitting saw.

Operation 41: Shave Opening for Retaining Bolt Finger.—This is accomplished on a Pratt & Whitney vertical bench shaving machine, using a special fixture for holding the work.

Operation 42: Mill Off and Bevel Bolt Guide Rib.—This operation is accomplished on a knee type plain milling machine, using a special fixture for holding the work. This is provided with a special center which supports the cutter, and the upper part of the fixture carrying the work is moved instead of the table of the machine.

Operation 43: Hollow-mill Front Guard Screw Boss.—This operation is accomplished on an upright drilling machine, using a special jig for holding the work and guiding the hollow milling tool.

Operation 44: Drill and Counterbore Guard Screw Holes and Drill Hole for Front Sear Tooth.—These operations are performed on a five-

spindle sensitive drilling machine, using a special jig for holding the work.

Operation 45: Spline-mill Elongated Sear Opening in Tang.—This is done on a Pratt & Whitney spline milling machine, using a special fixture that holds two pieces.

Operation 46: Profile Lightening Cut on Front Base End.—This operation is accomplished on a one-spindle profiling machine, using a special fixture for holding the work, and an outside former plate.

Operation 47: Mill Remainder of Bottom Circular Surface on Tang.—This is accomplished on a hand milling machine, using a special rotary fixture, the excess stock left in the previous operations being removed.

Operation 48: Mill Chamfer on Top Rear End of Chamber.—This operation is accomplished on a hand milling machine, using a special rotary fixture in which the work is located at an angle.

Operation 49: Tap Guard Screw Holes.—This operation is accomplished on a single-spindle drilling machine, using a tapping attachment.

Operation 50: Roll Inscriptions on Side.—This is accomplished on a Noble & Westbrook marking machine, using a special fixture for holding the work and a special roll.

Operation 51: Stamp.—This is a hand operation.

Operation 52: File and Burr.—This operation consists in removing the burrs and sharp corners.

Operation 53: Pack-harden.—See "Pack-harden."

Operation 54: Polish.—See "Polish."

Operation 55: Blue.—See "Blue—Gas Furnace Process."

OPERATIONS ON RETAINING BOLT

The retaining bolt (see Fig. 33) is made from a ¾-inch square hot-drawn gun steel bar. The first operation is to cut off pieces, preferably six at a time, to approximately the required length, leaving about 1/32 inch of stock on each end for finishing; then the part is rough-milled on the right-hand side and the top, rough cuts being first taken from all four surfaces. The bottom surface is finished and then the top. For the subsequent gaging and machining operations, the top and bottom surfaces and the rear end act as locating points. For additional details, such as feeds, speeds and production, see Table XV.

Operation 1: Cut Off to Length.—This operation is accomplished on a cutting-off machine, using a high-speed steel inserted-tooth saw. Six pieces are cut off at one time.

Operation 2: Mill Right-hand Side and Stop Lug, and Face Off to Length, Rough.—This operation is accomplished on a Lincoln type milling machine, using special vise jaws that hold two pieces. The eccentrically relieved form milling cutters are made from high-speed steel.

Operation 3: Mill Top Surface, Boss and Finger Lug, Rough.—This is done on a Lincoln type milling machine, using special vise jaws that hold two pieces. The work is located from the previously milled surface and the rough bottom.

Operation 4: Mill Bottom Surface.—This operation is performed on a Lincoln type milling machine, using special vise jaws as before.

Operation 5: Mill Left-hand Side and Slot, Rough.—This operation is accomplished on a Lincoln type milling machine, using special vise jaws that hold two pieces. The pieces are held in contact with each other and parallel with the axis of travel of the table, so that the slot is rough-milled at the same time that the left-hand surface is finished. The jaws are cut away to clear the finger lug.

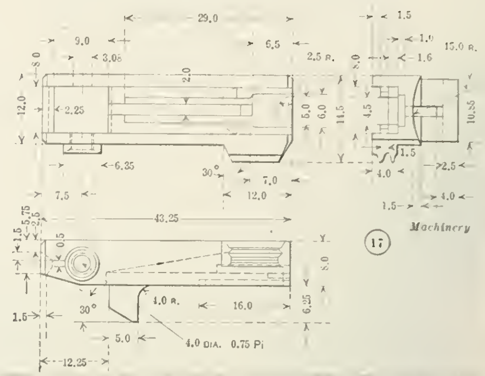
Operation 6: Mill Right-hand Side and Stop Lug, and Face Off to Length, Finish.—This operation is accomplished on a Lincoln type milling machine in the same manner as Operation 2.

Operation 7: Mill Top Surface, Boss and Finger Lug, Finish.—This is done on a Lincoln type milling machine in the same manner as Operation 3.

Operation 8: Drill Retaining Bolt Lug Clearance Hole and Hollow-mill Screw Hole Boss.—This operation is accomplished on a two-spindle upright drilling machine, using a special jig for holding the piece.

Operation 9: Spot, Drill and Ream Fulcrum Screw Hole.—

TABLE XV. OPERATIONS ON RETAINING BOLT—PART NO. 17



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off to length	Cutting-off mach.	Insert-tooth H. S. steel saw	40	0.090	180	3
2	Mill right-hand side and stop lug, and face off to length, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.062	75	2
3	Mill top surface, boss and finger lug, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.062	90	2
4	Mill bottom surface	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.062	90	2
5	Mill left-hand side and slot, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.050	60	2
6	Mill right-hand side and stop lug, and face off to length, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	65	0.032	80	2
7	Mill top surface, boss and finger lug, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	65	0.032	80	2
8	Drill retaining bolt lug clearance hole and hollow-mill screw hole boss	Two-spindle upright drill. mach.	Spec. jig	60-80	Hand	50	1
9	Spot, drill and ream fulcrum screw hole	Three-spindle sensitive drill mach.	Spec. jig	40-90	Hand	50	1
10	Shave retaining bolt lug clearance hole	Vertical bench shav. mach.	Shaving tool	100 st'k's	Hand	60	1
11	Straddle-mill retaining lug	Hand mill. mach.	Spec. vise jaws	70	Hand	50	1
12	Mill receiver clearance groove	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
13	Mill remainder of top surface	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
14	Mill serrations in finger piece	Hand mill. mach.	Spec. vise jaws Spec. hob	70	Hand	60	1
15	Mill retaining bolt spring leaf clearance slot	Hand mill. mach.	Spec. vise jaws	65	Hand	25	1
16	Mill ejector spring slot	Hand mill. mach.	Spec. vise jaws	70	Hand	35	1
17	Mill retaining bolt spring locking lug clearance	Hand mill. mach.	Spec. vise jaws	70	Hand	50	1
18	Mill retaining bolt spring T-slot	Hand mill. mach.	Spec. vise jaws	70	Hand	45	1
19	Mill stop for retaining bolt spring	Hand mill. mach.	Spec. vise jaws	70	Hand	60	1
20	Mill ejector slot	Hand mill. mach.	Spec. vise jaws	65	Hand	45	1
21	File clearance on retaining bolt lug hole	......	Filing jig files	..	..	50	1
22	Tap ejector screw hole	Bench tap. mach.	Spec. jig	30	..	70	1
23	Stamp	......	Hand stamps	..	..	250	1
24	File and burr	......	Files	..	..	45	1
25	Caseharden	Cyanide furnace	......	..	..	75	..
26	Polish	Polishing lathe	Leather covered wheels	5000	Hand	45	1
27	Blue	American "bluing" gas furnace	Rack to hold work	..	..	20	1

This is accomplished on a three-spindle sensitive drilling machine, using a special jig for holding the work.

Operation 10: Shave Retaining Bolt Lug Clearance Hole.—This is done on a Pratt & Whitney vertical bench shaving machine. A shaving tool of the "fish-tail" type is used.

Operation 11: Straddle-mill Retaining Lug.—This operation is accomplished on a hand milling machine, using special vise jaws for holding the work, one piece being milled at a time.

Operation 12: Mill Receiver Clearance Groove.—This is accomplished on a hand milling machine, using special vise jaws for holding the work, and one piece is milled at a time.

Operation 13: Mill Remainder of Top Surface.—This operation is performed on a hand milling machine, and consists in milling the remainder of the stock left at the hand lug.

Operation 14: Mill Serrations in Finger Piece.—This is accomplished on a hand milling machine, using a special type of milling cutter for finishing the serrations in one cut.

Operation 15: Mill Retaining Bolt Spring Leaf Clearance Slot.—This operation is accomplished on a hand milling machine, using a milling cutter with teeth on the sides. The cutter is fed down to the required depth, and then the table is moved longitudinally, the piece being set at the required angle to finish the angular surface of this slot.

Operation 16: Mill Ejector Spring Slot.—This is done on a hand milling machine, using special jaws for holding the piece. A cutter with side clearance is used.

Operation 17: Mill Retaining Bolt Spring Locking Lug Clearance.—This operation is accomplished on a hand milling machine, using an end-milling cutter.

Operation 18: Mill Retaining Bolt Spring T-slot.—This operation is accomplished on a hand milling machine, the work being held in special vise jaws, and the cut is made with a small T-cutter.

Operation 19: Mill Stop for Retaining Bolt Spring.—This is done on a hand milling machine, using an end-milling cutter.

Operation 20: Mill Ejector Slot.—This operation is accomplished on a hand milling machine, using special vise jaws as before. A slitting saw is used for finishing the slot, the cutter being fed down into the work to the required depth, without any traverse of the table.

Operation 21: File Clearance on Retaining Bolt Lug Hole.—This operation is performed on a special filing jig held in the vise, and consists in filing a slight angle on the clearance slot that has previously been shaved.

Operation 22: Tap Ejector Screw Hole.—This operation is accomplished on a small bench tapping machine, using a special jig for holding the work.

Operation 23: Stamp.—This is a hand operation.

Operation 24: File and Burr.—This is also a hand operation.

Operation 25: Casehardcn.—See "Caseharden."

Operation 26: Polish.—See "Polish."

Operation 27: Blue.—See "Blue—Gas Furnace Process."

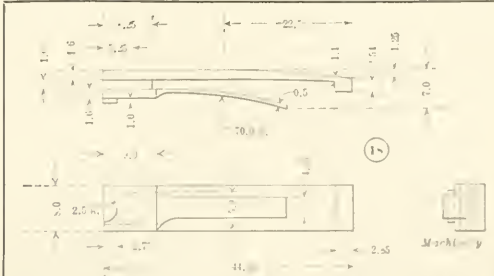
OPERATIONS ON RETAINING BOLT SPRING

The retaining bolt spring (see Fig. 33) is made from vanadium type D steel which is capable of taking a spring temper. The most economical way of making this piece is to do all the roughing in strips of a sufficient length to make ten pieces. Briefly reviewed, the preliminary steps comprise cutting off strips 4 5/16 inches long from rectangular hot-rolled stock, 1⅞ inch wide by ⅜ inch thick. The cutting-off operation is done in a cutting-off machine. The first machining operation consists in gripping ten rough strips in a vise and milling lengthwise along one edge in order to secure a point for location, in roughing out the pieces. These milled strips are subsequently cut up into pieces, allowing 0.010 inch on each side for finishing by milling. For additional details, such as feeds, speeds, and production, see Table XVI.

Operation 1: Cut Off to 4 5/16-inch Lengths.—This operation is accomplished on a cutting-off machine, in which four bars are held at one time. A high-speed steel inserted-tooth saw is used.

Operation 2: Mill One Edge.—This is accomplished on a Lincoln type milling machine, in which ten strips are held in a special vise, the milling being done lengthwise of the strips

TABLE XVI. OPERATIONS ON RETAINING BOLT SPRING—PART NO. 18



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev. Inches	Hourly Produc. per Mach.	Machs. per Operator
1	Cut off to 4 5/16 in. length	Cutting off mach.	Insert-tool H. S. steel saw	30	0.075	1800	2
2	Mill one edge	Lincoln type mill. mach.	Spec. vise; holds ten strips	35	0.040	2000	2
3	Mill bottom surface, rough	Lincoln type mill. mach.	Spec. vise jaws, hold two strips	35	0.040	200	2
4	Mill top surface, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two blanks	35	0.040	200	2
5	Mill remaining edge	Lincoln type mill. mach.	Spec. vise holds ten blanks	35	0.010	2000	2
6	Mill bottom surface, finish	Lincoln type mill. mach.	Spec. vise jaws, hold two strips	45	0.015	200	2
7	Mill top surface, finish	Lincoln type mill. mach.	Spec. vise jaws, hold two strips	45	0.015	200	2
8	Mill ends and cut up into ten pieces	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	35	0.050	200	[illegible]
9	Remove burrs	Bench	Files	..	..	50	1
10	Mill upper edge	Lincoln type mill. mach.	Spec. vise jaws, hold two pieces	45	0.010	70	1
11	Mill lower edge	Lincoln type mill. mach.	Spec. vise jaws; hold two strips	45	0.010	70	1
12	Profile right- and left-hand sides of ejector spring	Two-spindle profiling mach.	Spec. fixt	50	Hand	25	1
13	Profile stop lug	One-spindle profiling mach.	Spec. fixt.	50	Hand	60	1
14	Mill right-hand slot for ejector spring	Hand mill. mach.	Spec. vise jaws	40	Hand	40	1
15	Mill left-hand slot for ejector spring	Hand mill. mach.	Spec. vise jaws	40	Hand	50	1
16	Mill right-hand locking slot	Hand mill. mach.	Spec. vise jaws	45	Hand	60	1
17	Mill left-hand locking slot	Hand mill. mach.	Spec. vise jaws	45	Hand	60	1
18	Stamp	Bench	Hand stamps	..	..	250	1
19	File and burr	Bench	Files	..	..	45	1
20	Bend retaining bolt spring	Punch press	Bending punch and die	80 st'k's	..	180	1
21	Bend ejector spring	Punch press	Bending punch and die	80 st'k's	..	180	1
22	Harden and temper	Hard. furnace Temp. bath	......			150	1
23	Polish	Polishing lathes	Leather covered wheels	5000	..	50	1
24	File and fit	Bench	Files, templet	..	..	30	1

and a special backing-up stop being provided for preventing the work from being pulled out of the vise.

Operation 3: Mill Bottom Surface, Rough.—This operation is performed on a Lincoln type milling machine, using special vise jaws arranged to hold two strips.

Operation 4: Mill Top Surface, Rough.—This is done on a Lincoln type milling machine, using special vise jaws, as before, that hold two blanks.

Operation 5: Mill Remaining Edge.—This operation is accomplished on a Lincoln type milling machine, using special vise jaws that hold ten blanks, and doing the milling lengthwise as in Operation 2.

Operation 6: Mill Bottom Surface, Finish.—This operation is performed in a similar manner to Operation 3.

Operation 7: Mill Top Surface, Finish.—This operation is similar to Operation 4.

Operation 8: Mill Ends and Cut Up into Ten Pieces.—This operation is accomplished on a Lincoln type milling machine, using two milling cutters with side teeth for milling each end

of the strip and slitting saws 3/32 inch wide, ground on the sides. The strips are held in special vise jaws in a Lincoln type milling machine. Care is taken in cutting the pieces to hold the thickness within close limits.

Operation 9: Remove Burrs.—This consists in removing the burrs thrown up in the milling operation, so that the pieces can be held without difficulty when taking the light finishing cuts from the upper and lower edges.

Operation 10: Mill Upper Edge.—This is done on a Lincoln type milling machine, using special jaws that hold two pieces.

Operation 11: Mill Lower Edge.—This operation is accomplished on a Lincoln type milling machine in a similar manner to Operation 10.

Operation 12: Profile Right- and Left-hand Sides of Ejector Spring.—This is done on a two-spindle profiling machine, in which a roughing and finishing cut are taken.

Operation 13: Profile Stop Lug.—This operation is accomplished on a single-spindle profiling machine, the work being held in a special fixture.

Operation 14: Mill Right-hand Slot for Ejector Spring.—This operation is done on a hand milling machine, and consists in slotting the piece to form the ejector spring. The cutter is fed down into the work.

Operation 15: Mill Left-hand Slot for Ejector Spring.—This is similar to Operation 14 except that the cut is much lighter. This finishes the slotting of the spring.

Operation 16: Mill Right-hand Locking Slot.—This operation is accomplished on a hand milling machine by holding the piece in special vise jaws, and using a slitting saw with side clearance for finishing the slot.

Operation 17: Mill Left-hand Locking Slot.—This is similar to Operation 16.

Operation 18: Stamp.—This is a hand operation.

Operation 19: File and Burr.—This consists in removing all the burrs from the piece and rounding the corner on the front end.

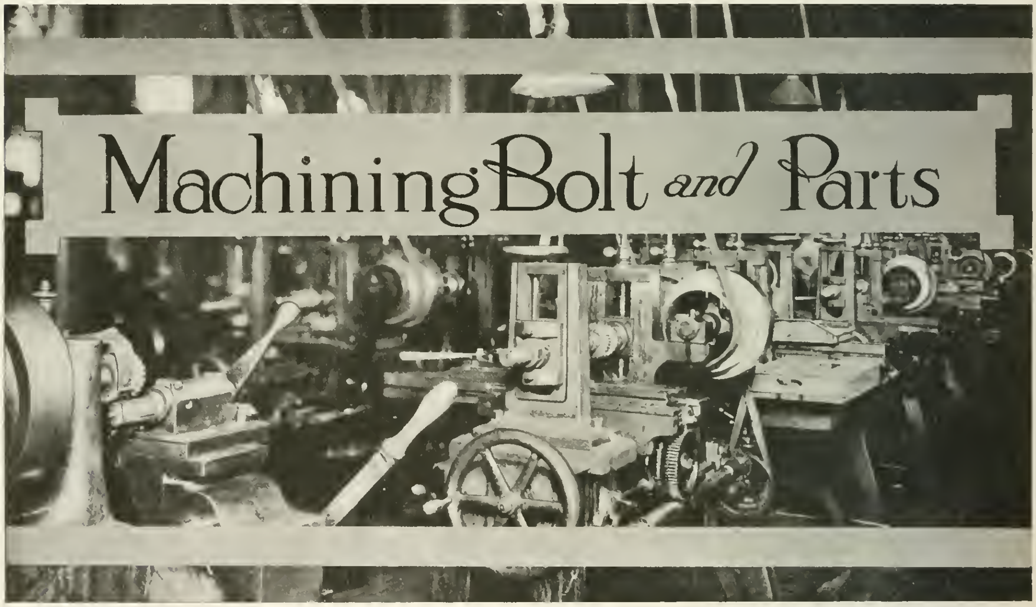
Operation 20: Bend Retaining Bolt Spring.—This operation is accomplished on a punch press, using a bending punch and die. The punch is made so that it straddles the ejector spring.

Operation 21: Bend Ejector Spring.—This is accomplished on a punch press, using a bending punch and die. In this case the bending punch is somewhat similar to a wedge, and comes down in the slot, forcing out the ejector spring to the required shape.

Operation 22: Harden and Temper.—See "Harden" and "Temper."

Operation 23: Polish.—See "Polish."

Operation 24: File and Fit.—Owing to the great accuracy required in the fit of the retaining bolt spring in the retaining bolt slot, a final hand fitting operation is necessary.



THE bolt, see Fig. 38, is drop-forged from C steel, and after forging and trimming is annealed and pickled. Following this, the ends are straddle-milled to approximate length. Two bolt forgings are then held in a pistol barrel drilling machine and the large striker holes are rough-drilled. The next operation consists in finishing this hole and counterboring, reaming, bottoming and recessing, which is done in a hand screw machine, using an adjustable jaw fixture for holding the work and floating tools in the turret. This finished hole and the faced end then act as locating and gaging points in the subsequent operations, as is clearly indicated in Figs. 39 to 42, which show graphically how each operation is accomplished. For additional information on feeds, speeds and production, see Table XVII.

Operation 1: Drop-forge and Trim.—This operation is performed on a 1200-pound drop-hammer. The bolt is forged from a one-inch bar, trimmed hot, and cut off. One operator attends to the heating furnace, hammer and trimming press.

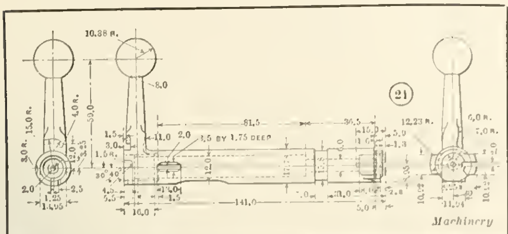
Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Straddle-mill Ends.—This operation is accomplished on a Lincoln type milling machine provided with a fixture that is arranged to hold ten pieces. The work is located from the circular portion of the rough forging. Clearance should be provided in the fixture for burrs or fins, and a rigid clamping device should be used. The cutters should be made from high-speed steel, with teeth cut slightly ahead of the radial line in order to obtain a shearing cut.

Operation 4: Drill Striker Hole, Large Diameter.—This operation is done on a pistol barrel drilling machine, using a deep-hole oil groove drill. Two forgings are located in the fixtures in V supports and clamped rigidly. One operator runs two machines, each machine having two spindles. The drill should leave about 0.005 inch for reaming.

Operation 5: Ream and Bottom Small Hole; Counterbore, Recess and Ream Large Hole; and Face Rear End.—This operation is performed on a hand screw machine provided with a special fixture or chuck of the floating type, screwed

TABLE XVII. OPERATIONS ON BOLT—PART NO. 21



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	1200-pound hammer	Forg. dies and trim. punch and die	..	..	50	1
2	Anneal and pickle	Annealing furnace pickling bath	......	..	..	..	..
3	Straddle-mill ends	Lincoln type mill. mach.	Spec. fixt. holds ten pieces	50	0.010	45	4
4	Drill striker hole, large diameter	Pistol barrel drill. mach.	Spec. fixt. barrel drill	05	0.0008	15	2
5	Ream and bottom small hole; counterbore, recess and ream large hole; and face rear end	Hand screw mach.	Spec. floating chuck and tools	30	Hand	12	1
6	Center front end; face; drill and ream small striker hole	Hand screw mach.	Spec. chuck and tools	50	Hand	30	1
7	Turn outside diameter, rough	Engine lathe	Spec. chuck shaving tools	45	0.010	40	1
8	Mill outside diameter at rear end	Hand mill. mach.	Spec. rotary fixt. and tools	45	Hand	30	1
9	Mill flat faces on handle, right and left sides	Lincoln type mill. mach.	Spec. fixt.	45	0.010	30	1
10	Mill top form of front lugs, rough and finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	45	0.032	25	2
11	Mill bottom form of front lugs, rough and finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	45	0.032	25	2
12	Turn handle knob, finish	Hand screw mach.	Spec. chuck shaving tools	30	0.010	25	1
13	Mill bolt lock stop, rough	Hand mill. mach.	Spec. rotary fixt.	50	Hand	40	1
14	Finish-turn outside diameter	Engine lathe	Spec. chuck shaving tools	40	0.010	45	1
15	Mill under side of front end of bolt	Hand mill. mach.	Spec. fixt.	45	Hand	50	1
16	Mill front face of hand lug and diameter of body	Lincoln type mill. mach.	Spec. rotary fixt.	45	0.010	30	2
17	Mill top of lugs, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	45	0.025	25	2
18	Mill rear end diameter of body, finish	Hand mill. mach.	Spec. rotary fixt.	45	Hand	30	1
19	Mill cam corner on front left-hand side of hand lug	Hand mill. mach.	Spec. fixt.	45	Hand	50	1
20	Mill bolt lock stop, finish	Hand mill. mach.	Spec. rotary fixt.	50	Hand	45	1
21	Mill cocking-piece lock slot	Hand mill. mach.	Spec. fixt.	45	Hand	45	1
22	Mill cocking-piece cam slot, rough	Hand mill. mach.	Spec. fixt.	45	Hand	45	1
23	Mill cocking-piece cam slot, finish	Hand mill. mach.	Spec. fixt.	50	Hand	45	1
24	Mill safety bolt tooth slot	Hand mill. mach.	Spec. fixt.	45	Hand	50	1
25	Mill clearance slot for front tooth on sear, rough	Hand mill. mach.	Spec. fixt.	45	Hand	50	1
26	Mill clearance slot for front tooth on sear, finish	Hand mill. mach.	Spec. fixt.	45	Hand	40	1
27	Mill uncocking clearance flat	Hand mill. mach.	Spec. fixt.	45	Hand	40	1
28	Mill front end between lugs	Hand mill. mach.	Spec. rotary fixt.	45	Hand	30	1
29	Mill extractor head clearance	Hand mill. mach.	Spec. rotary fixt.	45	Hand	35	1
30	Mill extractor groove	Hand mill. mach.	Spec. rotary fixt.	45	Hand	30	1
31	Mill ejector slot	Hand mill. mach.	Spec. fixt.	45	Hand	30	1
32	Mill radius on front end of right lug	Hand mill. mach.	Spec. rotary fixt.	45	Hand	35	1
33	Mill radius on front end	Hand mill. mach.	Spec. rotary fixt.	45	Hand	35	1
34	Tap for bolt plug	Hand oper. bench mach.	Spec. fixt. spec. taps	..	Hand	15	1
35	Turn extractor collar groove; face front end to length, and cut recess	Hand screw mach.	Spec. fixt.	45	Hand	30	1
36	Mill front end of bolt	Hand mill. mach.	Spec. index fixt.	45	Hand	40	1
37	Mill cartridge head clearance	Hand mill. mach.	Rotary fixt. with form cam	45	Hand	[illegible]	1
38	Shave rear corners of bolt lugs	Engine lathe	Spec. relieving fixture	10	Hand	20	1
39	File corners and burr	......	......	..	..	30	1
40	Pack-harden	Gas or oil furnace	Casehardening boxes	..	..	[illegible]	..
41	Polish	Polishing lathe	Leather covered wheels	4500	Hand	[illegible]	1
42	Blue	American "bluing" gas furnace	Rack to hold work	..	..	15	..
43	Polish	Polishing lathe	Leather covered wheels	4500	Hand	[illegible]	1

on the nose of the spindle. The work is located in the chuck by first being placed on a plug held in the turret. Then the clamping mechanism of the fixture is adjusted to grip it. All the tools are of the floating type so as to work from the previously drilled hole.

Operation 6: Center Front End; Face; Drill and Ream Small Striker Hole.—This operation is accomplished on a hand screw machine, the work being located from the previously drilled and reamed hole on a mandrel held in the spindle. The drilling, centering and reaming is done by using two electric drills held in suitable fixtures on the turret. The work is driven by a pin coming in contact with the bolt handle.

Operation 7: Turn Outside Diameter, Rough.—This operation is performed on an engine lathe having a power cross-feed. The work is located on one end by the tailstock center, and on the other by a special center in the spindle. The turning is accomplished with shaving tools presented tangentially and provided with vertical adjustment.

Operation 8: Mill Outside Diameter at Rear End.—This operation is accomplished on a hand milling machine, using a special rotary fixture for holding the work. The cutters are screwed onto a shank and are made from high-speed steel.

Operation 9: Mill Flat Faces on Handle, Right- and Left-hand Sides.—This is done on a Lincoln type milling machine provided with a special fixture that carries two special cutters diametrically opposed to each other. The fixture only provides for holding one piece at a time.

Operation 10: Mill Top Form of Front Lugs, Rough and Finish.—This operation is accomplished on a Lincoln type milling machine to which is attached a double fixture carrying two sets of centers for holding the work. One set of centers is arranged on a tapered wedge in order to provide for variations in the diameter of the cutters due to grinding. A roughing cut is taken from the top on one side of the fixture and a finishing cut on the other.

Operation 11: Mill Bottom Form of Front Lugs, Rough and Finish.—This is done in a similar manner to Operation 10, with the exception that interlocking milling cutters are used.

Operation 12: Turn Handle Knob, Finish.—This operation is performed on a hand screw machine provided with a special type of chuck in which the work is located from the rear end and center hole. The first cut finishes about one-third of the circle on the full end of the handle by means of an inserted-tooth blade hollow mill held in the turret. A rotating support is then brought into position to support the handle while a finishing cut is taken with a shaving tool held on the cross-slide.

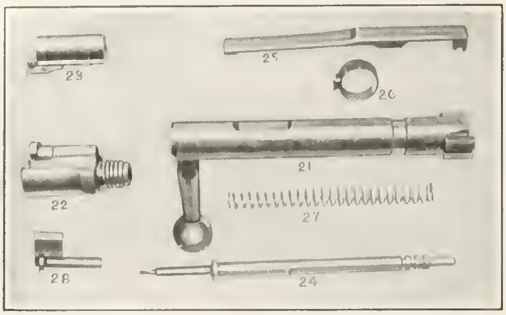


Fig. 38. Mauser Rifle Bolt, Plug, Cocking-piece, Safety Lock, Extractor, Extractor Collar, Main Spring and Striker

Operation 13: Mill Bolt Lock Stop, Rough.—This is done on a hand milling machine, using a former plate for controlling the movement of the cutter-head. The work is also held in a rotary fixture.

Operation 14: Finish-turn Outside Diameter.—This is the same as Operation 7.

Operation 15: Mill Under Side of Front End of Bolt.—In this operation the stock left at the front end of the bolt where the circular portion runs into the slot end is removed. The operation is accomplished on a hand milling machine, using a special fixture for holding the work and a form cutter for "sweeping" up to the flat portion.

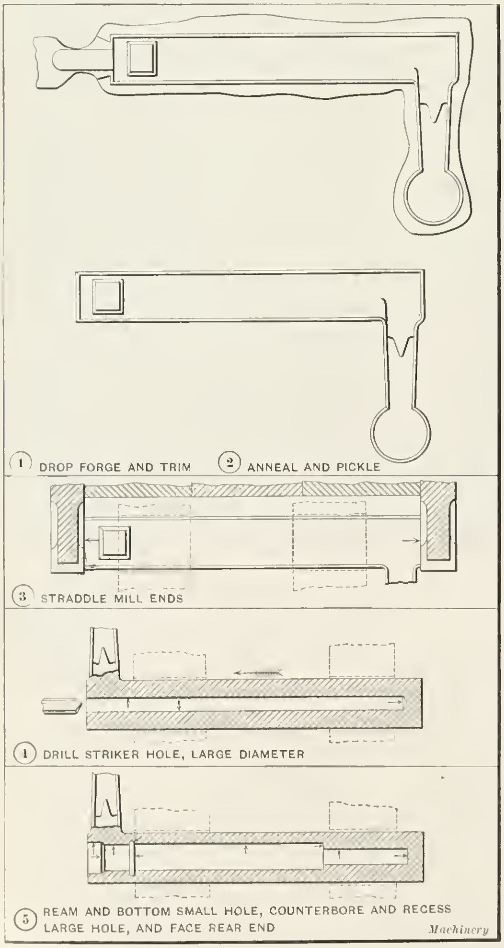


Fig. 39. Operations on Mauser Rifle Bolt

Operation 16: Mill Front Face of Hand Lug and Diameter of Body.—This is accomplished on a Lincoln type milling machine, using a special rotary fixture operated by a rack on the table. A long-shank milling cutter is used that is supported near the cutter end by a special arm.

Operation 17: Mill Top of Lugs, Finish.—This operation is accomplished on a Lincoln type milling machine provided with a special fixture that holds two pieces. The work, as before, is located from the center hole and from the flat on the lugs. One set of centers on the fixture is arranged on a tapered wedge in order to provide for variations in the diameter of the cutters due to grinding. One lug is rough-milled on one side of the fixture and the other lug is finished on the opposite side.

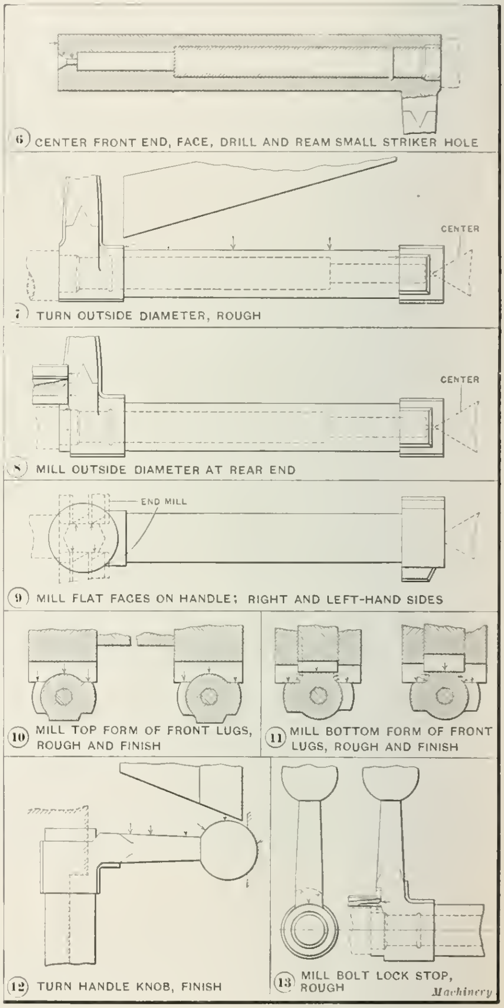


Fig. 40. Operations on Mauser Rifle Bolt (Continued)

Operation 18: Mill Rear End Diameter of Body, Finish.—This is accomplished on a hand milling machine provided with a special rotary fixture. The operation consists in finishing the portion left by the shaving and milling cuts. A long-shank cutter is used supported by a special arm, the work being located from the center hole.

Operation 19: Mill Cam Corner on Front Left-hand Side of Hand Lug.—This operation is accomplished on a hand milling machine, using a special fixture that holds the work at an

angle and provides for rotating it. An angular cutter is used, and one cut finishes the work.

Operation 20: Mill Bolt Lock Stop, Finish.—This is similar to Operation 13.

Operation 21: Mill Cocking-piece Lock Slot.—This operation is accomplished on a hand milling machine, using a special fixture for holding the work in a vertical position, and locating it from the bolt body.

Operation 22: Mill Cocking-piece Cam Slot, Rough. This is accomplished in a similar manner to Operation 21.

Operation 23: Mill Cocking-piece Cam Slot, Finish.—This operation is accomplished on a hand milling machine, using a special rotary fixture in which the work is supported from the hole and held in an angular position in relation to the cutter.

Operation 24: Mill Safety Bolt Tooth Slot.—This is done on a hand milling machine, using a special fixture. The work is located from the center hole. An end-mill is used that is slightly smaller in radius than the cut to be made in the bolt, and the table is moved to mill the slot to the correct width.

Operation 25: Mill Clearance Slot for Front Tooth on Sear, Rough.—This operation is accomplished on a hand milling machine equipped with a special fixture which locates the work from the center hole.

Operation 26: Mill Clearance Slot for Front Tooth on Sear,

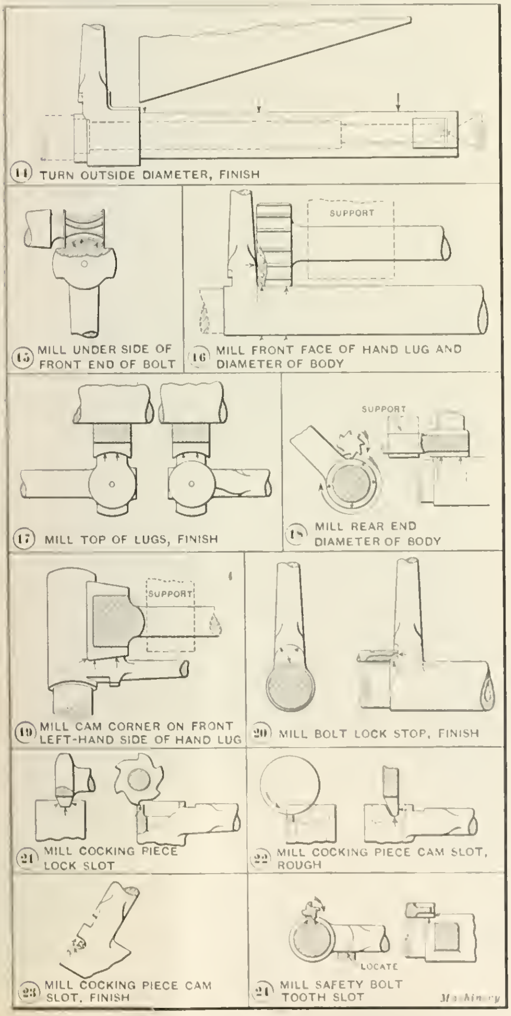


Fig. 41. Operations on Mauser Rifle Bolt (Continued)

Fig. 42. Operations on Mauser Rifle Bolt (Continued)

Finish.—This is accomplished in a similar manner to Operation 25, with the exception that a smaller cutter is used.

Operation 27: Mill Uncocking Clearance Flat.—This operation is accomplished on a hand milling machine in which the work is held on a special fixture and located from the center hole and from the flat on the hand lug.

Operation 28: Mill Front End Between Lugs.—This operation is accomplished on a hand milling machine, using a special rotary fixture.

Operation 29: Mill Extractor Head Clearance.—This is accomplished on a hand milling machine, using a special rotary fixture.

Operation 30: Mill Extractor Groove.—This operation is accomplished on a hand milling machine, using a special rotary fixture, the work being located from the center hole, as in the previous cases.

Operation 31: Mill Ejector Slot.—This is done on a hand milling machine in which the work is located from the center hole. A metal slitting saw is fed in to depth and not traversed to cut the slot.

Operation 32: Mill Radius on Front End of Right Lug.—This operation is accomplished on a hand milling machine, using a special rotary fixture, and the work is located from the center hole. A formed end-mill is used.

Operation 33: Mill Radius on Front End.—This operation is accomplished on a hand milling machine, using a special fix-

ture of the rotary type, which presents the work in an angular position to the milling cutter.

Operation 34: Tap for Bolt Plug.—This is accomplished on a special hand tapping fixture in which the work is located from the rear end. The lead of the tap as well as the position at which the thread starts is controlled by a lead-screw in the fixture. This thread is of a modified buttress form having an angle of 3 degrees and 45 minutes in order to obtain a slight clearance.

Operation 35: Turn Extractor Collar Groove; Face Front End to Length, and Cut Recess.—This is done on a hand screw machine, using a special fixture in which the work is gripped on the outside. This operation finishes the bolt to length, recesses the hole for the cartridge head, and cuts the groove for the extractor collar.

Operation 36: Mill Front End of Bolt.—This operation is accomplished on a hand milling machine, using a special fixture that holds the work in a vertical position, locating from the outside. This cut prepares the end of the bolt for the final milling cut for the cartridge head clearance, removing much of the excess material.

Operation 37: Mill Cartridge Head Clearance.—This operation is performed on a hand milling machine, using an end-milling cutter, a rotary fixture for holding the work, and a forming cam to control the movement of the cutter-head.

Operation 38: Shave Rear Corners of Bolt Lugs.—This is done on an engine lathe, using a special relieving fixture similar to that used for relieving cutters.

Operation 39: File Corners and Burr.—This is a hand operation.

Operation 40: Pack-harden.—See "Pack-harden."

Operation 41: Polish.—See "Polish."

Operation 42: Blue.—See "Blue—Gas Furnace Process."

Operation 43: Polish.—See "Polish."

OPERATIONS ON BOLT PLUG

The bolt plug (see Fig. 38) is drop-forged from a hot-drawn 1⅛-inch bar of C steel. After forging, trimming, annealing and pickling, the first machining operation is performed in a turret lathe where the work is held in a special chuck and the cocking-piece hole is spotted, drilled, counterbored, reamed and the end faced. This hole then acts as a locating point for the subsequent machining operations. For additional information on feeds, speeds, and production, see Table XVIII.

Operation 1: Drop-forge and Trim.—The drop-forging operation is accomplished on an 800-pound drop-hammer, using forging dies; the trimming is done in a trimming press, using trimming punches and dies.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Spot, Drill, Counterbore, Ream and Face Striker and Cocking-piece Hole.—This operation is accomplished on a turret lathe, using a special chuck for holding the work. The machining operations are performed in the order given.

Operation 4: Turn, Face and Counterbore Tang.—This is accomplished on a turret lathe, using a special chuck for holding the work. This chuck has adjustable jaws and is provided with a hardened and ground plunger on which the work is located from the center hole.

Operation 5: Spot, Drill, Ream, Counterbore and Face Safety Lock Hole.—This operation is also accomplished on a turret lathe, using a special chuck for holding the work; the locating pin on which the work is held is eccentric to the axis of the spindle, so as to bring the safety lock hole in the correct position. The work is located from the rear end, being held in place by a screw clamp bushing.

Operation 6: Mill Lower Surface and Guide Ribs, and Sear Tooth Slot, Rough.—This operation is performed on a Lincoln type milling machine, using a special fixture that holds two pieces. The work is located from the cocking-piece hole.

Operation 7: Mill Left Guide Lug and Safety Bolt Lock Projecting Boss, Rough.—This is done on a Lincoln type milling machine, using a special fixture that holds two pieces.

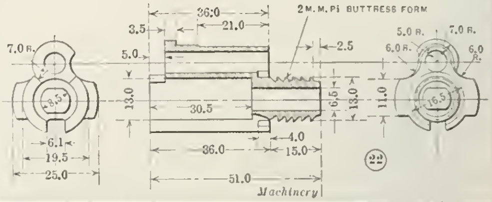
Operation 8: Mill Right Guide Lug and Safety Lock Projecting Boss, Rough.—This is accomplished in a similar manner to Operation 7.

Operation 9: Mill Remainder of Left Side.—This operation is accomplished on a Lincoln type milling machine, and consists in milling that portion remaining between the parts milled in Operations 6 and 7.

Operation 10: Mill Remainder of Right Side.—This is similar to Operation 9.

Operation 11: Sweep-mill Safety Lock Locking Rib and Boss, Rough.—This operation is accomplished on a hand milling ma-

TABLE XVIII. OPERATIONS ON BOLT PLUG PART NO. 22



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-lb. drop-hammer	Forging and trimming dies	..	..	65	1
2	Anneal and pickle	Annealing furn. Pickling bath	......	..	..	100	..
3	Spot, drill, counterbore, ream and face striker and cocking-piece hole	Turret lathe	Spec. chuck	30-65	0.004-0.012	30	1
4	Turn, face and counterbore tang	Turret lathe	Spec. mandrel chuck	30-65	0.004-0.010	50	1
5	Spot, drill, ream, counterbore and face safety lock hole	Turret lathe	Spec. fixt.	30-65	0.004-0.010	55	1
6	Mill lower surface and guide ribs, and sear tooth slot, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	50	2
7	Mill left guide lug and safety lock projecting boss, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	55	2
8	Mill right guide lug and safety lock projecting boss, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	55	2
9	Mill remainder of left side	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	55	2
10	Mill remainder of right side	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.012	55	2
11	Sweep-mill safety lock locking rib and boss, rough	Hand mill. mach.	Spec. rotary fixt.	50	Hand	40	1
12	Sweep-mill remainder of safety lock locking boss, rough	Hand mill. mach.	Spec. rotary fixt.	50	Hand	50	1
13	Mill cocking-piece tooth slot, finish	Lincoln type mill. mach.	Spec. fixt. holds six pieces	75	0.012	200	2
14	Mill lower surface and guide ribs, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.012	60	2
15	Mill remainder of left side, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.012	65	2
16	Mill remainder of right side, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	75	0.012	65	2
17	Sweep-mill safety lock locking rib and boss, finish	Hand mill. mach.	Spec. rotary fixt.	75	Hand	60	1
18	Sweep-mill remainder of safety lock locking boss, finish	Hand mill. mach.	Spec. rotary fixt.	75	Hand	75	1
19	Broach striker hole	No. 1 Lapointe broaching mach.	Spec. broach	..	..	40	1
20	Mill thread on tang	Thread mill. mach.	Spec. chuck Hob cutter	50	0.005	45	2
21	Stamp	......	Hand stamps	..	..	250	1
22	File and burr	......	Files	..	..	60	1
23	Pack-harden	Gas or oil furnace	Case-hardening boxes	..	..	50	1
24	Polish	Polishing lathes	Leather covered wheels	4500	..	40	1
25	Blue	Niter bath tank	......	..	..	See text	

chine, using a special rotary fixture. The work is located on a plug fitting in the safety bolt hole.

Operation 12: Sweep-mill Remainder of Safety Lock Locking Boss, Rough.—This is also accomplished on a hand milling machine, using a special rotary fixture and rotating the work on the safety lock hole axis. The operation is performed on the front end of the boss.

Operation 13: Mill Cocking-piece Tooth Slot, Finish.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds six pieces, which are held on close fitting plugs that enter the cocking-piece hole.

Operation 14: Mill Lower Surface and Guide Ribs, Finish.—This is accomplished in a similar manner to Operation 6.

Operation 15: Mill Remainder of Left Side, Finish.—This is similar to Operation 9.

Operation 16: Mill Remainder of Right Side, Finish.—This is accomplished in a similar manner to Operation 10.

Operation 17: Sweep-mill Safety Lock Locking Rib and Boss, Finish.—This is done on a hand milling machine in a similar manner to Operation 11.

Operation 18: Sweep-mill Remainder of Safety Lock Locking Boss, Finish.—This is similar to Operation 12.

Operation 19: Broach Striker Hole.—This operation is accomplished on a No. 1 Lapointe broaching machine, using a special broach.

Operation 20: Mill Thread on Tang.—This is accomplished on a thread milling machine, using a special chuck for holding the work and a hob type of cutter.

Operation 21: Stamp.—This is a hand operation.

Operation 22: File and Burr.—This is also a hand operation.

Operation 23: Pack-harden.—See "Pack-harden."

Operation 24: Polish.—See "Polish."

Operation 25: Blue.—See "Blue—Niter Bath Process."

OPERATIONS ON COCKING-PIECE

The cocking-piece (see Fig. 38), which is subjected to considerable wear and shock, is made from a 7/8-inch round bar of hot-drawn C steel. The first machining operation is accomplished in a multiple-spindle automatic screw machine, where the bar is turned to form the rear part of the body, spotted, drilled, faced, chamfered, and cut off. For the second operation, which consists in reaming, counterboring, facing and recessing the opposite end, the work is held by the finished shank. This machined body then acts as a locating point for the subsequent machining and gaging operations. For additional information on feeds, speeds, and production, see Table XIX.

Operation 1: Turn, Spot, Drill, Face, Chamfer and Cut Off.—This operation is accomplished on a four-spindle automatic screw machine, using an eccentric collet for holding the work. The operations are performed in the order listed.

Operation 2: Ream, Counterbore, Face and Recess.—This is accomplished on a hand screw machine, holding the work in a chuck by the external diameter.

Operation 3: Mill Right and Left Sides of Body and Cocking-piece Tooth, Rough.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces.

Operation 4: Mill Bottom of Tooth, Rough.—This is done on a hand milling machine, using a quick-action vise provided with special jaws that hold two pieces.

Operation 5: Mill Right and Left Sides of Body and Cocking-piece Tooth, Finish.—This is similar to Operation 3.

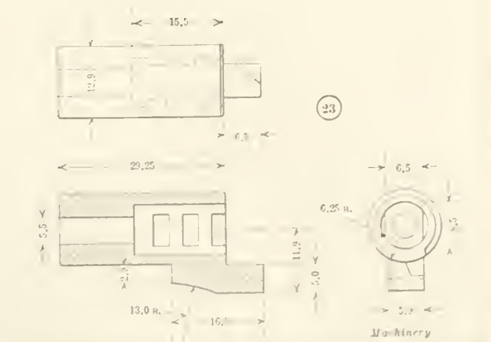
Operation 6: Mill Bottom of Tooth, Finish.—This is accomplished in a similar manner to Operation 4.

Operation 7: Mill Bolt Tooth Lock Cam.—This operation is accomplished on a hand milling machine, using a special rotary fixture that holds one piece.

Operation 8: Mill Chamfer on Front End of Body.—This is also accomplished on a hand milling machine, using a special rotary fixture that holds one piece, and a bevel type of end-milling cutter.

Operation 9: Shave Striker Locking Flats.—This operation is accomplished in a Pratt & Whitney vertical bench shaving machine, using a special fixture for holding the work and a special shaving tool; one piece is held at a time.

TABLE XIX. OPERATIONS ON COCKING-PIECE—PART NO. 23



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev. Inches	Hourly Product per Mach.	Machs. per Operator
1	Turn, spot, drill, face, chamfer and cut off	Mult spindle auto. screw mach.	Ecc. collet	65	0.010 0.020	60	3
2	Ream, counterbore, face and recess	Hand screw mach.	Tools and fixtures	30-65	0.010	40	1
3	Mill right and left sides of body and cocking-piece tooth, rough	Lincoln type mill. mach.	Mill. cutter and fixt. holds two pieces	65	0.020	50	2
4	Mill bottom of tooth, rough	Hand mill. mach.	Vise jaws; hold two pieces	65	Hand	60	1
5	Mill right and left sides of body and cocking-piece tooth, finish	Lincoln type mill. mach.	Mill. cutter and fixt. holds two pieces	65	0.010	50	2
6	Mill bottom of tooth, finish	Hand mill. mach.	Vise jaws; hold two pieces	65	Hand	60	1
7	Mill bolt tooth lock cam	Hand mill. mach.	Rotary fixture	60	Hand	50	1
8	Mill chamfer on front end of body	Hand mill. mach.	Rotary fixture	60	Hand	50	1
9	Shave striker locking flats	P. & W. bench upright shaving mach.	Fixture and tools	100 st'k's	Hand	30	1
10	Stamp	Bench work	Hand stamps	..	..	250	1
11	File and burr	Bench work	Files	.	..	40	1
12	Pack-harden	Gas or oil furnace	Case-hardening boxes	..	..	50	..
13	Polish	Polishing lathe	Leather covered wheels	4500	..	40	1
14	Blue	Niter bath tank	......	..	..	See text	

Operation 10: Stamp.—This is a hand operation.

Operation 11: File and Burr.—This is also a hand operation.

Operation 12: Pack-harden.—See "Pack-harden."

Operation 13: Polish.—See "Polish."

Operation 14: Blue.—See "Blue—Niter Bath Process."

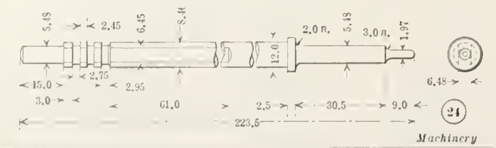
OPERATIONS ON STRIKER

The striker (see Fig. 38) is subjected to severe service, and is made from best grade tool steel. The first operation, which is performed on a 1 1/4-inch multiple spindle automatic screw machine, consists in rough-turning a 9/16-inch diameter round bar on one end to the size required. The piece is then reversed and the opposite end finished in a hand screw machine. For additional information on feeds, speeds, and production, see Table XX.

Operation 1: Turn Body to Shoulder, Cocking-piece Diameter, Face, Groove and Cut Off.—This operation is accomplished on an automatic screw machine provided with standard tools. Particular attention should be given to the quality of finish obtained, in order to avoid later polishing operations.

Operation 2: Turn and Form Front End.—This operation is performed on a hand screw machine. After roughing out with two box-tools, the work is clamp milled in order to size the firing pin diameter and finish the form with the smoothest pos-

TABLE XX. OPERATIONS ON STRIKER PART NO. 24



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Turn body to shoulder, cocking piece diameter, face, groove and cut off	1¼" mult. spin. auto. s. m.	Spec. tools	45	0.004	30–35	3
2	Turn and form front end	Hand screw mach.	Std. box-tools. Spec. clamp mill	60	Hand	25–30	1
3	Mill flats on sides	Hand mill. mach.	Index. fixt. H. S. steel cutter	60	Hand	80	1
4	Stamp	Bench work	Stamps	..	..	250	1
5	File and burr	Bench work	Files Filing jig	..	..	30	1
6	Harden and temper	Hard. and temp. bath	......	..	..	100	..
7	Polish rear end	Polishing lathe	Leather covered wheels	4500	Hand	200	1
8	Blue	Niter bath, tank	Spec. tongs to hold work	..	..	250	1

sible surface. This clamp milling operation is necessary in order to secure a perfectly formed point on the firing pin.

Operation 3: Mill Flats on Sides.—This is done on a hand milling machine, by holding the work in an indexing fixture, and using an end-milling cutter.

Operation 4: Stamp.—This is a hand operation.

Operation 5: File and Burr.—This is also a hand operation, in which a filing jig is used to finish the radius on the flats of the body, and remove burrs.

Operation 6: Harden and Temper.—See "Harden" and "Temper."

Operation 7: Polish Rear End.—See "Polish."

Operation 8: Blue.—This operation is performed on the rear end of the striker only, in a niter bath.

OPERATIONS ON EXTRACTOR

The extractor (see Fig. 38) which is subjected to considerable hard use and wear is made from a hot-drawn bar of 7/16-inch square vanadium type D steel, and carefully hardened and tempered. The first operation is cutting off to approximate length in a cutting-off machine holding six pieces at one time. Following this, both sides are ground on a Blanchard vertical surface grinder. Then the top surface is ground, using a special magnetic chuck which has radial slots into which the work fits closely, registering from the ground sides. Following this, the sides and top act as locating and gaging points. For feeds, speeds, production, etc., see Table XXI.

Operation 1: Cut Off from Bar Stock.—This operation is accomplished on a Higley cutting-off machine, using a high-speed steel inserted-tooth saw, and holding six pieces at one setting.

Operation 2: Surface Grind Right- and Left-hand Sides.—These operations are accomplished on a Blanchard vertical surface grinder in which eighty pieces are held on the magnetic chuck at one setting. From 0.015 to 0.020 inch is removed from each side, and the limits are ± 0.001 inch. The wheel used is silicate corundum, 16 inches in diameter, 1½ inch rim, grain 30, grade ¾, rotating at 4190 surface feet per minute. The speed of the work-table is roughing, 17 R. P. M.; finishing, 5 R. P. M. The down feed of the wheel-spindle is 0.001 inch per revolution of the work-table.

Operation 3: Surface Grind Top.—This is also accomplished on a Blanchard vertical surface grinder, but the work is not held directly on the magnetic chuck. A special plate with radial grooves of a width equal to the finish-ground work is fastened to the magnetic chuck, and thirty pieces of work are slipped into these slots. The other data, feeds, etc., are the same as for Operation 2.

Operation 4: Mill Ends and Bottom Surfaces.—This operation is accomplished on a Lincoln type milling machine, using a standard quick-action vise, equipped with special jaws for holding four pieces. The interlocking type of milling cutters is used.

Operation 5: Mill Remainder of Bottom.—This is accomplished on a Lincoln type milling machine, using a standard quick-action vise provided with special jaws for holding two pieces. These vise jaws are milled with the form milling cutters used for milling the piece, to approximately the same shape and height as the work, so as to support it rigidly at all points.

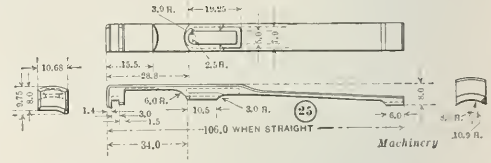
Operation 6: Mill Rear Stop.—This is done on a hand milling machine, using a standard quick-action vise with jaws that hold one piece.

Operation 7: Mill Holding Lug.—This operation is accomplished on a hand milling machine, using a standard quick-action vise that holds one piece.

Operation 8: Mill Clearance for Bolt Lug.—This is accomplished on a hand milling machine, using a standard quick-action vise that holds one piece. In this case, the cutter-spindle is dropped down without traverse of the table.

Operation 9: Mill Recess in Rear of Hook.—This operation is accomplished on a hand milling machine, using a standard quick-action vise with special jaws that hold one piece. The

TABLE XXI. OPERATIONS ON EXTRACTOR PART NO. 25



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off from bar stock	Higley cutting-off saw	H. S. steel inserted-tooth blade saw	30	0.062	100	2
2	Surf. grind right- and left-hand sides	Blanchard surface grinder	Silicate corundum wheel	See text		200-250	1
3	Surface grind top	Blanchard surface grinder	Silicate corundum wheel	See text		200-250	1
4	Mill ends and bottom surfaces	Lincoln type mill. machine	Std. quick-action vise; holds four pieces	40	0.025	80	2
5	Mill remainder of bottom	Lincoln type mill. machine	Std. quick-action vise; holds two pieces	60	1/32	70	2
6	Mill rear stop	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	75	1
7	Mill holding lug	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	65	1
8	Mill clearance for bolt lug	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	50	1
9	Mill recess in rear of hook	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	50	1
10	Mill slot for collar	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	45	1
11	Mill under-cut for collar	Hand mill. machine	Std. quick-action vise; holds one piece	60	Hand	30	1
12	Mill hook and front corners	Hand mill. machine	Std. quick-action vise; with former plate	65	Hand	50	1
13	Mill front stop	Hand mill. machine	Std. quick-action vise; with former plate	65	Hand	50	1
14	Mill spring relief cut	Hand mill. machine	Spec. vise jaws; hold one piece	65	Hand	40	1
15	Mill relief cut on top, rough	Lincoln type mill. mach.	Std. quick-action vise; holds two pieces	60	0.030	60	2
16	Mill relief cut on top, finish	Hand mill. machine	Std. quick-action vise; with former plate	60	Hand	40	1
17	Mill front bevels	Hand mill. machine	Spec. rotary fixture	65	Hand	60	1
18	Bend	Bench fixt.	Bending punch and die	..	..	120	1
19	File corners and burr	Bench work	Files	..	..	25	1
20	Harden and temper	Hard. furn. Temp. bath.	......	..	..	150	1
21	Polish	Polishing lathe	Leather covered wheels	5000	..	30	1

spindle is also dropped down in this case.

Operation 10: Mill Slot for Collar.—This is done on a hand milling machine, using an end-milling cutter and holding the work in a standard quick-action vise.

Operation 11: Mill Under-cut for Collar.—This operation is accomplished on a hand milling machine, using a standard quick-action vise and an end-milling cutter.

Operation 12: Mill Hook and Front Corners.—This operation is performed on a hand milling machine, using a standard quick-action vise for holding the work. The movement of the cutter is controlled by a former plate fastened to the fixture.

Operation 13: Mill Front Stop.—This is accomplished on a hand milling machine, using a standard quick-action vise, with a former plate that controls the movement of the milling cutter.

Operation 14: Mill Spring Relief Cut.—This operation is accomplished on a hand milling machine by holding the work in special vise jaws, and supporting the shank milling cutter on the outer end by a center held in the over-arm. The table is traversed in line with the axis of the machine spindle.

Operation 15: Mill Relief Cut on Top, Rough.—This is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces. One side of the fixture is made adjustable to compensate for variation in the diameters of the cutters.

Operation 16: Mill Relief Cut on Top, Finish.—This operation is performed on a hand milling machine, using a standard

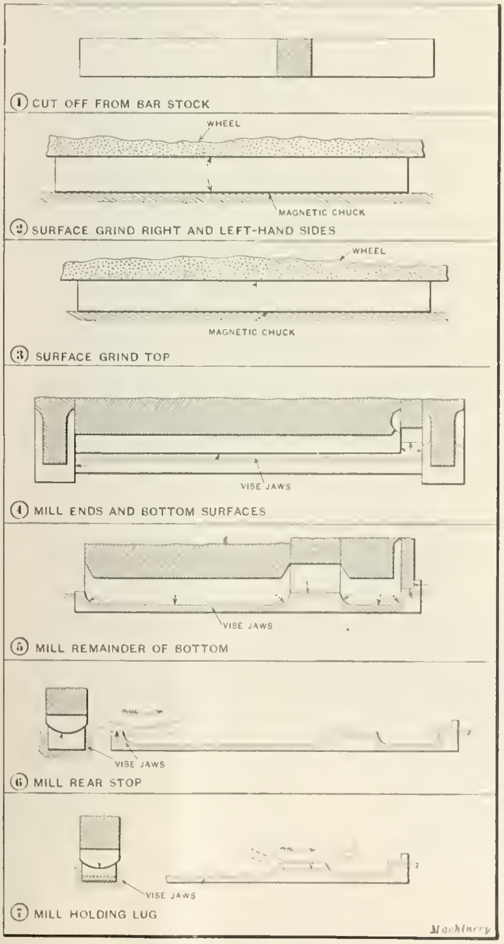


Fig. 43. Operations on Mauser Rifle Extractor

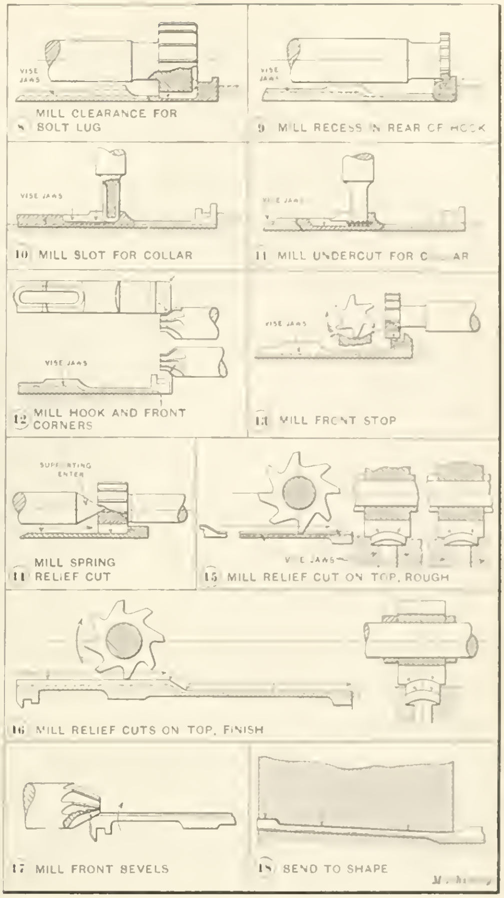


Fig. 44. Operations on Mauser Rifle Extractor Continued

quick-action vise with special jaws that hold one piece. The movement of the cutter is controlled by a former plate on the fixture.

Operation 17: Mill Front Bevels.—This operation is accomplished on a hand milling machine, using a special rotary fixture that holds one piece.

Operation 18: Bend.—This is accomplished in a special bench fixture operated by hand.

Operation 19: File Corners and Burr.—This is a hand operation.

Operation 20: Harden and Temper.—See "Harden" and "Temper."

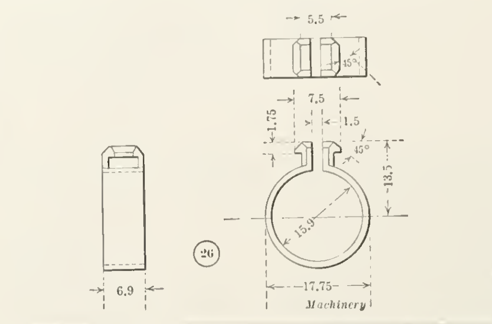
Operation 21: Polish.—See "Polish."

OPERATIONS ON EXTRACTOR COLLAR

The extractor collar (see Fig. 38) which must be hardened and spring tempered is made from a $1\frac{1}{4}$-inch hot rolled bar of vanadium type D. mild steel. The first operation consists in drilling and reaming the hole, facing one end and cutting off in a multiple spindle automatic screw machine. These finished surfaces then act as locating and gaging points for subsequent operations, the complete sequence of which is shown in Fig. 45. For additional data, such as feeds, speeds and production, see Table XXII.

Operation 1: Drill, Ream, Face and Cut Off.—This operation is accomplished on a $1\frac{1}{4}$-inch four-spindle automatic screw machine, using standard tools. Large stock is used so that it can be held concentrically and thus avoid the trouble usually experienced in cutting off eccentric stock.

TABLE XXII. OPERATIONS ON EXTRACTOR COLLAR—PART NO. 26



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drill, ream face and cut off	1¼" mult. spin. auto. screw. mach.	1 drill H. S. steel 1 reamer	60	0.006	160	2
2	Surface-grind one side	Blanchard surface grinder	Grinding wheel	See text	0.001	800–1000	1
3	Mill top and sides of lug	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	1/32	60	2
4	Mill outside edge	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	1/32	60	2
5	Mill under-cut for extractor	Hand mill. mach.	Spec. fixt. holds two pieces	75	Hand	40	1
6	Mill radius on corners	Hand mill. mach.	Spec. fixt. and former	75	Hand	65	1
7	Mill slot to open	Hand mill. mach.	Spec. fixt.	75	Hand	90	1
8	File cornera and burr	..	Bench oper.	..	..	50	..
9	Harden and temper	Hard. and temp. bath	..	..	..	150	..
10	Tumble	Ball burnishing mach.	..	..	..	25	5

Operation 2: Surface-grind One Side.—This is accomplished on a Blanchard vertical surface grinder, holding 400 pieces on the magnetic chuck. The wheel used is 16 inches diameter. 1½ inch face, silicate corundum, grain 30, grade ¾, rotating at 4190 feet surface speed. The table speeds are roughing, 17 R. P. M.; finishing, 5 R. P. M. The depth of cut is 0.001 inch per revolution of the work-table.

Operation 3: Mill Top and Sides of Lug.—This operation is accomplished on a Lincoln type milling machine provided with a special fixture for holding two pieces.

Operation 4: Mill Outside Edge.—This operation, which is accomplished on a Lincoln type milling machine, consists in milling the remainder of the outside circular surface to size and shape in two settings. The fixture holds two pieces, and half the diameter is milled on one side, the remainder being finished on the other side of the fixture, one piece being completed at each pass of the work under the cutters.

Operation 5: Mill Under-cut for Extractor.—This operation is accomplished on a hand milling machine, using a special fixture that holds two pieces. The work is arranged so that opposing sides of the under-cut are milled on each side of the fixture, one piece being completed at each pass of the work under the cutters.

Operation 6: Mill Radius on Corners.—This is done on a hand milling machine provided with a special fixture for holding one piece, and a roller on the spindle arranged to follow a former plate on the fixture, thus forming both corners at one setting.

Operation 7: Mill Slot to Open.—This is accomplished on a hand milling machine, using a special fixture to hold one piece and a slitting saw.

Operation 8: File Corners and Burr.—This is a hand operation, consisting in removing the sharp corners from the lug.

Operation 9: Harden and Temper.—See "Harden" and "Temper."

Operation 10: Tumble.—See "Tumble."

OPERATIONS ON SAFETY LOCK

The safety lock (see Fig. 38) is made from lockwork steel by drop-forging. After forging and trimming, the forging is annealed and pickled, after which it is ready for the first machining operation. This consists in finishing the stem, drilling the clearance hole and facing the shoulder on the flange. The work is done in a five-spindle upright drilling machine, using a special jig for holding the work that can be turned over for drilling and milling the clearance hole and located in an upright position for hollow-milling the stem. The stem and this finished shoulder then act as locating points for the subsequent milling and gaging operations. For feeds, speeds, production, etc., see Table XXIII.

Operation 1: Drop-forge and Trim.—This operation is accomplished on an 800-pound drop-hammer, using forging dies, and the trimming is done in a trimming press, using a trimming punch and die.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Hollow-mill Stem, Drill and Mill Clearance Hole and Face Shoulder.—This operation is accomplished on a five-spindle upright drilling machine, using a special jig for holding the work and performing the operations in the following order: First, rough hollow-mill stem down to top of thumb piece; second, finish-mill stem down to shoulder; third, drill clearance hole in thumb piece; fourth, mill out clearance slot in thumb piece; and fifth, face shoulder and clearance slot with a T-end hollow mill. To perform this last operation it is necessary to stop the machine so the slotted mill can pass the thumb piece without interference. This tool is brought down to a swinging stop to locate it before the spindle is started. The first and the last hollow mill carry facing tools for facing off the end of the stem to length.

Operation 4: Mill Right- and Left-hand Sides of Thumb Piece, Boss and Top, Rough.—This is accomplished on a Lincoln type milling machine, using a special fixture provided with V-type jaws that hold two pieces. On one side of the fixture the right-hand side of the work is milled, and on the other side the left-hand side. One side of the fixture is made adjustable so as to compensate for variation in the diameter of the cutters.

Operation 5: Mill Right- and Left-hand Sides of Thumb Piece, Boss and Top, Finish.—This is done in a similar manner to Operation 4.

Operation 6: Straddle-mill Front and Rear Ends of Thumb Piece.—This operation is accomplished on a Lincoln type milling machine, using two side milling cutters separated by spac-

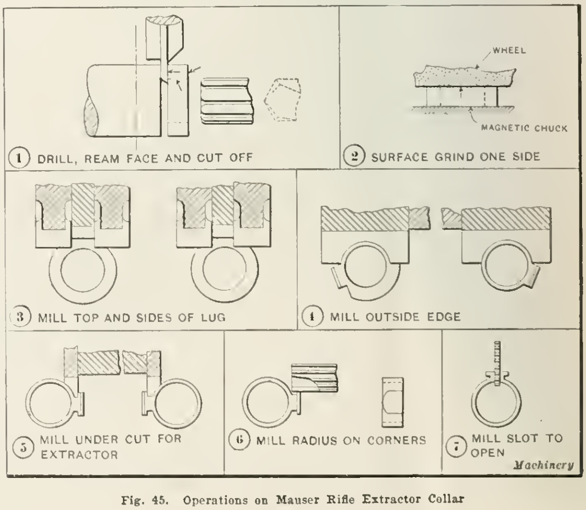
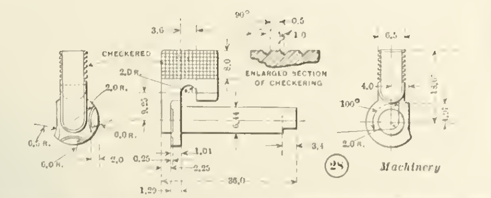


Fig. 45. Operations on Mauser Rifle Extractor Collar

TABLE XXIII. OPERATIONS ON SAFETY LOCK PART NO. 28



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800 lb. drop-hammer. Trimming press	Forging dies Trimming punch and die	..	..	60	1
2	Anneal and pickle	Anneal. furn. Pickling bath	......	..	..	100	..
3	Hollow-mill stem, drill and mill clearance hole and face shoulder	Five-spindle drill. mach.	Spec. jig	25 60	Hand	25	1
4	Mill right- and left-hand sides of thumb piece, boss and top, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.040	60	2
5	Mill right- and left-hand sides of thumb piece, boss and top, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.020	60	2
6	Straddle-mill front and rear ends of thumb piece	Lincoln type mill. mach.	Spec. vise; holds two pieces	50	0.040	70	2
7	Sweep-mill radius on rear end of thumb piece	Hand mill. mach.	Spec. rotary fixt.	60	Hand	60	1
8	Mill cam on end of stem	Hand mill. mach.	Spec. rotary fixt.	60	Hand	60	1
9	Spline-mill radius on thumb piece	P. & W. spline mill. mach.	Spec. fixt. Spec. cutters	60	0.005	35	2
10	Mill cocking-piece cam on flange	Hand mill. mach.	Spec. fixt. Former cam	60	Hand	100	1
11	Mill locking steps in rear of flange	One-spindle sensitive drill. mach.	Spec. jig Spec. cutter	60	Hand	70	1
12	Mill serrations in right- and left-hand sides of thumb piece, first setting	Hand mill. mach.	Spec. vise Spec. hob	50	Hand	80	1
13	Mill serrations in right- and left-hand sides of thumb piece, second setting	Hand mill. mach.	Spec. vise Spec. hob	50	Hand	80	1
14	Stamp	Bench work	Stamps	..	..	250	1
15	File corners and burr	Bench work	Files	..	..	50	1
16	Harden and temper	Hard. furn. Temp. bath	......	..	..	175	1
17	Polish	Polishing lathe	Leather covered wheels	4500	..	30	1
18	Blue	Niter bath	Wire basket			175	1

ing bushings. Two pieces are held in the vise jaws at one time.

Operation 7: Sweep-mill Radius on Rear End of Thumb Piece.—This is done on a hand milling machine, provided with a special rotary fixture, the fixture having two stops for locating the terminus of the radius and for milling the sides which is done by traversing the table longitudinally.

Operation 8: Mill Cam on End of Stem.—This operation is accomplished on a hand milling machine, using a special type of rotary fixture for holding the work. The fixture is provided with stops as in the previous case, to locate the terminal points when starting and stopping the radius cut.

Operation 9: Spline-mill Radius on Thumb Piece.—This is accomplished on a Pratt & Whitney spline milling machine, using a special fixture for holding one piece at a time. The cutters are set so that one feeds in, in advance of the other and then retreats while the other feeds in and passes the center.

Operation 10: Mill Cocking-piece Cam on Flange.—This operation is accomplished on a hand milling machine, using a special fixture for holding the work, and having a cam for controlling the movement of the cutter-spindle.

Operation 11: Mill Locking Steps in Rear of Flange.—This is accomplished on a single-spindle upright drilling machine, using an end-milling cutter which is guided by two bushings in the jig.

Operation 12: Mill Serrations in Right- and Left-hand Sides of Thumb Piece, First Setting.—This operation is accomplished on a Lincoln type milling machine, using a special vise that holds two pieces. The serrations on both sides are milled longitudinally of the stem.

Operation 13: Mill Serrations in Right- and Left-hand Sides of Thumb Piece, Second Setting.—This operation is accomplished in a similar manner to Operation 12, with the exception that the serrations do not run clear across the work, requiring a stop on the table of the machine.

Operation 14: Stamp.—This is a hand operation.

Operation 15: File Corners and Burr.—This operation consists in removing all the sharp corners from the thumb piece.

Operation 16: Harden and Temper.—See "Harden" and "Temper."

Operation 17: Polish.—See "Polish."

Operation 18: Blue.—See "Blue—Niter Bath Process."

The machining operations and other data on: the magazine and trigger guard, with components; various parts used in connection with the stock, such as butt plate, bands, etc.; and all other parts not treated in this number, including the stock and hand guard, will be described in the May number.

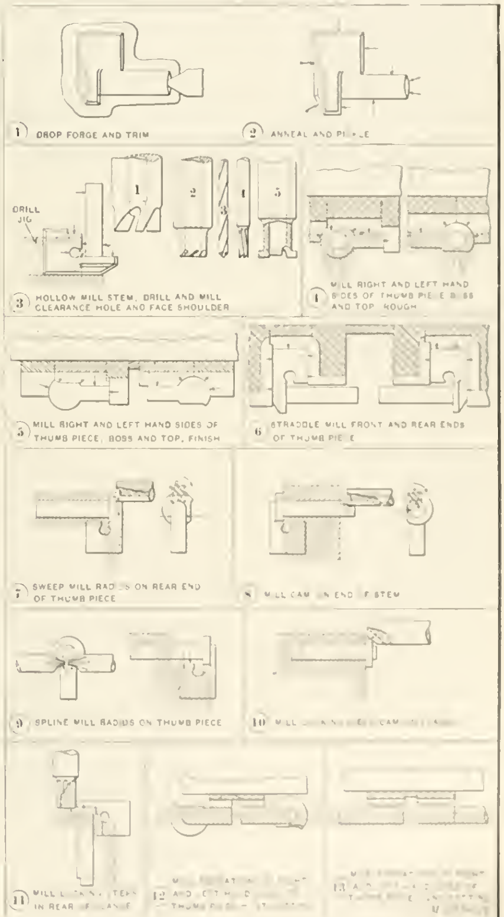


Fig. 46. Operations on Mauser Rifle Safety Lock

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MANUFACTURE OF MILITARY RIFLES

The articles on the military rifle begun in this number are unique in the annals of technical journalism. They specify step by step the operations employed in the manufacture of the Spanish Mauser rifle, which is conceded to be one of the simplest and best military arms used by the nations of the world. The American Springfield rifle is virtually a copy of the Mauser with certain modifications and improvements worked out by United States Army officers.

This is the first time that any journal has undertaken to publish a detailed description of the complicated and special methods by which the barrel, receiver, bolt and other parts are manufactured. Probably no other product is as exacting in the requirements of manufacture as the military rifle. It has to be accurately made of high-grade materials and in complicated and irregular shapes that defy description without the use of many drawings. The impulse of an ordinary mechanical expert on first examining a typical military arm is to say that many of the shapes and parts are finical and unnecessary, that other shapes would work just as well, that many operations could be eliminated, and that the arm generally represents the ideas of military officers to whom expense counts for nothing. But after analyzing the Spanish Mauser arm, we were much impressed to find that practically every shape is required, and that every part has a useful function.

With the possibility of this nation becoming involved in war at some not distant time, and finding it necessary to manufacture millions of army rifles, we feel that the publication of this article is serving a patriotic purpose. It takes out of the possession of a few and puts before thousands of readers, the knowledge of methods and tools employed by the most up-to-date armories. Besides making public these data, the articles will serve to indicate the extent of the task that any manufacturer undertakes when he starts to manufacture military arms on contract.

* * *

SHUTTING OUT IDEAS

One of the surest ways for a manufacturing concern to fall behind in mechanical progress is to keep a closed shop to all visitors. Any concern that develops original ideas and keeps abreast of the times must be constantly in touch with all developments which affect its methods or product. By closing the plant to outsiders, its own representatives must expect a similar lack of courtesy when traveling, and must necessarily be restricted in the interchange of knowledge mutually beneficial. The concern that strives to confine all ideas and novel developments within its walls generally succeeds in shutting out new ideas.

A large arms manufacturing plant, noted for its conservatism, which for many years has consistently excluded engineers and others familiar with manufacturing methods, was recently obliged to call in new blood to revise its methods and bring its manufacturing practice up to date. This experience is not unusual with unprogressive concerns, but it seems strange for a concern with a reputation for ingenuity and highly developed manufacturing practice. These changes were not necessary because of the lack of ingenuity among the men responsible for the shop methods, but because those men were so restricted in their contact with the outside mechanical world that they could not take advantage of improvements made in parallel lines of work. The habit of conservatism had become so fixed with them that it prevented them from mixing freely with other mechanical men, and from giving and taking ideas which would have been mutually helpful. A policy which produces this effect is a detriment to any concern, no matter how large and strong it may be financially.

* * *

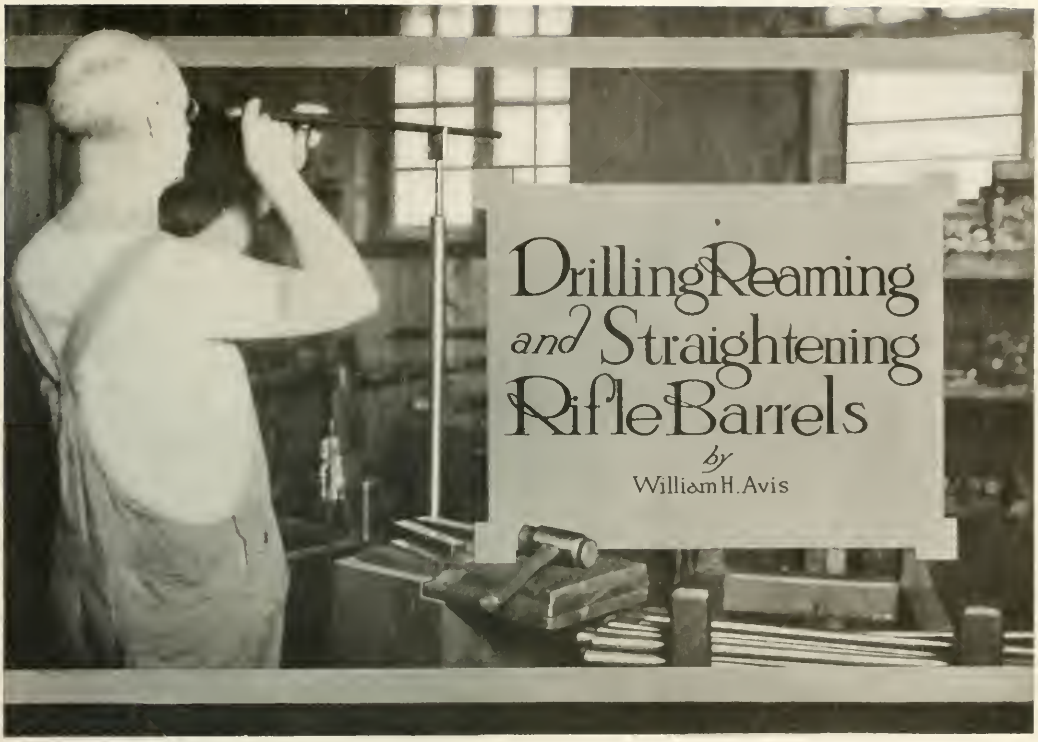
MATHEMATICS IN THE TOOL-ROOM

The value of clearly understanding the underlying principles of simple mathematics and trigonometry is not always evident to the toolmaker. He often relies on makeshift or graphical methods to get out of a difficulty when any question involving a mathematical calculation comes up. The cut-and-try process seems to the average toolmaker the only practical way of solving any problem that varies slightly from the ordinary run of tool work. He will spend hours arranging buttons to find the position of certain holes which could be quickly determined by a simple mathematical calculation and direct measurement.

An instance of this was recently brought to our attention. A toolmaker was given the job of laying out a multiple punch and die for blanking and cupping six blanks located diagonally in the strip, at one stroke of the press. The problem was to find the width of strip stock required to punch out six blanks economically. From experience this toolmaker knew that to get the greatest number of blanks from a given area the holes or circles should be laid out diagonally, and he set out to find their positions. Not realizing that they could be determined mathematically, he tried to find them by the button method, setting five buttons in a group having diameters equal to the blank plus the web. This took over a day, as the position of each hole had to be determined progressively; but a few minutes would have sufficed had he known that the distances of the holes from two given lines at right angles could be determined by finding the sides and bases of a series of right-angle triangles.

Where the work is laid out in the designing department and all essential dimensions given on drawings it is not so necessary that the toolmaker have a knowledge of mathematics as it is when he has to lay out the work for himself as he goes along. Many toolmakers point to this fact, stating that a knowledge of mathematics is useless to them. They overlook the inspiring fact that a toolmaker who has a knowledge of mathematics is unlikely to remain a toolmaker always, because his knowledge fits him for higher positions which he could not satisfactorily fill without it. Practical experience is absolutely necessary, but when coupled with a good technical education it is far more valuable to the possessor.

Lack of appreciation of technical journals and books which contain solutions of problems that come up every day in the tool-room is one of the reasons that many toolmakers lack the rudimentary knowledge of mathematics necessary to the successful prosecution of their work. A man who is looking out for his future should study as he goes along and read articles on the problems connected with his daily work.



RIFLE making experts in general concede that the most difficult part of a rifle to make is the barrel. A rifle with a barrel which is untrue is worthless; hence, the greatest care in manufacture is necessary in order to insure that this portion be as nearly correct as it is possible to make it. Should the interior of a barrel be out of alignment, the rifle would be unreliable and could not be depended upon to give accurate results under all conditions.

It can readily be seen from the foregoing that gun barrel making is a business in itself. As a matter of fact, there are factories where only gun barrels are manufactured and where no other gun parts are made, although there are no factories making other gun parts (except sights) exclusively. All the important operations on the barrel are carried on in the barrel department, although some of the minor operations are performed in other parts of the factory. The operations done in the barrel department are: cutting off the stock, outside straightening, centering, drilling, spotting, turning, reaming, straightening, grinding, finish-reaming, rifling, etc. All these operations are important and must be done correctly or else the barrel will never "make." Threading, sight-seat milling, slot-cutting, rifling, polishing, browning, and other operations, as well as proving under powder tests, are done in departments not connected with the barrel department proper.

Credit is due to Frederick Kutcher, manager of the American Gun Barrel Mfg. Co., New Haven, Conn., for many of the photographs and much of the data that has been herein incorporated. This company is the only firm in this country now making gun and rifle barrels exclusively.

Rifle Barrel Material

While rifle barrels were formerly made of mild steel exclusively, the modern military rifle barrel is made of a much tougher grade of steel, owing to the more exacting requirements of the modern powders as contrasted with the strength needed when only black powder was used as an explosive. Thus the nickel steel barrel has come to the front and no modern military rifle barrels are made of mild steel at present. The stock from which the barrels are made usually comes to the factory in long bars which vary in length and diameter according to the style of barrel to be manufactured. The general specifications for rifle barrel steel at the present day are: carbon 0.50; manganese, 1.00; silicon, 0.30; phosphorus under 0.015; sulphur, under 0.015.

Author's address: Whitneyville, New Haven, Conn.

Cutting off Stock

The first operation to which the bars are subjected is cutting off, the bars being placed two or three at a time in a cutting-off machine which is supplied with a gang of circular saws. Fig. 1 shows an arrangement for cutting off rifle barrels to their proper length, due allowance being made on the length to provide for errors that may be made in machining. This is a multiple saw of the Higley type, having blades $12\frac{1}{2}$ inches in diameter and 9/32 inch thick. The bars are clamped in place and are fed directly against the teeth of the revolving saws, the feed of the work being 5/8 inch per minute and the speed of the blades 10 R. P. M., which is equivalent to a cutting speed of 32 feet per minute. By means of a pump, a stream of oil is constantly directed onto the saws while the cutting operation is in progress, thus keeping them properly lubricated during the cutting-off operation. It is possible to arrange the saws so that barrels of various lengths can be cut off at the same time. A gang of eleven saws can be easily tended by one man with a helper.

Upsetting the Stock

After the stock has been cut into the proper lengths for barrels, it is upset at the breech end in order to bring it to the correct shape, after which it is ready for annealing. Two methods are used in upsetting the stock, viz., forging in a regular

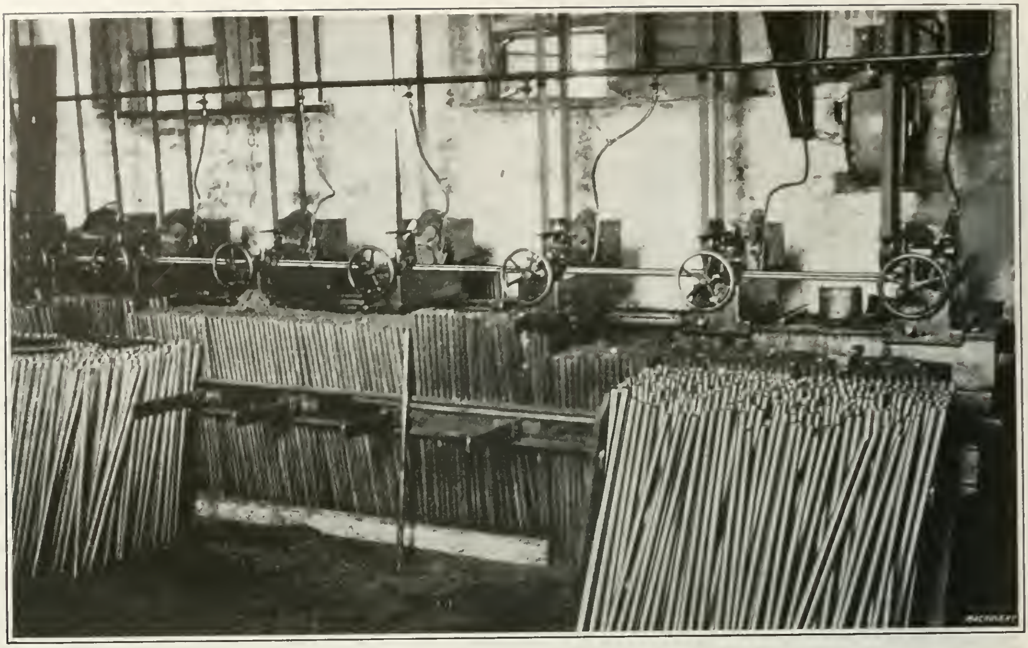


Fig. 1. Cutting off Stock for Rifle Barrels

forging machine and a process of rolling. In the factories where the barrel lengths are forged, the ram of the machine thickens and forms the butt of the barrel while the barrel is held lengthwise between two split dies. When the barrels are shaped by rolling, a pair of rolls is employed, these rolls having about six sets of various sized grooves, which are deep at the beginning and diminish as they progress around the rolls. As the deep cavity of the first groove in the roll comes around to the operator, he thrusts the end of the barrel stock into it and partially shapes it. By following this procedure with each set of grooves successively, the barrel is finally brought to its proper shape.

Annealing Barrels

After the barrels have been upset they are taken to the annealing furnace, where they are slowly heated to the critical temperature, which is dependent on the grade of steel being treated. They are then removed, packed in lime and allowed to cool slowly.

Outside Straightening

Before the barrels are sent to the drilling machines, they are looked over by a workman and any that are crooked on the outside are straightened by him. This process is called "outside straightening," and while it is important, it does not necessarily require an expert workman, as anyone of ordinary intelligence can learn to do it in a short time. If the straightening were improperly done and the barrels went to the drilling machines in a crooked condition, the result would be that the drills, in passing through the stock, would come out at one side instead of in the center, or that the walls of the barrel would be thick in some places and thin in others. Either of these conditions might result in disaster when the barrel was turned down to its proper size and shape in the turning lathe. In other words, a barrel which is not properly straightened on the outside might not "make" in the subsequent operations.

Butt Turning

After annealing, the barrels are taken to the butt turning machine as indicated in Fig. 2. In this operation, the barrel is placed through the spindle of a shaving machine and the butt end held in a split chuck while the end is turned down and made ready for the drilling operations. Some factories also center the butt end in order that the drill may enter the stock directly in the center when the drilling operation is started, while in other factories no centering is done.

Drilling Rifle Barrels

The drilling of a rifle barrel is an especially important operation for the reason that if a barrel is not properly drilled, it almost invariably finds its way to the scrap heap. In order, then, that this may not happen, it is absolutely necessary that the drills used be perfect, both as to gage and cutting capacity. The man who keeps the drills in proper condition, although he may not operate the machine, is called the "driller," and he must be a man having more than ordinary skill and intelligence. Highly skilled drillers who keep the drills in first-class condition are difficult to find.

Two types of drilling machines—horizontal and vertical—are in use today. One of the larger companies uses a vertical drilling press for barrel drilling, which was, perhaps, until recently, the most perfect press of its kind, and which is manufactured at the factory where it is used. These drilling machines have several secret attachments connected with them not found on other styles of drill presses. One of these attachments is a motor contrivance by which the drills can be speeded up from 1300 revolutions per minute to 3000 without necessitating a change of belting. When drilling nickel steel barrels, or 0.45 carbon steel, the speed at which the drills are run is about 1760 revolutions. For soft steel barrels, however, the highest speed obtained is about 3000 revolutions. The time necessary for drilling a high-grade steel barrel is from forty-five to sixty-five minutes, while the maximum speed at which soft steel barrels are turned out is about twenty minutes, according to the length of the barrel.

Under the drill presses at this factory, in the basement, an immense oil system is located, consisting of a series of reservoirs holding many hundreds of gallons of oil which is forced by pumps of high pressure through the whole drilling system. The pumps connected with this oil system develop pressure of 800 pounds or more, by which the oil is kept in constant circulation, passing through each drill and finally back to the great central reservoir in the basement. The drill chips which come from the center of the barrel are automatically carried out by the flow of oil and deposited in receptacles which are connected with the drilling system.

Fig. 2. Butt Turning Breech End of Barrel on Shaving Machine

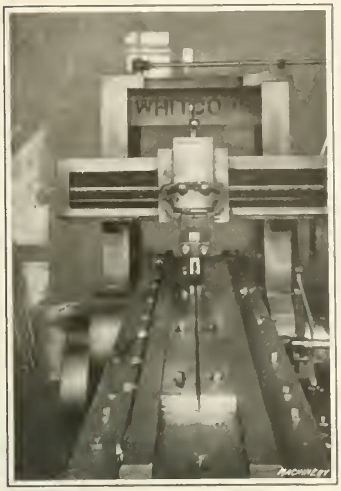


Fig. 3. Rolling in Drill Shank Groove on Planer with Special Fixture

Fig. 4. Gaging Accuracy of Gun Barrel after Reaming

Gun barrel drilling is a difficult operation on account of the extreme length of the hole as compared with the diameter of the drill and also because of the toughness of the steel in which the drilling must be done. In either horizontal or vertical drilling machines, the barrels are revolved and the drills held stationary. The vertical machines are a more recent development and are considered to have several advantages over the horizontal types, such as reduced floor space and better removal of chips. The horizontal type of machines is best known and will therefore be described here. Fig. 5 shows a Pratt & Whitney gun barrel drilling machine, while Fig. 6 shows a closer view of the work on the machine.

On this type of machine, two barrels are drilled simultaneously, there being two spindles, each of which is driven independently from an overhead belt. Beneath the spindles are worm-gears that carry motion to the lead-screws outside the two walls of the machine. These lead-screws can be seen in Fig. 6, and from each of these screws the corresponding carriage is operated. The feed of the carriages may be engaged or disengaged by hand-levers, and the disengagement is also automatically effected by a set of stops, as shown in Fig. 5. The rate of speed on a gun barrel drill depends on the quality of the steel which is being drilled. The barrels are usually drilled at a speed of about 1760 revolutions, as previously mentioned, and the rate of feed is about one inch per minute, which is about the maximum rate. The method of driving the barrel is by a contact on the muzzle end against the center of the spindle, while the other end is supported in a bushing as indicated in Fig. 6. The pump pressure, by means of which the oil is circulated through the drill when drilling, is of great importance, as this pressure must be sufficient to work out the chips along the passage provided for them so that they will not clog or cause other trouble. The shank of the drill rod is securely fastened in the chuck on the drill carriage at the end of the machine, while the tip or cutting end of the drill passes through a bushing at the center of the machine.

Shape of Drills

The shape of the drills used at the shops of the American Gun Barrel Mfg. Co. is the same as that used by other large manufacturing concerns. The shank to which the drill tip is brazed is the same shape as the drill, that is, half round, with a deep groove running from one end to the other, and having a crescent shaped hole which passes completely through the shank and drill tip. The method by which the groove in the shank is obtained is by placing the shank, which is a round thin-walled tube, in a special fixture and rolling in the groove under the pressure of a revolving wheel as shown in the illustration Fig. 3. This roll is forced down on the tube as the planer bed travels, thus compressing the metal and forcing it to take the form shown. The method of obtaining the crescent shaped hole in the drill tip is not the same as that employed on the shank. This tip is from $3\frac{1}{2}$ to 4 inches in length and is made of the best grade of high-speed steel. It is drilled through the center in its rough state before it is shaped up, the hole extending from end to end. The tip is then placed in a die and drop-forged to produce the groove from end to end in the tip. The displacement of the metal caused by forging in the groove causes the round hole to become crescent shaped. The tip is then shaped up and brazed to the end of the shank, after which the cutting end is ground to its proper shape by the operator. The method of forming the end of the drill tip and its tube is shown in Fig. 7, which represents a filing jig, in which the shank and tip are filed to correspond to the angular surfaces on the jig.

In grinding the drill tip, the practice varies somewhat in different factories, some claiming that the drill should be ground slightly below center so as to drill (as it is called) "for a wire," while others believe in grinding the drill tip on center in the usual manner. When drilling "for a wire," a slender thread of steel is left at the center of the barrel, and when the end of the drilling is reached a disk like that shown at *A* in Fig. 8 drops out. Care should be taken in the amount of feed used on the drill so that the chips may come out in such a way that they will be readily carried out through the groove in the drill shank without any tendency to clog. It is much better to have the chips like those shown at *B* in the illustration, which are fine and can be reduced to powder between the fingers, than to have them long as shown at *C*, for the reason mentioned. Medium grade oil is generally used in drilling barrels, although some manufacturers use a high grade of oil. It has been found, however, that the medium grade answers the purpose just as well as the higher quality and it is stated by some manufacturers that even better results are obtained by its use.

To obtain the best results in drilling rifle barrels, either of the military or sporting type, the very best judgment is necessary. When the drills are over-speeded or crowded, the result is a barrel defaced with drill rings and gouges from one end to the other. In addition, the operations which follow the drilling are retarded by attempts to save the barrels from the scrap heap. Judgment must therefore be used so that the drilling machines are manipulated in such a way as to produce the greatest amount of good work possible without overspeeding.

Varying Qualities of Steel

The quality of steel used in rifle barrels has a far-reaching effect on the drilling processes, and brands of steel which may

have been perfectly satisfactory at one time are often the cause of trouble at others. Single lots delivered at factories sometimes contain such variable qualities of steel that the greatest difficulty is experienced in working the stock up into barrels. Thus, in some shipments, part of the stock will run good while other portions will create trouble from the cutting-off process to the finished article. Soft and hard spots will be found in the stock and the drilling is therefore much handicapped, while the other processes such as straightening, reaming, grinding, etc., are also interfered with. In the working up of such stock, an inferior article is likely to be produced on account of the variable conditions under which the work is manufactured.

Reaming the Barrels

The first reaming operation usually comes just after drilling, but this is not always so, as some factories turn the barrel both before and after reaming. The tendency today is to do away with as many operations as possible and at the same time obtain the best results. Instead of using a medium or low grade of oil in the reaming operations, the highest grade of lard oil is used. The steel used for the reamers varies, a very excellent grade for this purpose being the "Gold Label Styrian" brand. The reamers used in this operation are fluted, and at the works of the American Gun Barrel Mfg. Co. a double reamer has been used with remarkable success. This reamer removes as much in one cut as was formerly taken in two. The construction of the reamer is such that it is smaller near the shank than it is at the other end, the part toward the shank being so proportioned that it will remove about 0.005 inch at one cut, while the second or finishing section removes 0.002 inch.

An illustration of a Pratt & Whitney gun barrel reaming machine is shown in Fig. 9. An enlarged view is shown in Fig. 10. The reamers are pulled through the work instead of pushed, as in drilling. The cutting edges of the first section of a double reamer are notched at regular intervals in order that the stock which is cut out of the barrel will not clog the cutting edges and cause the tube to "ring." "Ringing" a barrel means that under certain conditions a reamer, drill or boring tool cuts a deep circular hole below the otherwise level inside surface, thus causing a serious defect. The first section of a double fluted reamer contains only one-half the cutting edges of the second half. Reamers are not hollow like drills, and instead of the oil passing through the center of the reamer, it flows through the reamer shank into the barrel. The reamers do not revolve at the high rate of speed at which the barrels revolve while being drilled, but the operation of reaming is performed much quicker than that of drilling, because the feed is greater. Six Pratt & Whitney reaming machines will take care of the output of ten drilling machines. Each reaming machine holds two barrels, and one man is required to run from two to three machines, while two men can run ten drilling machines.

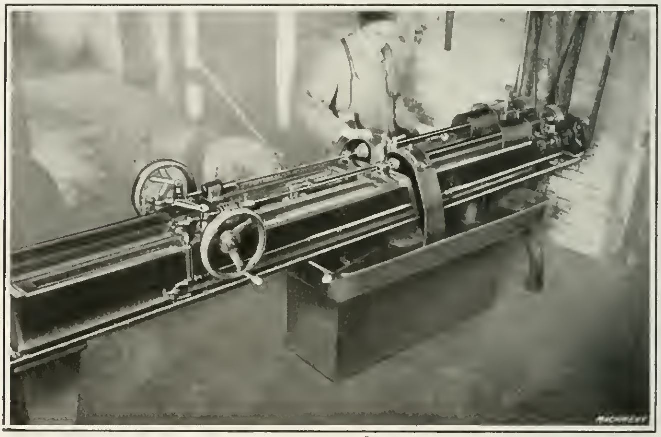


Fig. 5. Pratt & Whitney Gun Barrel Drilling Machine

The general construction of the Pratt & Whitney reaming machine will be understood by referring to Figs. 9 and 10. The drive is by a single pulley through gearing and a lead-screw, and a worm and bevel gears drive the two feed-rods. From these feed-rods the carriages are driven by bevel pinions and thrown out of gear by means of adjustable dogs. The head end of the machine is shown in Fig. 9 and reveals the bevel gears mentioned, together with some of the other details. In reaming, the barrels are clamped in the center of a long oil pan shown in the illustration, and are held by the butts while the reamer shanks are run through the barrels by sliding the carriages which contain the oil pans toward the head of the machine. The reamers are then fastened on the ends of the shank and the oil-pan slide is run back until the cutting edges of the reamer come in contact with the barrels, after which the machine is started. The reaming speed for 0.303 caliber is about 200 R. P. M., and the feed is about 4 inches a minute. As a general thing, the roughing reamer has four flutes, while the finishing reamer has six. It is very important to keep the reamers in first-class condition if good work is expected, and the services of a skilled mechanic are therefore required for this purpose. Close watch is required and the leeway allowed on finish-reaming is very small. An error of 0.00025 inch is sometimes sufficient to send the barrel to the scrap heap, providing the hole is that amount too large. The final or finish-reaming operation is done by practically the same method as that just described. Closer work and more skillful workmanship, however, are required on the finishing cuts than on the first cut, inasmuch as practically no leeway is allowed. On the finish cut all interior imperfections must be removed and the inside walls of the barrel must be made as clean and bright as the polished surface of a looking-glass, lest the keen-eyed inspector may discern some slight defect which would cause rejection of the barrel. Fig. 11 shows a group of drills and reamers used in the operations just described.

Reaming Gages

The gages used for the reaming operation are round and have a very slight taper. They are marked at intervals by fine lines which completely encircle them, and which indicate fractional parts of a thousandth of an inch. On account of the closeness of the work demanded, these gages are changed from time to time, and in the larger and more important small-arms factories, they are taken up weekly in order to discover and remedy any inaccuracies. The manner in which the reaming gage is used is clearly indicated in Fig. 4, which shows an operator testing the accuracy of a barrel that has just been reamed.

Forming and Turning Barrels

After the reaming operation, the barrels are taken to a turning lathe where they are spotted in the center preparatory to putting them on the barrel turning lathe. "Spotting" means that a cut is taken in the center of the barrel about 1 inch in length and to the diameter to which the outside of the barrel is to be first turned. The center-rests on the barrel turning lathe are brought up against this spotted center while the turning processes are in progress. The operation of spotting is clearly shown in Fig. 12. In turning the barrel after the spotting operation, the butt end is held by a dog while the muzzle is fitted to a center plug and the rest at the center of the barrel steadies it as indicated in Fig. 13. The two tool carriages, each of which carries a cutting tool, are now adjusted and each tool is started at the same time on the barrel, one at the muzzle and the other at the spotted center portion. The tool carriages feed toward the butt end of the barrel and remove about one-eighth inch

of stock during the turning operation. Over each cutting tool, a flexible hose is adjusted, through which a stream of soda water and oil is directed onto the cutting edge of the tool, lubricating and cooling it at the same time. Another stream of lubricant plays on the muzzle as it revolves on the center. Automatic adjustable knock-offs are provided so that when the two tools have reached the limit of the cut the feeds are knocked off.

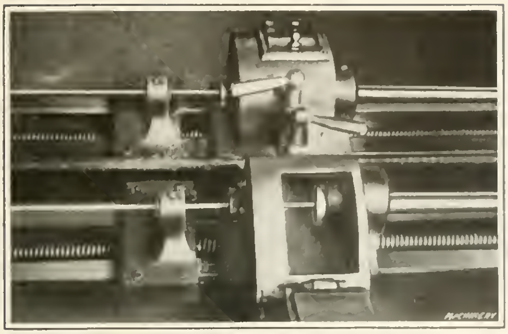


Fig. 6. Enlarged View of Drilling Machine showing Carriages

Forming Barrels

All rifle barrels are not of the same shape although military barrels of today are very similar. Thus in barrel turning, the turning lathe is equipped with formers of various shapes which conform in outline to the shape of the barrel to be turned. Fig. 14 shows a group of these forming plates, which are adjusted at the back of the lathe in such a manner as to act as guides for the tool carriage. In the majority of cases, the lathes used in these forming operations are equipped with two carriages as mentioned, although in some factories four or more cutting tools are used in order to increase the production as far as possible. The operation of turning and forming the barrels is clearly shown in Fig. 13, this illustration being obtained at the works of the American Gun Barrel Mfg. Co.

As a general thing, about one-eighth inch is taken off from a barrel at one cut and about fifteen minutes is the average

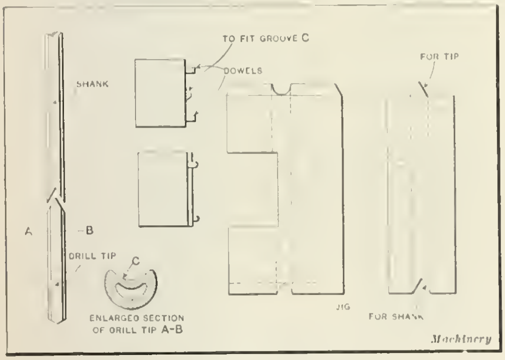


Fig. 7. Jig for filing Drill Tip and Shank

time required for turning. It must be understood that nice work is required in this operation, as the exterior surface of the barrel must be put in the best condition possible for the grinding operation. Grooves of any depth are not permissible and the turned surface must not show roughness to any extent. The cutting lubricant used for the turning and forming operation is generally a composition of soda water. The "Acme" compound (Cataract Refining & Mfg. Co.) is used by the American Gun Barrel Mfg. Co. as a turning lubricant. The speed of turning varies from 450 to 500 revolutions per minute and the rate of feed is about one inch per minute. It is of the greatest importance that the cutting tools used in turning should be very sharp, for there is nothing that will crook a rifle barrel more easily than dull cutting tools. Oftentimes the barrels are sprung through the use of dull cutting tools, so that when the barrel straightener has made the inside of the barrel straight and true, it is found that the outside is badly crooked and entirely out of shape.

Straightening Barrels

The straightening of the barrels is conceded to require the greatest skill of any operation in the manufacture of rifle barrels. As the writer of this article has spent nearly a third of a century in the occupation of straightening barrels, and as there has probably never been a comprehensive article written on this subject before, the operation will be treated exhaustively here in the hope that a real understanding of the method of rifle barrel straightening may be conveyed to the minds of the readers.

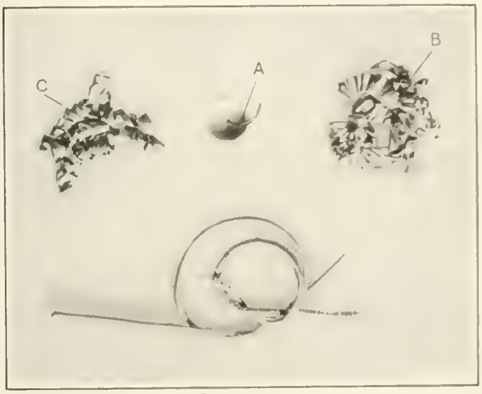


Fig. 8. Samples of Turning and Drilling Chips and Disk A removed when "drilling for a wire"

The first requirement for a rifle barrel straightener is the keenest and most perfect eyesight; in fact there must be positively no defect of any kind in the eye. One of the most peculiar features in connection with this is that no one knows whether or not his eyesight is sufficiently perfect for this line of work until he has tried to straighten rifle barrels. Young men who have supposed their eyesight to be perfect and who have never suffered from eye trouble of any kind, have endeavored to learn the art of rifle barrel straightening and have found that within a short time their sight has greatly deteriorated, so that they have been obliged to withdraw from the work in order to preserve their eyesight.

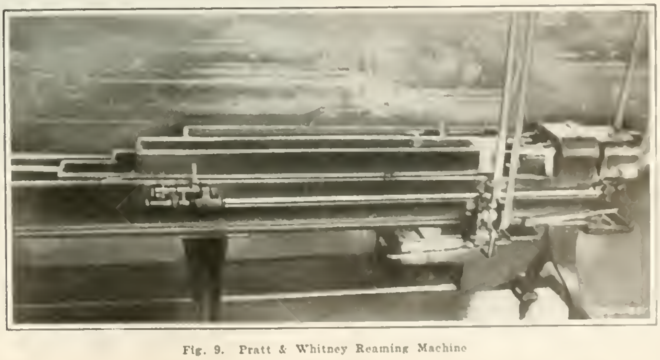


Fig. 9. Pratt & Whitney Reaming Machine

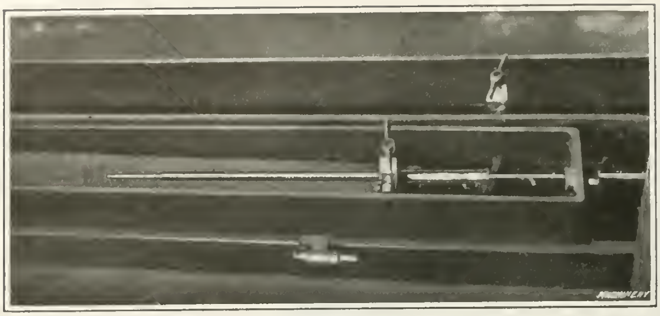


Fig. 10. Enlarged View of Reaming Machine shown in Fig. 9

It is not generally known that but one eye is trained in the art of barrel straightening, but in the writer's long experience as a straightener, he has met but one person who could straighten barrels by using either eye. To the average straightener, the inside of a rifle barrel looks as strange to his untrained eye as it does to a man who is not a straightener, and in order to straighten barrels by using the untrained eye, time would be required in which to train it to do the work. Despite the fact that only one eye is used in the straightening process, the barrel straightener never squints either eye but views the interior of the barrel with his trained eye while both eyes are wide open. It is amusing to a barrel straightener to see a person squint one eye in order to look through a rifle barrel. In connection with the straightening of rifle barrels, it should be said that there is no one living who can tell by the glance of an eye through the interior of a rifle barrel, whether or not the barrel is true so well as a straightener. The barrel straightener also learns by constant practice and training just how much can or cannot be done to a barrel.

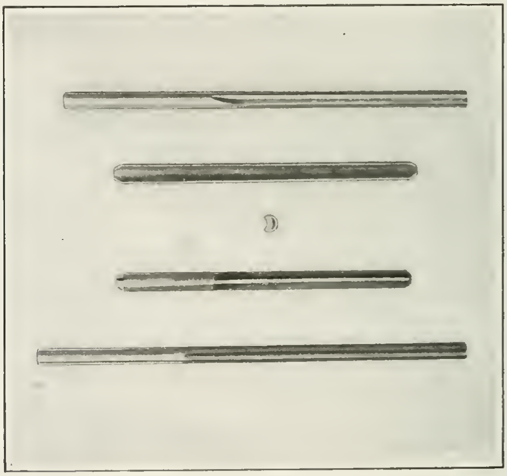


Fig. 11. Gun Barrel Drills and Reamers

In straightening a rifle barrel, the three important tools required are a shade, a straightening block and a hammer. The best light possible must be provided in order to produce the best results. Straightening shades should be placed in windows having northern exposure which insures a steady light all day long and eliminates those shadows that fall across the shade from surrounding objects when other exposures are used. The heading illustration of this article shows an ideal arrangement for rifle barrel straightening, in which the window shade consists of a ground glass window pane, one-half the size of a window, and fitted into the upper half of the sash. Across this ground glass pane, about in the center, a stick is fixed horizontally. This stick varies in thickness according to the distance of the straightening block from the shade. Thus, if the block is located a considerable distance from the shade a heavier stick is used than if the block is near the shade. At a distance of about twenty feet, the stick would be one-half inch in thickness in order to produce the necessary shade result in the barrel, as it is the shadow or shadows cast by this stick on each side of the interior of the barrel which indicate to the straightener whether or not the surface of the barrel is true and straight. Sometimes two sticks are fixed across a shade, one heavier than the other. This is in order that a heavy or a fine shadow may be used, according to the preference of the straightener. This is shown on the shade in the heading illustration.

The shadows on the inside of the barrel are two thin, dark lines, one on each side of the interior surface of the barrel and slightly below the center of the bore as indicated in Fig. 15 at *B*. These lines extend from the ends of the barrel nearest the shade to and slightly beyond the center, after which the shadows diffuse somewhat. To one unfamiliar with the interior of a barrel, the lines appear to extend back from the ends of the barrel only an inch or two, and practice is necessary in order to familiarize the eye with their appearance. Now if these lines run straight, as shown at *B*, it indicates that the end of the barrel where they are located is straight. However, should they diverge from a straight line and zigzag in various directions as the barrel is revolved by hand, as shown at *A*, it indicates that there are crooks in the barrel. When the appearance of these lines is anything but straight, the straightener is obliged to use his skill in overcoming the defects, and when the shadows are finally made to run straight on one end of the barrel the other end can be treated in like manner. When the shadows run straight on both ends, the barrel may be considered as being straight from one end to the other in its entire length.

The straightening block shown in Fig. 16 consists of a heavy base on which are fastened two narrow steel dies which converge at the left side of the operator. These dies are about 1½ inch in width and of hardened steel, in order to withstand the severe service to which they are put. The object of locating them in vee form is in order that the spot in the barrel where a long crook is indicated by the shadows, may be so placed that it will come about right on the dies. The reason for this is that the barrel must be straightened for a long distance when a long crook is encountered, and for only a short distance when the crook is short and sharp. The barrel is placed on these dies, while it is struck directly between them at a spot nearest the center where the first crook is located. The hammers used in straightening average about 5½ pounds in weight and are of mallet shape. Those used for rough-straightening, prior to the turning operation but after drilling, are of steel, while those used

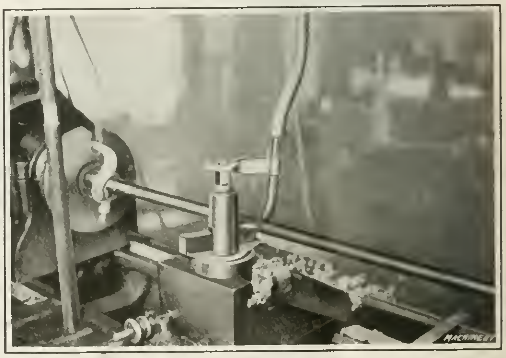


Fig. 12. Spotting Center of Barrel before Turning

after turning are of copper or babbitt. The copper hammers are to be preferred, because of their greater durability and also on account of the greater sensitiveness which the copper hammer gives, permitting the straightener to gage his blow to a nicety. In straightening a barrel, if it is struck at just the right place and with just the proper weight of blow, the crooks will be eliminated and the straightener can go ahead to the next defect, working always away from the center of the barrel toward the end.

It is absolutely necessary that the middle crook be eliminated before the next one can be operated upon successfully. In other words, each crook must be gotten out in its turn, beginning at the center of the barrel and working toward the end farthest from the operator. There are several methods of shading by means of which barrels are straightened, but the method which this article describes is one which is recognized as being the most advanced.* The shadows in a crooked barrel approach each other from each side of the interior of the barrel in places and diverge in other places. The point at which the shadows approach each other, is the proper place for the hammer blow to be struck, directly between the lines. If the blow falls just right, the line will spread and run true at that point, which will indicate that that particular crook has been eliminated. A little further on in the barrel, it will probably be found that the lines diverge or recede from each other, and it is important that the barrel should never be struck at this spot, for a blow between the diverging lines would cause them to diverge still more, which would mean that the crook would be intensified. By spinning the barrel around between the hands in the upright rest which is fixed as shown in the heading illustration, it will be found that directly opposite the place where the lines diverge they approach each other. Thus we have the same condition under which the first crook was eliminated, and a blow directed between the lines at this point, if properly struck, will also cause the lines to spread here, so that the second crook will be overcome.

This same method is followed to the end of the barrel and when all these crooks have been removed and the shadows run straight from the center to the end of the barrel, the other end may be operated upon.

Those who are not barrel straighteners are frequently fooled by the appearance of the shadows in the interior of rifle barrels when the surface is uneven. In this case they do not run straight, but in some places apparently run out of a straight line. No matter how the barrel may be turned and moved, this condition remains the same. In other words, the shadows look the same all around the interior surface of the barrel. The skilled straightener knows just what this indicates and he is also aware of the fact that all the pounding in the world cannot improve such a barrel in the least, for only reaming can eliminate this crooked appearance of the lines. In a case of this kind, if there should be enough stock in the barrel to permit a perfect leveling and smoothing up of the surface by means of reaming, it would be found that the lines would assume a straight and true appearance. This matter of uneven surface of the interior of a rifle barrel is one of the most unsatisfactory problems with which the barrel straightener has to contend, as the inspector who is not a barrel straightener himself, decides that the barrel is crooked on account of its appearance, and therefore sends it to the straightener to be straightened, when in reality it should have been returned to the reamer.

The difficulties of rifle barrel straightening vary with the caliber of the barrel and the quality of the steel used in its manufacture, the soft steel barrels being much easier to handle than those of the harder steel, such as 0.45 carbon or the regular nickel steel. The smaller the caliber of a barrel, the more difficult it is to straighten, and when small caliber and nickel steel are combined, then, indeed, the straightener has his hands full in getting out a satisfactory day's work. Perhaps there never was a more difficult barrel to straighten than the 0.23 caliber, nickel steel, Lee barrel which was made for the U. S. Navy at the time of the Spanish-American war. Added to the natural difficulties was the government inspection which was exceedingly rigid and severe. There are few military rifles, however, now used by any government in which the caliber is smaller than 0.30.

* The concentric ring method of observation in straightening rifle barrels is used in the Springfield Armory and abroad with very good results.—Editor.

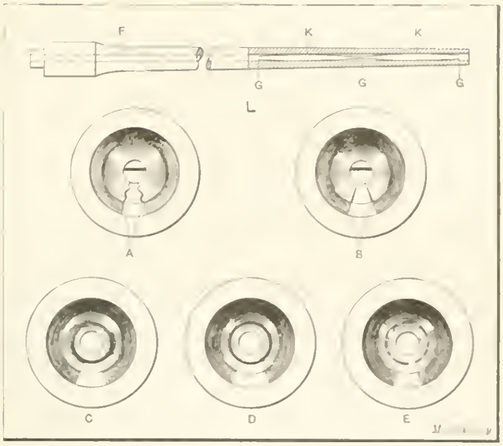


Fig. 15. Diagrams showing Appearance of Defects in Rifle Barrels


Fig. 14. Forming Plates used for Barrel Shapes

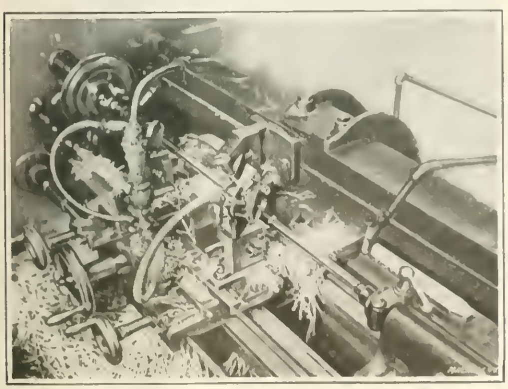


Fig. 13. Turning and forming Barrel

Straightening Machines

Before proceeding with a description of the hand straightening operations, it may be advisable to state here that in some gun concerns, principally abroad, straightening machines are used instead of the hammer and block. The writer has tried this method and can testify that excellent work can be done with the machine, but it is not nearly as fast as the hammer and block method. The impression prevails in some quarters

that anyone can run one of these machines and straighten rifle barrels with it, but this opinion is erroneous in the extreme, inasmuch as no one but a rifle barrel straightener can use such a machine, and while good work can be done in this way just as good work can be done and is being done every day with the block and hammer, it is doubtful if quite as difficult straightening can be done on a machine as with the hammer and block. It is admitted by those who use both methods that machine straightening is not nearly as economical as hammer and block straightening, and that one man can do fully as much work by the latter method as three can do on a machine. Machine straightening for shot gun barrels has proved more satisfactory than it has for rifle barrels, inasmuch as the former are much thinner and therefore can be bent more easily. Sharp, deep crooks in nickel steel barrels cannot be removed with any degree of swiftness by a machine and not nearly as satisfactorily as with a hammer and block. That fine work can be done on machines on barrels containing moderate crooks, however, is admitted by all experienced straighteners who have used them.

When barrels are straightened with a steel hammer after such operations as turning and grinding, hammer marks are invariably left on the interior, these being finally removed by reaming. When a barrel has been properly straightened on the inside, the outside should conform and be perfectly true and straight unless the turning has been improperly done. In order to discover whether or not the barrel is straight on the outside after it has been finished on the inside, it is placed in the centering machine and spun rapidly with the hand. If true and straight, the barrel will run true, but if the barrel should wobble during this test, it is evident that the outside is not true, and if very bad it is rejected and scrapped.

Defects in Rifle Barrels

Many times the interior surface of a barrel is marked by a ring caused either by the drill or reamer wearing a circular hole in the surface. Sometimes the defects are slight, while at other times they are very pronounced. When the rings are slight, a reamer cut will generally clean them out, but when too deep to be eliminated by reaming they are "set in" by the straightener in such a way that the final reaming will remove every trace of the defects. "Setting in" a ring means that the straightener locates the exact spot of the ring, and by hammering completely around the barrel at that spot while the barrel rests directly on the die, he raises the ring above the level of the interior surface so that when the reamer cut is taken only the raised surface containing the ring is cut out and the defect is thus removed.

The straightener soon learns the difference between a reamer ring *E*, a drill ring *D*, and a powder swell *C*, shown in Fig. 15. The reamer ring is invariably a succession of nicks or gouges which completely encircle the interior surface of the barrel at the spot where they are located. On the other hand, the circular cut of a drill is likely to be clean, deep and startlingly pronounced. A powder swell is indicated by the "downhill" like appearance of its nearer and farther edges which dip gradually to its extreme depth directly in its center. The edges of the swell are always smooth and the general appearance of the swell itself is smooth. This powder swell is produced during the testing of a rifle barrel, and is really a failure of the barrel to stand the strain of the test. The "proof-test" is always made before the barrel is rifled and the powder charge is much heavier than that used in regular service.

One of the greatest difficulties with which the straightener has to contend is the variation in some of the stock from which rifle barrels are made. In places the stock is found to be hard, while in other places soft spots occur. The result is that the straightener gages his blow on a crook as he judges it should be, but in the event that there is a soft spot at that particular place in the barrel, the blow is too heavy, with the result that the barrel is made more crooked than ever. A condition of this kind always results in much hammering that could have been avoided had the operator known of the soft spot beforehand. On the other hand, when a hard spot is encountered, no damage is done, as the blow is not heavy enough to cause the barrel to assume a more crooked shape. Hence, the crook is not disturbed and the next time a harder blow is struck which may be just hard enough to make the crook disappear. There is no way of discovering this irregularity of stock until the hammer falls upon the imperfect spot.

The upper diagram *L* in Fig. 15 represents a barrel with one-half perfectly true, as indicated by the dotted lines at *F*, and the other half with crooks at *K*, which are shown somewhat exaggerated in the sectional view. When straightening crooks, the barrel must always be struck at intermediate points such as *G*, but never at points *K*, as this would intensify the defect.

Final Straightening

The straightening thus far described is done on barrels between the various operations mentioned and a steel flat face or nearly flat face hammer is used. It is the straightening between the operations mentioned which is most likely to crook the barrel, and which takes place before the barrels reach the chambering or rifling stage in the manufacture. It is generally considered that there are no operations hard enough to crook barrels after they have passed beyond the grinding stage, but it has been found that barrels are crooked at times even after they are rifled and that because of thus being crooked, they fail to shoot as accurately as they should. Such barrels have, as a general thing, also passed the browning operation, and in handling they must not be bruised in the least either externally or internally, so that it is an exceedingly difficult thing to straighten the barrels under these conditions; yet a skillful straightener can put them in first-class condition even when they have reached this stage.

Fig. 16. Straightening Rifle Barrel

Such barrels are straightened on copper dies, a rawhide or copper hammer being employed. The barrels are wrapped in paper which is glued in several layers around but not to the barrel itself. The blow of the rawhide hammer on the paper leaves no mark on the barrel, either inside or outside, nor do the copper dies bruise the barrel, so that when carefully done it is found that the defect has been overcome and that the barrel is once more in good condition. The opinion is general among first-class straighteners that all rifle barrels should be looked over in their finished state and that those which need retouching should be attended to in this way before they are sent away from the factory to the market.

Grinding Barrels

When the barrels have been properly straightened, after the finish-turning, they are sent to the grindstone to be ground, and after the grinding operation they are reamed again, after which they are ready for the finish-straightening. If properly ground, the straightener has simply to touch them up and correct any slight imperfections that may be found. They are then sent to the finish-reaming machine which cuts the interior surface to the exact size required before the barrels are sent to the rifling machine. Two methods are now in use for grinding the barrels. One is that in which large stones of great weight are employed and the other is by means of automatic grinding machines. Each of these methods has

its advantages, but there is no doubt that barrels can be ground more expeditiously on the large stones than on the smaller ones of the grinding machines, especially when the grinder using the large stone is an expert at his work. When this is not the case, however, the barrels may be badly crooked both externally and internally, which makes it necessary for the straightener to do considerable work in order to bring them back to condition once more, and at the same time makes much work for the filers in filing out unnecessary hammer marks and other defects on the outside surface of the barrel.

The grindstones generally used in the operation of grinding rifle barrels are from five to six feet in diameter and from twelve to fourteen inches face width and weigh from 3500 pounds to two tons each. They are swung on an iron frame of great strength, and when in operation revolve at about 185 R. P. M. Fig. 17 shows an operator engaged in grinding a rifle barrel, using a steel rod passed through the bore of the barrel from the butt toward the muzzle. The butt end of the rod tapers which causes the rod to grip the barrel at this point. The rod is equipped with a handle on which a hollow wooden grip is fixed. This handle is grasped by the operator who places the barrel in a shoe set parallel with the horizontal axis of the grindstone and distant an inch or so from the face. The grinder now presses the long lever with his hip, which forces the shoe toward the face of the stone by means of a toggle action, and as the barrel touches the stone, the grinder turns the handle of the rod on which the barrel is held so that it is revolved against the face of the

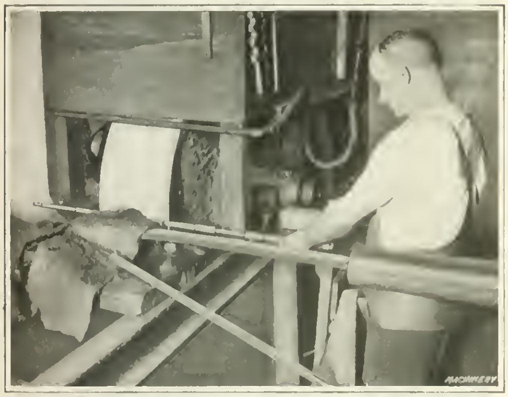


Fig. 17. Grinding Outside of Rifle Barrel

stone in the opposite direction to that in which the stone is revolving. The barrel is always ground from the center toward the butt, then from the butt toward the muzzle, working it across the face of the stone until it has been ground for its entire length. During this operation, a steady stream of water plays on the surface of the stone, which prevents the barrel from burning, and also prevents the stone from glazing. Furthermore, the water makes the stone cut faster by acting as a lubricant.

Grinding the exterior surface of rifle barrels removes all the defects and imperfections left by the turning process as well as the hammer marks caused by the various straightening operations which have preceded the grinding. An expert rifle barrel grinder has acquired through long experience a sense of touch which tells him the amount of pressure necessary to use in bringing the barrel into contact with the stone. A careless grinder, however, may press the barrel too hard against the stone and thereby cause it to buckle and bend. The average amount of stock removed from the barrel during the grinding operation is about 0.010 inch. A snap gage and gaging board are used to determine the proper size for a barrel when finish-ground, the barrel being laid on the gage board and gaged at the butt, middle and muzzle. After the barrels have been ground to their proper size, they are washed in limewater to prevent rusting.

As the face of a grindstone wears down, hard pebbles are often encountered embedded in the surface of the stone; unless these are removed, trouble is likely to be caused by these stones marking the outside surface of the barrel. As soon as a pebble is discovered, the stone is stopped and the pebble cut out by the grinder, using a cold chisel and hammer in the operation.

Military rifle barrels may be made either with or without forged front sight lugs. In some factories, muzzle sight lugs are brazed on the barrel just before the finish-reaming operations, between finish-reaming and finish-straightening. There is a difference of opinion as to which method is the better, as the brazing on of these lugs is likely to crook the barrel, thus making it more difficult to straighten in the final straightening operation. The writer is in favor of the latter method, however, inasmuch as the barrel is in better shape to straighten at the muzzle through all the first operations when the muzzle is free of a sight lug than when the lug is forged on. The hardest part of the straightening is always found in the early operations on rifle barrels, and many times crooks are met with directly under the forged lug which are almost impossible to eradicate because the lug is in the way. When, however, the brazing of the lugs takes place just before finish-straightening, the crooks are much easier to knock out than if they have been encountered during the earlier operations.

Inspection before Rifling

After the rifle barrels have been finish-reamed, they are subjected to the final inspection for reaming and straightening, consisting of the following operations: interior gaging, leading, shading and surface inspection. The gaging operation is for the purpose of determining whether or not the bore of the barrel is true to the size required, as the slightest variation one way or the other may mean the rejection of a barrel, especially if it is over size. If under size, however, it is sent back to the finish reamer who reams it to the exact size. The leading operation is done by pushing a lead bullet through the barrel by hand, a brass rod being used for this purpose. In the slow passage through the barrel, the bullet which fits the bore snugly must not meet with any obstruction from one end to the other. Should there be any resistance, even the slightest, the barrel is rejected and returned to the finish reamer who removes the imperfection. Just so is the barrel rejected in the shading operation, which determines whether or not the barrel is crooked or straight. When found to be crooked, it is up to the straightener to retouch and make the barrel straight. The slightest defect on the interior surface of the rifle barrel, such as rings, poor surface gouges, scratches or markings of any kind whatsoever, which can be discerned with the naked eye, will cause its rejection and it will be returned to the finish reamer or straightener for corrections.

Rifling Barrels

After the barrels have passed the various inspections for workmanship successfully, they are passed along to the rifling machines where the grooves are cut which cause the bullet to rotate in its passage through the barrel. The number of grooves in rifle barrels varies from four to six or even seven in some instances. The twist also varies in different makes and models of barrels, some making a complete turn to every ten inches, and others requiring thirty-six inches in order to make a complete turn. The operation of rifling is done on specially constructed machines and will not be described in detail in this article.

Other Operations on Barrels

After the barrels have been rifled, they are again inspected and given a thorough leading in order to remove all rough edges and smooth down the grooves. In some factories the operation is done by means of tools worked by hand while in other factories machines are used. Whether done by machine or hand, the operation is the same, as a lead slug which is cast to fit the bore of the barrel is worked back and forth through it, after it has been charged with fine emery and oil. After the leading operation, the chambering, threading,

slot-cutting and extractor-cut operations are done. In the chambering operation, five tools are used; a counterbore, two roughing reamers, a heading tool and a finish-reamer. A "Ball" speeder is then used to take out the burr at the beginning of the rifling grooves, beveling them to the right shape just where the bullet protrudes from the end of the barrel. In the finish-reaming operation on the chamber, the work is done by hand in some factories and on a chucking machine in others. The workmanship required in the cutting of the extractor slots must be exceptionally good because a fractional part of a thousandth of an inch out of the way may mean spoiling a barrel. Poor workmanship here would mean that the cartridge might not fit as it should in the chamber or that after the rifle had been discharged the shell could not be extracted.

The slot-cutting operation is sometimes done before rifling and the threading operation on the butt of the barrel is almost invariably done after rifling. The extractor cuts are made after chambering, and the sight studs are machined before rifling. Then comes the muzzle finishing, which is done partly by machine and partly by hand, the barrel being left longer in the rough state than is really necessary, in order that there may be no mistake in the final finishing.

Polishing Barrels

Military rifle barrels are polished on wheels which run at very high speeds, the larger wheels running at the rate of 3500 R. P. M., while the smaller ones attain an even higher speed than this. The wheels used for polishing have a wooden center and are covered with leather, the leather being coated with glue on which a heavy coating of emery is sprinkled. For rough polishing, No. 60 and 70 emery is used, and for finishing No. 90 is used. Plugs or handles made of metal are stuck into the muzzle and butt of the barrel when it is ready to be polished and fit snugly into the rifle grooves so that the barrel will not turn on the handles and injure the rifling. The handles spin in the hands of the operator at the same high rate of speed at which the barrel is spinning, but as these handles are very smooth the operator's hands are not injured by the friction. At one time the work of polishing was done exclusively by men, but at the present time women as well as men are employed in this part of the work. After the barrels are polished, they are ready for the browning operation, which is the final stage through which the barrel passes before it is assembled.

All military rifle barrels are subjected to a high powder test before, and a target test after, rifling. The first test varies according to the grade of steel in the barrel, high nickel steel barrels being tested with a powder charge which would burst a low-grade steel barrel. The test charge includes a heavy leaden slug, and the combination is from two to three times as heavy as the charge which would ordinarily be used in service. Should there be seams in the stock or other defects, the first test preceding the test after rifling, which is made with the regulation charge in order to determine the accuracy of the rifle, will bring them to light.

Browning Barrels

The final operation to which rifle barrels are subjected before they are ready for the assembling room is that of browning. While the finished barrel is blue in color and not brown, the operation is called "browning" because the barrels have to be rusted on the exterior surface before they can be blued. The coating of rust is obtained by covering the outside of the barrel with a browning mixture which causes it to rust after it has been baked in an oven heated by coil steam pipes. The air in the oven is moistened by perforated steam pipe through which the steam is allowed to escape into the oven. Before the rifle barrels are run into the hot oven for baking, they are subjected to a number of other operations, the first of which is wiping. In this operation the barrels are thoroughly wiped in order to relieve them of every particle of grease or other foreign substances and are then placed on circular iron trucks which are made to hold fifty barrels at a time. The truck and barrels are then placed in an upright caustic soda tank where they are boiled for about fifteen minutes. From this tank they are taken to another, where they are thoroughly rinsed so that every particle of grease and oil is removed and the barrels are ready for the spongers who apply the browning solution.

It is well to state here that the most successful rifle barrel browners have their own secret formulas which are jealously guarded so that only the browners themselves know the exact proportions of the mixtures. It is no unusual thing, therefore, to find barrel browners who have held their positions for many years, on the strength of their knowledge in this respect. One of the oldest and most satisfactory formulas for browning rifle barrels consists of the following mixture:

Spirits of wine	5 ounces
Spirits of niter	8 ounces
Tincture of steel	8 ounces
Corrosive sublimate	4 ounces
Blue vitriol	4 ounces
Water	1 gallon

The barrels are kept in the oven for four or five hours and when taken out are heavily coated with rust. They are then immersed in a third tank of chemicals for fifteen minutes, a secret formula often being used at this stage. A preparation which will give excellent results, however, is as follows:

Tincture of muriate of iron	1 ounce
Nitric ether	1 ounce
Sulphate of copper	4 scruples
Rain water	1 pint

If the process is to be hurried, two or three grains of oxymuriate of mercury can be added. When the barrel is finished, it is placed in limewater for a short time to neutralize any acid which may have penetrated. The barrels are now ready for carding, which is done on a 14-inch wheel having a face 3 inches wide covered with carding cloth. This wheel revolves at about 1600 R. P. M. and the man who does the carding stands at the back of the wheel and presses the barrel against the rim. After the barrels are carded they are returned to the spongers for a second coating of the browning solution. The operations of boiling and scratching on the carding wheel are continued until all the pores of the steel are thoroughly coated and their condition is satisfactory to the inspectors, who give them a most rigid examination. After using the scratch brush, the following formula can be used:

Shellac	1 ounce
Dragon's blood	25 ounces
Rectified spirit	1 quart

Or:

Nitric acid (specific gravity, 1.2)	1 part
Nitric ether	1 part
Alcohol	1 part
Muriate of iron	1 part

The above ingredients are mixed together, after which 2 parts of sulphate of copper and 10 parts of water are added.

After the barrels have been passed by the inspector, they are taken to the assembling room where they are assembled with the other parts. Many persons suppose that the browning of a barrel is done for the sake of appearance, and while this is partly the reason, the principal object is to preserve the barrel and prevent rusting. Were it not for the care taken in the browning operation, rifle barrels would not last nearly as long as they do.

* * *

ANALYSIS OF 1916 AUTOMOBILE ENGINE DESIGN

An analysis of motor car engine design made by *Motor* shows that 71.1 per cent of the 1916 model cars have the L-type of cylinder; 12.3 per cent, T head; 12.3 per cent, valves in the head; 4.4 per cent, sleeve valve or "Silent Knight" type. The cars are classified as 44.7 per cent four-cylinder; 41.1 per cent, six-cylinder; 11.6 per cent, eight-cylinder; and 2.6 per cent, twelve-cylinder. A higher revolution speed has been obtained either by using alloy pistons, which is being done only in comparatively few cases, or by reducing the thickness of the cast-iron pistons. The aluminum alloy piston introduced by a few concerns in their stock motors has worked out well. Connecting-rods have been lightened also by reducing the cross-section and by using stronger material. In some cases tubular connecting-rods are used.

SURFACE SCRAPING AND SURFACE PLATES

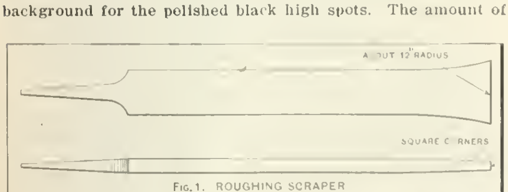
BY BRYAN T. HAWLEY*

The writer, who has worked in several shops with French, German and Swedish experts with the file and scraper, and who himself has had much experience in scraping machine parts, read the question and answer in regard to practice in surface scraping in the January number with much interest, and although the practice of scraping has been so generally eliminated by the use of precision machinery, grinding machines and American haste that it seems almost like a lost art, he will give the readers of MACHINERY the benefit of his experience and observation.

When the part to be surface scraped has been machined, it should be scraped once or twice all over before the color is applied. The common color compound is oil mixed with lampblack, Prussian blue or red lead. Lampblack mixed with lard oil and applied to the surface plate is used by patternmakers for woodworking mostly, but it is good also for marking metal surfaces for rough scraping. Prussian blue paste in tubes is smooth and convenient to use, but a small amount of lard oil mixed with the paste improves it. The Prussian blue mixed with oil should be applied to the surface plate and the high spots of the work are marked with the blue. Red lead mixed with mineral machine oil to the consistency of putty is the best mixture for all-around surface scraping and for fine spotting in particular. Lard oil can be used instead of mineral machine oil when the mixture is applied to the surface plate, but on account of its smeary nature it is undesirable to apply it to the work, on which a dull red lead surface is required which shows the high spots black and shiny when rubbed with the surface plate.

The mixing of red lead requires some patience, as the lead and oil do not unite readily, and considerable pounding, stirring and kneading are required. The mixture should be worked until it is smooth. When the compound is kept in a receptacle such as a hand soap can, it may be allowed to dry out some and then used like shoe or stove polish, mixing in as much machine oil as is required at the time.

For rough scraping, apply red lead generously to the surface with a rag, using machine oil as needed to assist in spreading. When an even coating has been spread, place the surface plate on the surface to be scraped, rub a little and remove. The high spots will be clearly defined by the red markings. This is the best way to show the bearing spots. When the spotting shows fairly uniform all over, the process should be reversed, applying the red lead and oil to the work in a somewhat drier form, with the object of attaining a dull red coating which, when rubbed with a clean surface plate, will make a good background for the polished black high spots. The amount of



Figs. 1 and 2. Unforged Roughing and Forged Finishing Scrapers made from Old Files

red lead should be gradually reduced and a little gasoline should be mixed with it to act as a drier, finally using just enough red lead to dull the surface without coloring it. This procedure will show the true high spots. They will be small, to be sure, but no false bearing will appear, which is likely to happen if the surface plate is kept colored.

* Address: 608 W. Brighton Ave., Syracuse, N. Y.

There are many forms of scraping tools used. It is common practice to use old fourteen- or sixteen-inch flat files, simply ground as desired and stoned to edge. The accompanying illustrations Figs. 1 and 2 show side and edge views of an unforged roughing and a forged finishing scraper. Forging the finishing scraper is worth while if a forge is convenient. The main difference in the finishing scraper is that the cutting edge should be more obtuse, giving less clearance and less rake.

Surface plates are apparently costly when looked on as simple pieces of cast iron, but they are accessories well worth

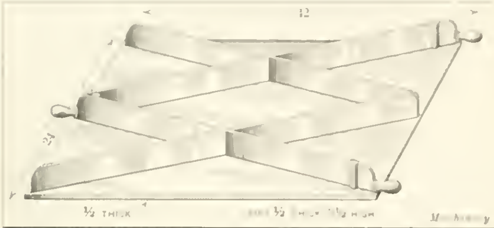


Fig. 3. Light Surface Plate with Ribbed Back

their cost in any up-to-date machine shop. Often machine parts are set up to be planed or shaped when the surfaces machined could be quickly filed and scraped at lower cost if a surface plate were available.

A long time is required to season cast iron to the state that will entirely eliminate warping, and even a well seasoned surface plate has to be scraped occasionally. It should be very thick and heavy, considering the area. Shops that have considerable use for surface plates will find it a good investment to make a pattern for a convenient size surface plate and have three castings made from it. With these three plates planed, a good mechanic can finish the surfaces of all true without the use of a master surface plate, and produce plates as accurate as can be supplied by any of the well-known makers of small tools and shop accessories. The home-made surface plates would have the advantage of having the size and weight best suited to the conditions in that shop, and they need be not more than one-fourth as heavy as a surface plate would necessarily be which could not be checked up often. A convenient surface plate is 24 inches wide by 42 inches long, ribbed on the back and provided with three handles, two on one end and one in the center at the other end, as shown in Fig. 3. Two men can handle this plate when necessary without tackle, its weight being about 200 pounds. This weight no doubt will seem very light to some mechanics, but as the writer has used surface plates of these proportions and weight with satisfaction for several years, he feels justified in recommending them to others. Surface plates should be made of close-grained gray iron and machined at least one month before scraping. Several months of seasoning will be required before they can be depended on for very accurate surfacing, but as long as three plates are used, they can always be resurfaced accurately. Following is the method employed for obtaining a truly flat surface on three plates without using a master plate.

Numbering the surface plates 1, 2 and 3, respectively, we scrape the three plates smooth, removing all tool markings; then put red lead on plates Nos. 1 and 2 and roughly scrape them together, with the object of eliminating all rocking. Now put red lead on plate No. 3 and roughly scrape it to fit plate No. 1. Plate No. 1 may be concave and plate No. 2 convex, and yet both rubbed together would show a good bearing, and plate No. 3 also may show a good bearing with plate No. 1. But plates Nos. 2 and 3 will be imperfect in opposite ways and to about the same extent. The next step is to scrape Nos. 2 and 3 together, taking off as nearly as possible the same amount of metal from each until a fairly good bearing is secured. Next scrape Nos. 1 and 2 together and 1 and 3 will be found imperfect to the same extent, but in opposite ways. Now scrape these together, taking the same amount off each, and follow this order of operations until a good bearing is shown on all.

METAL CUTTING WITH OXY-ACETYLENE GAS*

A REVIEW OF PRACTICE OF CUTTING METALS WITH ACETYLENE OR HYDROGEN FLAME

BY S. W. MILLER†

To the general public, the method of cutting steel by the use of the oxy-acetylene torch is probably better known than the operation of welding. It certainly is more spectacular, on account of its application to the wrecking of burnt steel frame buildings, obsolete bridges, etc., which is work that is generally done in view of a large number of people. As a general rule, the cost of cutting by this process is less than by any other means, and in some cases the saving effected is very great. For instance, in armor plate plants, it is common practice to cut 16-inch armor plate at the rate of nineteen feet per hour, a speed which cannot be attained by any other process. This is done at an expense so low that it is not comparable with the cost when done by ordinary machines. The time element enters largely into such cases, as well as the fact that irregular shapes can be produced as readily as straight lines.

The principle of oxy-acetylene cutting is based on the fact that if a piece of steel or iron is brought to a red heat and a jet of pure oxygen is turned against it, the metal will be oxidized or will burn. It is frequently thought that the process is one of melting the metal. This is not correct, as the metal is simply burnt away where the jet of pure oxygen comes in contact with it. In other words, it is simply an intensified form of oxidization or rusting.

The Cutting Torch

The ordinary cutting torch consists of a heating jet using oxygen and acetylene, oxygen and hydrogen, oxygen and coal gas, or in fact, any other gas which when combined with oxygen will produce heat. By the use of this heating jet, the metal is brought to a sufficiently high temperature and an auxiliary jet of pure oxygen is turned onto the red hot metal, when the action just referred to takes place.

The early form of torch for cutting was generally an ordinary welding torch with an extra tube carrying the auxiliary oxygen at the necessary pressure, which was clamped to the welding torch when it was desired to cut. Of course the cutting jet has to follow the welding jet, and hence such torches were unsatisfactory, because it was necessary to turn them around when the direction of cutting was changed. It was also difficult to bring the cutting jet as close to the welding jet as desirable. Later the auxiliary jet of oxygen was placed between two or more welding jets in one tip, so that no matter what the direction of the cut, the torch could be held in the same position, making it more convenient for the operator and consuming much less time.

The Operation of Cutting

The operation of cutting is one that is very readily learned. The difficulty increases considerably with the thickness of the metal, but for all ordinary thicknesses, a few hours' instruction will enable good and economical work to be done. It is impossible, however, to cut very smoothly by hand, as the torch cannot be held sufficiently steady to do work which requires great accuracy. Cutting machines have therefore been produced which not only cut straight and clean, but also make a very narrow kerf, which, of course, implies a considerable reduction of the oxygen used, as compared with that consumed in hand cutting.

The principal difficulty encountered in cutting is the presence of scale, rust, paint or other foreign matter, which will not burn, or which interferes with the passing away of the slag or oxide formed during the process. It is therefore advisable, and in many cases absolutely necessary, to remove these substances before doing the work. For example, in cutting up old boilers in a district in which the water contains lime or other impurities, it is almost certain that the inside of the boiler sheets will be coated with scale. This scale must either be removed by pounding the outside of the boiler with a sledge at the points where the cuts are to be made, or it must be chipped off from the inside. In the case of bridges with several heavy coats of paint, it is sometimes necessary to remove part of it by burning off with an ordinary gasoline torch, or by some other method. Not only is time saved by doing this, but the consumption of oxygen, which is very much greater in cutting than in welding, is greatly reduced. Without exception, it pays to take the precaution of removing such foreign matter.

In cutting a comparatively thin piece, say ½ inch thick, a beginning can be made at the top and edge of the piece by holding the heating flame at that point, and as soon as the metal becomes red hot, turning on the auxiliary jet of oxygen. The thickness is not sufficient to prevent the slag from being blown out through the bottom of the cut, which is necessary in all cases. It is evident, however, that in the case of a somewhat thicker piece, it would be advisable to begin at the bottom of the edge instead of at the top, so that the slag would be sure to be blown out and fall through easily. It is apparent that the thicker the piece, the higher must be the pressure of the auxiliary jet of oxygen to force the slag out. It will also be clear that unless the slag is kept in a melted condition, it will clog the bottom of the slot and stop the proper action of the torch.

Any lack of continuity in the piece being cut, such as a blow-hole in a steel casting, will make it impossible to cut through the piece. This is the reason why it is more difficult to cut through two or more pieces of sheet steel riveted together than through a single piece of the same thickness. The mill scale on steel sheets is not generally removed when they are riveted together and this breaks the continuity of the metal in the joint.

It has been found possible, however, to cut as many as twelve or fourteen pieces of material, ¼ inch thick, if the scale is cleaned off and the pieces clamped together tightly. This can be done by hand only with difficulty, although it is readily done and a smooth, clean and uniform cut obtained when the work is done on the "oxygraph" or a similar power-driven machine. The possibility of cutting a number of pieces at the same time reduces the expense of such work materially, and makes profitable some operations which, if they had to be performed on single sheets, could not be done economically on account of the high cost of labor and gases.

In view of such difficulties as blow-holes in steel castings, scale on sheets, etc., it is generally unsafe for a welding shop to make a flat or contract price on any cutting job, even after an inspection of the work to be done. A better plan is to cover the labor charge and overhead expenses, profit, etc., by an hourly rate, and make a reasonable charge for the gases used. The gas consumption cannot be determined except by separating the gases used by the heating and auxiliary jets, respectively. A fairly accurate figure for the gases used by the heating jets can be obtained from the manufacturers of the torch, but the oxygen used in the auxiliary jet will vary so much, due to the opening and closing of the valve and the change of pressure necessary for the requirements of the case, that it is impossible to do any more than guess at the amount consumed, by reading the gage on the oxygen tank. Of course in the case of a long job, the total amount of oxygen can be obtained quite accurately from the number of tanks used, but this cannot be used as a basis for other jobs without considerable risk.

Metals that can be Cut

Only wrought iron and steel can be cut by the oxy-acetylene flame. An appreciation of the real action which takes place during the cutting of iron or steel will make clear why cast iron and other metals cannot be cut. If a very thin strip of steel, such as a watch spring, be heated red hot and plunged

* For further information on oxy-acetylene welding, see "Oxy-acetylene Welding Practice," in the March, 1916, number of MACHINERY, and articles there referred to.

† Address: Rochester Welding Works, Rochester, N. Y.

in a jar of pure oxygen, the steel will immediately take fire and burn, and if there is a sufficient amount of oxygen, the burning will continue until the steel is consumed. Again, if a piece of steel be heated red hot and kept at this temperature, a simple jet of oxygen will cut through it, the requirements for cutting being that the metal be brought to a sufficiently high temperature to combine with the oxygen rapidly.

The other essential feature of the process is the removal of the oxide which results from the combining of the oxygen with the metal. In the case of ordinary low-carbon steel, the melting point of the metal is higher than the melting point of the oxide, and as the action of the cutting is largely self-sustaining, that is, the heat from the melted slag materially helps to raise the temperature of the steel in contact with it to the necessary point for the continuation of the process, it appears that the slag will flow away without mixing with the metal. On the other hand, with high-carbon steels, the melting point of which is very nearly that of the oxide, there is a considerable tendency for the metal to melt under the heat of the slag and for the two to mix, preventing the oxygen from reaching the clean metal, as it does when the slag flows away smoothly. However, high-carbon steel can be cut, but if an attempt is made to cut a piece of chilled iron, it will be found that, while the action starts, it will not continue; that is, the metal will not fly out of the cut in sparks, but will drop in little globules of melted metal.

The reason for selecting chilled cast iron for the experiment is that there is no graphite in it, all of the carbon being in the combined state, while in ordinary cast iron, part of the carbon is in the form of graphite, which, of course, interferes with the action to an even greater extent than is the case with chilled iron, on account of the lack of continuity of the cast iron grains between which the graphite is located. Hence, cast iron cannot be cut by the oxy-acetylene torch.

Again, if malleable iron be tested with a cutting torch, it will be found that a white-heart casting, which is really a low-grade steel, will readily cut, because the percentage of carbon is lower than in the case of the chilled iron of which it was made; while if a rather thick black-heart casting be tested, with an outer skin in which the percentage of carbon is low enough to entitle it to be called steel, and a center containing the same percentage of carbon as the chilled iron of which it was made (although its form has been changed to that of temper instead of combined carbon), it will be found impossible to cut. However, the writer has done a large amount of cutting in cases of thin sections of black-heart malleable iron, with satisfactory results. It should be understood, however, that the edges of the cut are not smooth, and that the action in the center of the piece was more that of melting than of cutting. For the results desired, however, these imperfections were immaterial. The sections were not over 3/8 inch thick, and generally not over 1/4 inch.

Different Gases Used

The use of the cutting process has been extended to exceedingly thick sections, particularly in the case of armor plate, as already referred to. In the case of such heavy metal the oxy-acetylene flame is much shorter than the oxy-hydrogen flame. As it is necessary to keep the slag in a melted condition, the longer flame is preferable, so that for all heavy cutting, hydrogen is used rather than acetylene. With a more general introduction of electrolytic plants for the production of oxygen, the use of the oxy-hydrogen flame for cutting may be expected to develop at a rapid rate, as hydrogen, in this case, may be considered as a by-product. It also has the advantages of being free from danger when compressed to any pressure, and of being readily handled in tanks of the same light weight as oxygen tanks. Coal gas or ordinary illuminating gas, being largely composed of hydrogen, can also be used with very satisfactory results for cutting, and in one case, at least, it is used exclusively, being much cheaper than either acetylene or hydrogen. For the best results, however, each of these gases requires a torch with the openings properly proportioned and different from those for the other gases.

Temperature of the Oxygen

One very important factor in the cost of cutting is the temperature of the oxygen in the cutting jet. Anyone who has handled oxygen tanks in cold weather knows that when the valve is open, and oxygen allowed to escape at a fairly rapid rate, the valve body and other parts in the vicinity become coated with snow or ice formed by the condensation of the moisture in the surrounding air. This is caused by the heat absorbed from these parts by the expansion of the gas. It is evident that under such conditions the issuing gas is very cold, and when it is used in cutting, the tendency is to cool the slag and metal and delay the operation of the process. It would appear to be very easy to place a small steam coil around the head of the torch through which the oxygen used for cutting would pass, thus preheating it. In fact, such torches have been constructed, although, as far as the author knows, they are not in use in this country; an increase in cutting speed of from 15 to 25 per cent is claimed for them. In the case of large cutting, the oxygen could be preheated in a special heater in the same way as is often done with compressed air.

Effect of Heat on Steel

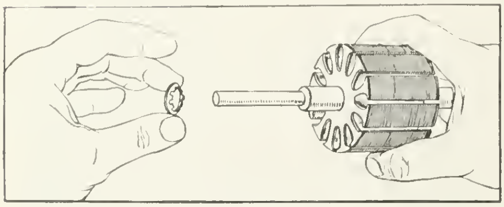
What effect has the heat from cutting on the percentage of carbon in the vicinity of the cut? This point arises, particularly in the case of high-carbon steel used for dies, a large number of these now being cut on automatic machines, particularly where the shape of the die is irregular. It can be stated with perfect confidence that no change occurs as far back as to injure the steel for this purpose, for while there is a slight decarbonization of the steel, the depth to which it penetrates is less than the amount removed in finishing the die. An examination of annealed pieces under the microscope shows this to be the case, the structure being uniform after the annealing treatment, except for a distance of less than 0.020 inch from the cut surface. The change in the structure should preferably be remedied by annealing from above the recalescence point after the cutting is done, because the change in structure is always accompanied by some strain which would possibly cause trouble later by distorting the die when hardening. Of course, no good diemaker would think of hardening a piece of steel without removing the surface for at least 1/32 inch to take off the decarbonized portion. The same condition—and no worse—exists where oxy-acetylene cutting has been employed.

* * *

Tungsten is one of the rare metals that has been found extremely useful in the industrial arts. It is the constituent in high-speed steel that gives it the "red hardness" characteristic and enables it to stand up at cutting speeds far beyond those possible with carbon tool steels. Tungsten has a high specific gravity or density, ranging from 19.3 to 20.2, depending upon the treatment. The melting point is so high that it cannot be melted directly into a mass, and for this reason is obtained from the tungsten bearing ores only as a metallic powder. By indirect means tungsten can be worked into solid masses, ranging from fine wire to chunks weighing two or three pounds. It does not oxidize readily and is practically insoluble in the common acids. Its hardness varies from 4.5 to 8 (razor steel is rated from 5 to 5.5). It is harder than quartz, which has a hardness of 7, and is almost as hard as topaz. Tungsten forms alloys with other metals besides steel. It has many other uses than the manufacture of high-speed steel, being used instead of platinum and platinum-iridium alloys, as contact points in spark coils, voltage regulators, telegraph relays and spark plugs for gas engines. It is also used for phonograph needles, writing pens, drawing dies, knife blades, gas engine valves, etc. Considerable quantities are used for the filaments of tungsten lamps. Tungsten wire may be drawn to smaller sizes than any other known metal. The use of tungsten is recommended for standard weights, since in the wrought state it can be made so hard that it will readily scratch glass and still remain ductile. Being non-oxidizable under ordinary atmospheric conditions, it remains wonderfully constant. The price of tungsten was only $6.50 per unit before the outbreak of the war. A unit is one per cent of a ton in tungsten trioxide. Since the outbreak of the war, the price has risen extraordinarily because of the difficulty of getting it from abroad, the price of pure tungsten now being about $10 a pound or thirty times what it was two years ago.

SNAPSHOTS ON THE ROAD

WEDGE WASHER FOR HOLDING ARMATURE SHEETS ON SHAFT—EFFICIENT LIGHTING SYSTEM—PREVENTING REPAIRS ON SLAG CARS—TIME-SAVING ESTIMATE SHEET



"By squeezing the wedge washer onto the shaft, the teeth would lock into the shaft, holding the punchings"

WE can never tell just what little remark or incident may lead to the passing of an important bit of information. To illustrate—a manufacturer of electrical apparatus had shown MACHINERY's field service editor through the shop and was about to say goodby, when the editor drew from his pocket a sample of a wedge washer. It was originally made for locking a nut on a screw, and as it was something new it interested the manager at once.

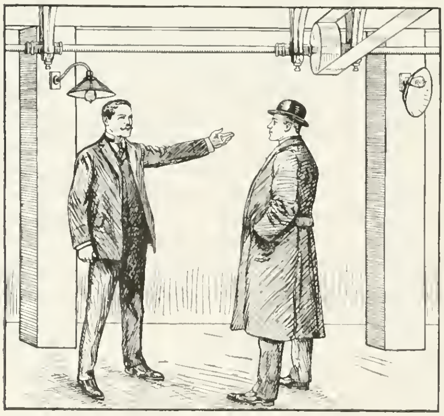
"Do you think it would be possible," said he, "to assemble armature sheets for a small motor on the shaft and hold them in place by a flange collar and this washer? By squeezing the wedge washer onto the smooth shaft, the teeth of the washer would lock into the shaft, forming a collar and holding the assembled punchings."

"Say, I believe that idea would work out fine," said the shop manager, "just give me the name of the man who makes those wedge washers and I'll soon get in touch with him."

And the result—well, if you happen to run into a certain line of electrical apparatus that has the armature punchings locked in place on the shaft with a wedge washer, just remember that you read about it in MACHINERY.

An Efficient Lighting System

"Come down in the new shop," said the manager, "I want to show you how I'm lighting the erecting floor."



"The men have plenty of light over the benches and still there is plenty for the erecting floor"

So down they went, and on the way the manager explained the problem he had. "You see, I couldn't put in overhanging arc lamps because they would be either too high above the floor to be effective or else they would be in the way of the traveling crane. I'm a great believer in tungsten incandescent lights, anyhow, and I wanted to use them this time if I could, but the question was how to throw the light out on the floor and still have it over the erectors' benches. So here's what I did," said he, as he pointed along the central bay, "on one side of every other post I put an incandescent lamp with a wide shade arranged in the usual way. On the alternate posts I put incandescent lamps with the shades inclined at an angle so as to throw the light out into the middle of the floor. Then on the opposite side, I had the lights arranged exactly opposite so that each inclined light works against a straight light, and *vice versa.*"

"Well, how does it work out?"

"Work out? Why, the scheme works fine! The men have plenty of light over the benches and still there is plenty for the erecting floor. Not only that, but just see for yourself how the opposing lights kill the shadows."

And the manager was right.

Preventing Repairs on Slag Cars

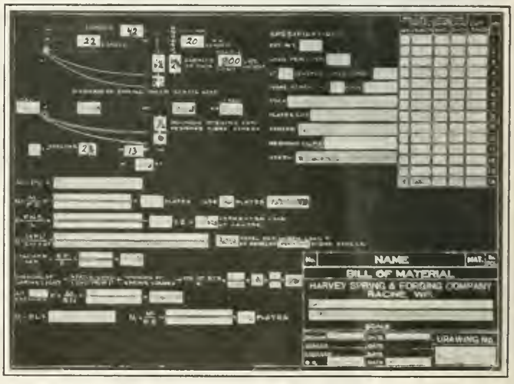
"We used to have to replace the bottoms of those slag cars often because the hot slag wore them out so quickly"

"Say," said the general superintendent as he sat at his desk looking out into the yard between the factory buildings, "there's a case where a little hint saved me a thousand dollars a month, and the saving is going right on continuously."

"How—what do you mean?" said the field service man as he followed the superintendent's glance up along a line of slag cars in front of the foundry.

"It's all so simple it hardly seems worth telling, but up to a few months ago we used to have to replace the bottoms of those slag cars very often because the hot slag wore them out so quickly—in fact, the heat simply burned them out. One day I had a visiting foundryman in here showing him around, and was complaining about the expense of repairs on slag cars.

"'Why, that's easy,' said the visiting foundryman, 'we used to have the same trouble, but we've overcome it almost entirely by keeping a little water in the bottom of each car.'



"When an estimate was to be made, it was simply a matter of filling in the blank spaces with the information"

"Well, say, I was ashamed to think that I hadn't seen that same remedy myself, but you can bet your bottom dollar that I'm keeping water in every slag car I have now, and the result is the chopping off of about 90 per cent of the repair bills on the cars."

This is just one more instance of the value of the right kind of a shop visitor.

A Time-saving Estimate Sheet

Up state on the field service man's last trip he ran into a little kink that ought to be of assistance to any man who has estimating to do.

"You see, it's this way," said the chap who passed the tip along, "I have lots of estimating to do on steel spring contracts. Every time I made out an estimate sheet I had to carry through the same list of questions concerning length of springs, width and gage of plates, loads, weights, etc. So I devised this blueprint form, leaving blank spaces where the figures that varied with every estimate were to go. Then, when an estimate was to be made, it was simply a matter of filling in the blank spaces with the information, and the job was done. Of course, I could have used a printed form, but we hardly had enough estimating to set up an expensive type form, and then, too, the average mechanical man pays more attention to a blueprint than to a printed card. It's a simple little kink, but some fellow in the estimating line may find it of use.

* * *

LAY-OUT AND OPERATION OF A BRIGHT DIP

BY GEORGE B. MORRIS[*]

Where there are a great many brass parts to be finished, especially in shops where repair parts are brought in for refinishing, a bright dip is almost indispensable. A piece that is badly tarnished, and that would ordinarily require a polishing or buffing operation, can be put into even better condition by the use of a bright dip, and the latter method is much quicker. An ideal lay-out for a bright dip is in the corner of the plating room; this is far superior to locating the tanks along a side wall, which will be apparent from the following description.

The brass parts to be bright-dipped are first thoroughly washed in a potash cleaning solution, in the same way that they are before plating. If several small pieces are to be bright dipped it is advisable to wire them together, while in handling large pieces a brass hook answers the purpose very nicely. After cleaning, the piece is first dipped into cold water and then into the acid crock. The acid solution is made of equal parts of commercial nitric and sulphuric acids; and a cupful of common salt is added to the contents of a 20-gallon crock. The piece must not be left too long in the acid—less than a second is often long enough and one dipping is usually sufficient; but the experienced workman may find it advisable to dip a piece more than once, depending upon the nature of the metal.

* Address: Kenmore, N. Y.

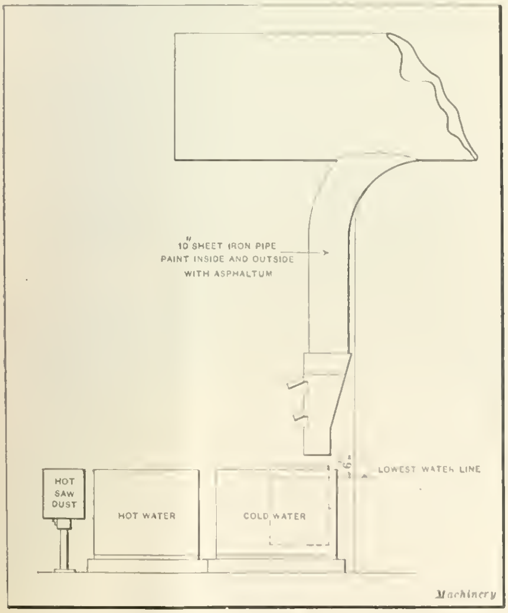


Fig. 1. Lay-out of Bright Dip Plant in Corner of Plating Room

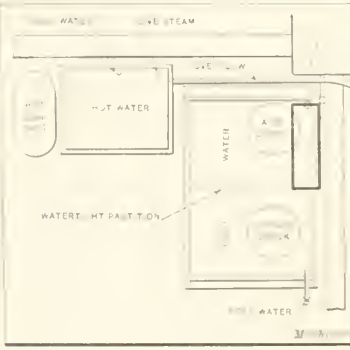


Fig. 2. Arrangement of Exhaust System for Acid Fumes

Upon being taken from the acid, the piece is again dipped in cold water, after which it is dipped in the cyanide crock for an interval of a second or two, the purpose being to remove all signs of tarnish from the surface of the metal. In making up the cyanide solution, $1\frac{1}{2}$ pound of cyanide crystals is dissolved in a 20-gallon crock of water. In some cases it may be found advisable to dip the work in the cyanide solution two or three times, but there is no need of caution in regard to the length of time that the work is left in—as in the case of the acid solution—as no harm will be done if the work is left in for several minutes. After being removed from the cyanide crock, the work is again dipped in cold water, and then into hot water to heat the metal so that it will dry quickly. If the drying takes too long the work is likely to have a streaky appearance. For small work it may be advisable to use a hot sawdust bath, which is simply a box filled with sawdust and having steam coils for heating to the required temperature.

Attention is called to the water-tight partition in the cold water tank and also to the cold-water faucet in Fig. 2. The partition is a little lower than the sides of the tank, allowing the water on the right-hand side of the partition to flow over into the left-hand compartment; the pure water is contained in the right-hand compartment. As the operator becomes experienced, he will learn when to add more cyanide crystals to the cyanide solution, and he may find it advisable to vary the proportions of nitric and sulphuric acid in the acid solution; if the action of the acid is too slow, more nitric acid should be added. It may also be found advisable to heat the metal in hot water before dipping it in the acid, but this method of treatment is the exception rather than the rule, and is done simply to stimulate the action of the acid.

With a bright-dip outfit, it is absolutely necessary to have an exhaust system for the acid crock, as the acid fumes are both disagreeable and injurious. The accompanying illustrations show the arrangement of the bright dip in the factory where the writer is employed, and they also show clearly the arrangement of the exhaust system for the acid crock. This exhaust system was installed to replace an old style "umbrella" hood which was found inefficient in carrying off nitric acid fumes, owing to the fact that these fumes are slightly heavier than air and do not rise. For a small establishment it is not necessary to have such a large exhaust pipe, but in the present case the exhaust is the one which is opened into the room for ventilating the whole plating department. For a small shop, the exhaust pipe may be carried down from the exhaust system used in connection with buffing wheels. After the parts have been bright-dipped and thoroughly dried, they should be lacquered with an air drying lacquer to prevent tarnishing.

MAKING A PRESSED STEEL BALL RETAINER

BY ERNEST WALTERS*

The pressed steel hub ball retainer illustrated at *B* in Fig 1 is made of 12-gage cold-rolled steel; it is drawn from a devel-

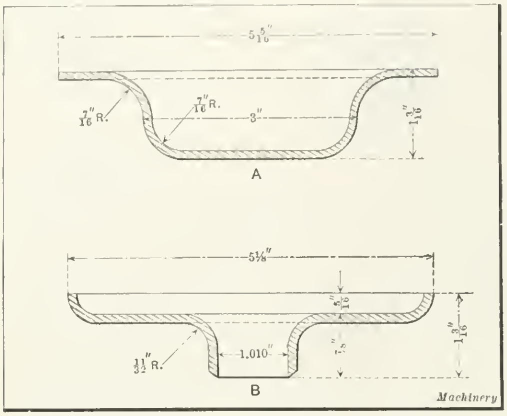


Fig. 1. Shell A after First Operation, and Finished Hub Ball Retainer B

oped blank 7 1/16 inches in diameter and is finished in two operations. Shell *A* is blanked and drawn in the compound die shown in Fig. 2, and in setting this die it is important to make a careful adjustment in order that just the required pressure may be developed by the rubber buffer. If this pressure is too great, the diameter of the shell will be increased to such an extent that it will not enter the die shown in Fig. 3, in which the final operation is performed. On the other hand, if the rubber buffer does not exert enough pressure, wrinkles will be formed in the shell, that are likely to develop into cracks.

In blanking and drawing the shell to the form shown at *A* in Fig. 1, it has been found convenient to use an inclinable power press which allows the die to discharge the shell instantly so that the press may be operated continuously. When punch *A*, Fig. 2, moves downward, it enters the opening in blanking die *B* and stamps out a blank of the required size. The way in which the blanking die is supported in cast-iron holder *C* will be evident from the illustration. As the downward motion of the punch continues, the blank is carried down into contact with forming punch *D*, which draws it to the shape shown at *A* in Fig. 1.

It will be seen that forming punch *D* fits in a hole bored in die-holder *C*, and that this punch is held down by means of screw *F*. By means of this screw and plates *G*, rubber buffer *E* applies pressure to plate *I* that holds the work against punch *A*, the amount of pressure applied being regulated by adjusting screw *F*. The work is stripped from the punch by means of stripper plate *H*, and should there be a tendency for the work to stick in the punch, pin *J*, which engages a stationary knock-out bar bolted to the body of the press, acts as an ejector. It will, of course, be evident that tapped holes *K* are for the purpose of securing the die to the bolster on the press.

* Address: 219 W. Buena Vista St., Highland Park, Mich.

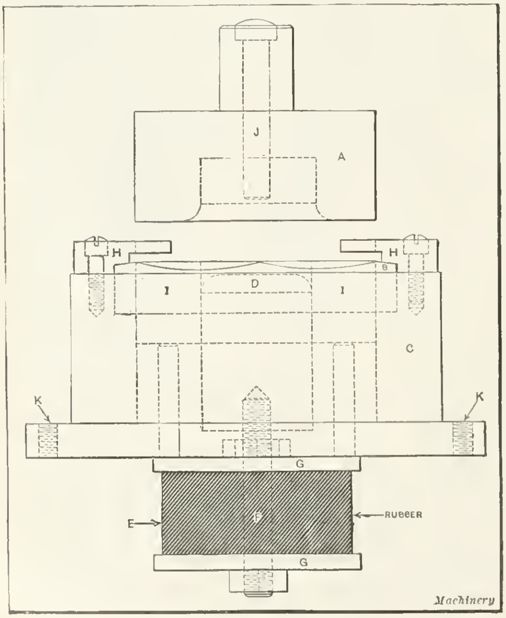


Fig. 2. Compound Blanking and Drawing Die in which First Operation is performed

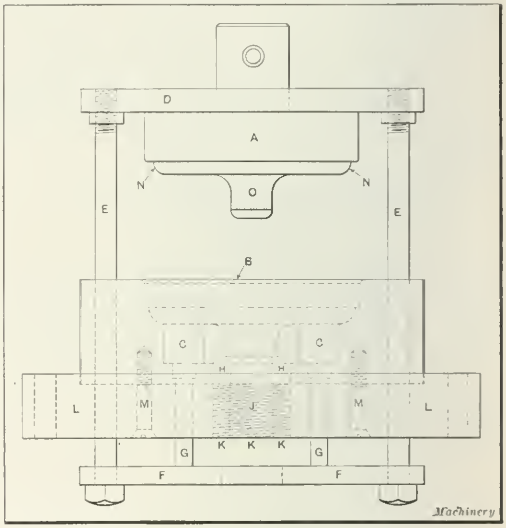


Fig. 3. Drawing and Piercing Die in which Final Operation is performed

After the performance of the first operation, the work is brought to the condition shown at *A* in Fig. 1, and these shells are then turned over and dropped into the forming and punching die, Fig. 3, in which they are drawn to the finished shape *B*, Fig. 1. In Fig. 3, the punch is shown at *A* and the die at *B*. Die *B* is bored out to form a seat for ring *C* which acts as a knock-out to eject the stamping from the die. It will be seen that the punch carries plate *D* which supports knock-out rods *E;* these rods carry plate *F* at their lower ends, and by making a suitable adjustment, plate *F* comes into contact with pins *G* on the up stroke of the ram, thus lifting ring *C* and ejecting the finished stamping from the die.

At the bottom of forming die *B* there is a small hardened steel ring *H* which is bored to fit the pilot on punch *A*. This is the piercing die which provides for punching the hole in the bottom of the stamping. Die *H* is held in place by threaded bushing *J* which is tightened with a spanner wrench fitting into holes *K*. It will be evident that *L* is the die-plate and that the die is secured in place by means of screws *M*.

In performing the final operation in this punch and die, which brings the work to the form shown at *B* in Fig. 1, shell *A* is put in the die upside down, and when the punch descends it turns the shell inside out and punches out the bottom. When the shell starts turning, the flange turns upward and comes into contact with the shoulder *N* on the punch, which forces the stock into the die. Pilot *O* on the punch forms the hub of the retainer and punches out the bottom without stretching the stock. The pilot is 3/16 inch longer than the hub of the retainer, which gives the punch the necessary over-travel to upset the end of the hub and prevent leaving a ragged edge.

HIGH-POWER SPRING MOTOR

BY SVEND HELWEG*

With the assistance of a friend, I have been experimenting for some time with what I believe to be a new form of spring motor which varies from the ordinary type in having batteries of springs wound from heavy tempered round wire in place of the common flat clockwork spring. The motor is more powerful than the ordinary type and will run for a much longer time; the operating life of a motor constructed in this way is also longer, as there is no danger of overwinding the heavy springs employed. In the motor shown in the illustrations only four batteries of springs are used, each battery consisting of three springs; but the number of springs in each battery—as well as the number of batteries—could be increased or decreased according to the amount of power which the motor is required to generate.

This type of spring motor consists of four main sections; first, the cranking mechanism; second, the batteries of springs; third, the transmitting mechanism; and fourth, the speed control. The illustrations plainly show the general features of the design, so that it will only be necessary to give a brief description of the motor. The cranking section and the transmitting section may be made to suit various conditions under which the motor is to be used, depending largely upon the kind of power applied for cranking and the amount of power to be developed by the spring motor. Any suitable form of governor mechanism can be employed for controlling the speed. All four sections of the motor may be mounted in a steel or cast-iron frame which may be placed in any convenient position. A spring motor may be used in a fixed position or it can be housed in a movable cabinet to enable the motor to be carried about from place to place.

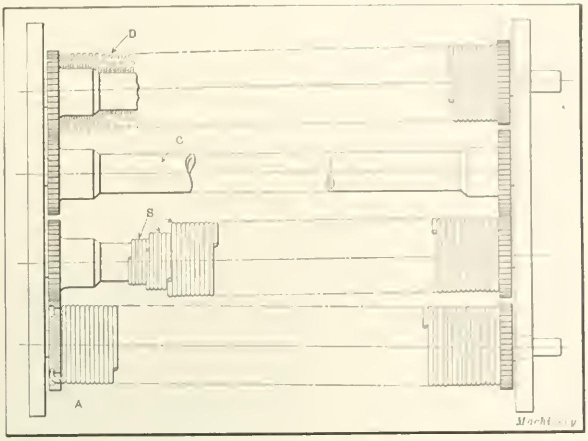


Fig. 1. Construction of Spring Batteries and Arrangement of Geared Drive

Fig. 1 shows the construction of the spring batteries, the motor being shown with the springs unwound. At *A* is shown the way in which the springs are connected to the gear wheels; for this purpose the end of each spring is bent to form a hook which fits into a hole provided for that purpose in the gear wheel. Three springs wound from wire of different diameters are mounted one outside the other on the same roller, as shown at *B*. The springs have been removed from the third battery in order to show the reel *C* made of hollow steel tubing on which the springs are wound; the design of this spool is worked out in such a way that it prevents the springs from being overwound and also holds them in place. A partial cross-sectional view through the springs is shown at *D* and gives a little clearer idea than is shown at *B* of the arrangement of concentric springs wound from wire of different sizes. The rollers are mounted on ball bearings, and it will be seen that the drive is transmitted through gearing, the gears on adjacent shafts coming into mesh alternately at opposite ends of the shafts. When cranking the motor, the coils on each individual spring are gradually contracted until they have

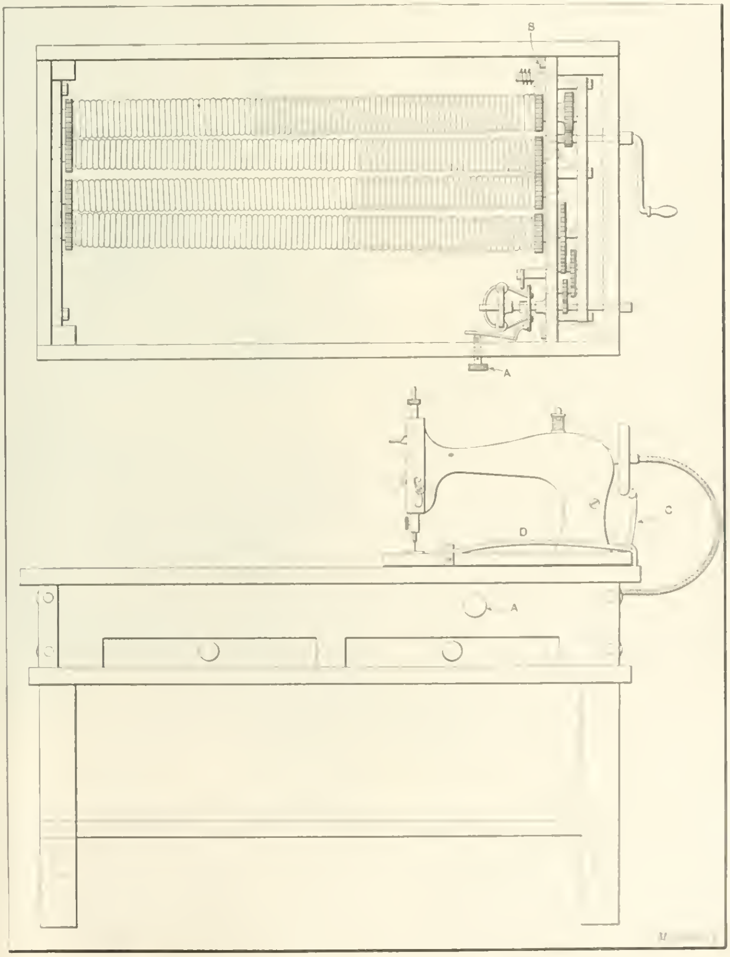


Fig. 2. Application of Spring Motor for driving Sewing Machine

* Address: 1121 E. 15th St., Brooklyn, N. Y.

reached the limit fixed by the outside diameter of the reel.

Fig. 2 shows a sewing machine driven by a spring motor. In this instance the motor is mounted inside a table and connected with the sewing machine by means of a flexible shaft. Screw *A* controls the expansion of the governor for regulating the speed at which the machine is driven. A ratchet wheel and pawl located at *B* make it impossible for the motor to run back, and a buffer brake is provided at *C*, which was especially designed to meet the requirements of this application of the motor. By pressing down spring *D* the operator can stop the sewing machine at any time, bringing brake *C* into operation, and when the brake is released the motor starts itself. With this arrangement of the spring motor, it is an easy matter to disconnect the sewing machine and couple the motor to any other apparatus, such as a rotary fan for instance; in the latter case, the use of the spring motor does away with the necessity of paying for electric current to operate the fan with an electric motor. This spring motor, provided with four batteries having three springs each, will drive a sewing machine for about five hours. I have used this motor in my home for over a year and have not experienced the least trouble with the mechanism; if I wind the motor in the morning my wife can use her sewing machine all day long and she says that it makes sewing a pleasure.

Last summer we tried the experiment of connecting the spring motor with a graphophone and the results were entirely satisfactory; we could play the instrument for three hours without the necessity of rewinding the motor. Encouraged by the results of this experiment, we built a smaller motor, *i. e.*, with shorter springs, and mounted it inside a standard graphophone cabinet with the springs in a vertical position. A flexible shaft was used to connect the gearing to the mechanism of the graphophone. This little spring motor kept the graphophone running for an hour and a half as compared with fifteen minutes, which is the limit for an ordinary clock-spring motor. The spring motor could be mounted in a separate cabinet, making it easy to move from place to place, and the same motor could then be used for driving both the sewing machine and the graphophone, and for numerous other purposes.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Purchaser Only Entitled to Damages

(Federal) A contract for the sale of an engine contained certain guaranties, and provided for an endurance test by means of which the engine should be shown to possess the qualities specified, and that, if the engine did not fulfill the test or satisfy the guaranties, the purchaser should not be required to pay therefor, and the engine should be forthwith removed. The test left the question whether the engine fulfilled the guaranties in controversy, and the purchaser, though continuing to use the engine, refused to accept it or pay for it.

An action was brought for the price of the engine by the manufacturer and it was held that a recovery for the purchase price should be allowed. As a matter of fact, the engine failed to meet the test to which it was subjected, but the court held that the continual refusal of the purchaser either to accept or return the engine made it liable for the purchase price. Keeping and using the engine caused title to pass to it, and from that time the guaranties ceased to be conditions precedent and became collateral agreements, for the breach of which the purchaser was confined to a recoupment of damages, as its conduct in continuing to use the engine was conclusive evidence that the engine was a substantial performance of the contract. *(Crescent Milling Co. v. Strait Mfg. Co., 227 Fed. 808.)*

Entitled to File Creditor's Claim

(Federal) Where machinery was leased under a condition that if the lessee became bankrupt, the leases should at the option of the lessor cease, and that upon any breach of the lessee of any of the conditions therein the lessor should have the right by notice in writing to terminate the leases—that upon the termination of the leases the lessee should deliver the machinery to the lessor in good order, reasonable wear and tear excepted, and should thereupon pay certain amounts as reimbursement for deterioration, etc., the bankruptcy of the lessee terminated the lease, and the cost of necessary repairs, return freight charges, etc., became a fixed liability absolutely owing at the time of bankruptcy. The lessor was privileged to file such claim as a general creditor of the bankrupt. *(In re Desnoyes Co., 227 Fed. 401.)*

Machinery May be Real Estate

(Massachusetts) A mortgage described the property as a certain parcel of land, with buildings thereon and all privileges and appurtenances thereto belonging and included with the real estate, and as a part thereof enumerated machinery attached to the premises. At the time of the execution of the mortgage there was other machinery in the building, not specially designed for use in the building, nor peculiar in its pattern. This other machinery was easily removable without injury to it or to the building, and was equally adapted for use in any other similar building. Held, that the intention of the parties is the controlling fact in determining whether a chattel affixed to realty becomes real estate or continues personalty. The question must be determined on consideration of all the circumstances, including the adaptation of the chattels to the end sought to be accomplished, and the means, form, and degree of annexation. A chattel so affixed to real estate that its identity is lost, or so annexed that it cannot be removed without material injury to it or the real estate, is "real estate." *(Stone v. Livingston, 110 N. E. 298.)*

Assignor of Patent Estopped

(Federal) The assignor of a machine patent for value, with covenants of warranty, is estopped, when sued for infringement thereof by the assignee, to deny that the claims cover every structure within the fair meaning of the language of the claims. The words "substantially as described" do not limit the claim to the construction shown in the patent. *(United Printing Machine Co. v. Cross Paper Feeder Co., 227 Fed. 600.)*

Sale and Installation Contract

(Texas) Where a contract for the sale and installation of machinery for irrigation declared that the agreement was subject to delays due to fires, strikes, or other causes, the purchaser could recover damages suffered through delay in installing the machinery after it had arrived, as it is presumed that the contract referred only to delays beyond the control of the manufacturer of the machinery. *(Southern Gas & Gasoline Engine Co. v. Richolson, 181 S. W. 528.)*

Failure to Guard Machinery

(New York) The New York labor law requires all machinery of every description to be properly guarded. Plaintiff operated a machine, the plunger of which was set in motion by pressure on a treadle, and his hand was injured by pressure accidentally applied to the treadle by another workman who was not operating the machine, and who voluntarily and outside the line of his duty, and in disobedience of plaintiff's request, attempted to pick up material which had fallen on the floor near the machine. Held, that, assuming that it was practicable to guard the treadle, and that the employer would have been liable if the machine had been put in motion by some accidental movement reasonably to be apprehended, plaintiff was not entitled to recover, as the risk or accident was one not reasonably to be anticipated, since the operator of the machine, in stooping to pick up fallen material, could not leave his hand where it would be injured by pressure on the treadle. *(Basel v. Ansonia Clock Co., 110 N. E. 767.)*

* * *

Bill H. R. 6458 has been introduced providing for the registration of designs. The move to secure legislation for the protection of designs is promoted by the National Design Legislation Relief, Loan & Trust Bldg., Washington, D. C. It provides that the author of any new and original design as applied to any manufactured product may have it copyrighted and obtain certificate of such registration. The bill if enacted will provide for the adequate registration of designs and should check the stealing of designs, which is now so common.

SCREWS USED IN JIG DESIGN*

STANDARDIZED SPECIAL SCREWS USED IN GENERAL ELECTRIC CO.'S TOOL EQUIPMENT

BY R. F. POHLE†

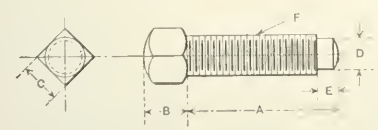
Headless set-screws are used in jig design for binding spring-pins, stop-pins and locating plugs after they have been adjusted to the work. Headless set-screws are made in several styles, but only those having a round or flat point are used in tool design. The flat points are generally used when in contact with finished surfaces. They are occasionally casehardened to prevent the end in contact with the work from becoming upset. Round points are often used as adjustable stops for rough work.

The square-head set-screw is essentially a binding screw; it often replaces headless set-screws when it is necessary to obtain a greater clamping force than can be exerted with a screwdriver. It is also used for clamping work against stops, when great rigidity of the work is required, or when the screw must take the thrust of cutting tools. As these screws require

* The tables of standards given in this article embody the practice of the General Electric Co., at Lynn, Mass. These standards have been developed for the company by R. F. Pohle, who is in charge of the tool designing department.

† Address: General Electric Co., Lynn, Mass.

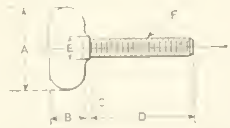
TABLE I. SQUARE-HEAD SET-SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
7/8 to 1 7/8	1/4	1/4	3/16	1/8	No. 14—24
1 to 2 1/2	5/16	5/16	15/64	1/8	5/16—18
1 to 2 1/2	3/8	3/8	9/32	1/8	3/8—16
1 3/8 to 2 7/8	7/16	7/16	11/32	1/8	7/16—14
1 3/4 to 3 1/4	1/2	1/2	25/64	1/8	1/2—13
2 1/8 to 4 1/8	5/8	5/8	1/2	3/16	5/8—11
2 1/2 to 4 1/2	3/4	3/4	5/8	1/4	3/4—10

Machinery

TABLE II. THUMB-SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
1/2	13/32	5/64	1/4 to 1/2	3/16	No. 8—32
21/32	1/2	3/64	1/4 to 1	5/16	No. 10—32
31/32	5/8	1/16	1/2 to 1 1/2	3/8	No. 14—24
1 1/8	23/32	1/16	1/2 to 1 1/2	7/16	5/16—18
1 1/4	13/16	7/64	1/2 to 2	1/2	3/8—16
1 9/16	1	9/64	1/2 to 2	5/8	1/2—13
2	1 5/16	3/16	3/4 to 2 1/4	7/8	5/8—11

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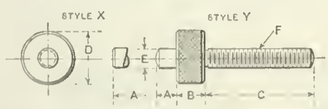
TABLE III. KNURLED JACK-SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
3/16	3/16	5/8 to 1 5/8	3/8	3/16	No. 10—32
3/16	5/16	3/4 to 1 3/4	9/16	1/4	No. 14—24
1/4	3/8	7/8 to 2 3/8	11/16	5/16	5/16—18
1/4	3/8	1 to 2 1/2	13/16	3/8	3/8—16
1/4	7/16	1 3/8 to 2 7/8	7/8	7/16	7/16—14
1/4	1/2	1 3/4 to 3 1/4	1	1/2	1/2—13

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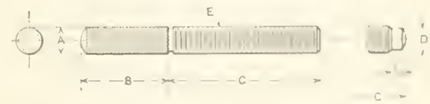
TABLE IV. SCREW PINS



A	B	C	D	E Diameter and Number of Threads per Inch
3/16	5/8	3/4 to 1 3/4	9/64	No. 10—32
1/4	3/4	7/8 to 1 7/8	3/16	No. 14—24
5/16	1	7/8 to 2 3/8	15/64	5/16—18
3/8	1	1 to 2 1/2	9/32	3/8—16
7/16	1 1/4	1 3/8 to 2 7/8	11/32	7/16—14
1/2	1 1/4	1 3/4 to 3 1/4	25/64	1/2—13

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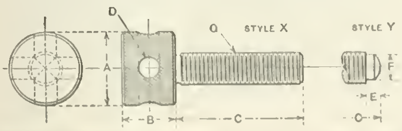
TABLE V. KNURLED CAPSTAN SCREWS



A	B	C	D	E	F	G Diameter and Number of Threads per Inch
1/2	5/16	5/8 to 1 5/8	3/32	1/8	9/64	No. 10—32
11/16	3/16	7/8 to 1 7/8	1/8	1/8	3/16	No. 14—24
13/16	7/16	1 to 2 1/2	5/32	1/8	15/64	5/16—18
7/8	9/16	1 to 2 1/2	3/16	1/8	9/32	3/8—16
1	5/8	1 3/8 to 2 7/8	7/32	1/8	11/32	7/16—14
1 3/16	3/4	1 3/8 to 3 1/4	1/4	1/8	25/64	1/2—13
1 5/16	13/16	1 7/8 to 3 3/8	9/32	3/16	1/2	5/8—11
1 1/2	7/8	2 1/4 to 3 3/4	5/16	1/4	5/8	3/4—10

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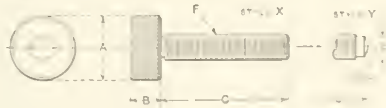
TABLE VI. KNURLED THUMB-SCREWS



A	B	C	F	E Diameter and Number of Threads per Inch
1/2	1/4	5/8 to 1 5/8	9/64	No. 10—32
11/16	3/16	7/8 to 1 7/8	3/16	No. 14—24
13/16	3/8	1 to 2 1/2	15/64	5/16—18
7/8	3/8	1 to 2 1/2	9/32	3/8—16
1	7/16	1 3/8 to 2 7/8	11/32	7/16—14
1 3/16	1/2	1 3/4 to 3 1/4	25/64	1/2—13

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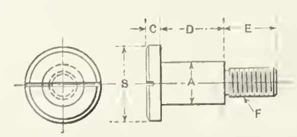
a wrench, they do not lend themselves to rapid clamping action. Proportions of square-head set-screws are given in Table I. A pin may be driven through the head on the larger sizes to act as a handle for turning the screws. On the smaller sizes this is not advisable, as the pin must necessarily be so small in diameter that it cuts into the fingers in tightening the screws. It is then better to use the style shown in Table II.

Cap-screws are used for fastening parts to the body of the tool. When the part which they fasten must have an accurate location with reference to other parts of the same tool, they are generally used in conjunction with dowel pins. The clearance holes for these screws are usually made 1/64 inch larger than the head of the screw. Shoulder screws, as shown in Table VII, are used for fastening clamping blocks, latches, or any parts that must move through a limited distance while still remaining permanently fastened to the tool.

TABLE VII. SHOULDER SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
0.249	1/2	1/8	1/2 to 3/4	7/16	No. 10—32
0.249	1/2	1/8	3/16 to 7/16	5/16	No. 10—32
0.3115	5/8	5/32	3/16 to 1/2	3/8	No. 14—24
0.3115	5/8	5/32	9/16 to 7/8	1/2	No. 14—24
0.374	3/4	5/32	1/4 to 7/16	3/8	No. 14—24
0.374	3/4	5/32	1/2 to 11/16	1/2	No. 14—24
0.374	3/4	5/32	3/4 to 1	5/8	No. 14—24
0.4365	13/16	5/32	3/8 to 9/16	1/2	5/16—18
0.4365	13/16	5/32	5/8 to 13/16	5/8	5/16—18
0.4365	13/16	5/32	7/8 to 1 1/8	3/4	5/16—18
0.499	7/8	3/16	3/8 to 9/16	1/2	3/8—16
0.499	7/8	3/16	5/8 to 7/8	5/8	3/8—16
0.499	7/8	3/16	15/16 to 1 1/4	3/4	3/8—16
0.5615	1	3/16	1/2 to 3/4	5/8	7/16—14
0.5615	1	3/16	7/8 to 1 1/8	3/4	7/16—14
0.5615	1	3/16	1 1/4 to 1 1/2	7/8	7/16—14
0.6235	1 1/8	1/4	1/2 to 5/8	5/8	1/2—13
0.6235	1 1/8	1/4	3/4 to 1	3/4	1/2—13
0.6235	1 1/8	1/4	1 1/8 to 1 5/8	7/8	1/2—13
0.686	1 1/4	1/4	5/8 to 1	3/4	1/2—13
0.686	1 1/4	1/4	1 1/8 to 1 3/4	1	1/2—13
0.7485	1 3/8	5/16	3/4 to 1 1/8	7/8	5/8—11
0.7485	1 3/8	5/16	1 1/4 to 2	1 1/8	5/8—11

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III to VI. The knurled screw is adapted to light clamping, and is also used where the work is frail, so that there is danger of bending it, and where it is not necessary to take the thrust of the cutting tool. Where it is necessary to take the thrust of the cutting tool and yet provide for rapid manipulation of the screw, the knurled capstan screw or the fluted capstan screw is used. The knurled capstan screw is screwed up with the fingers, while the fluted capstan screw is screwed up by a pin engaging in the flutes; both are tightened with the aid of a pin.

The knurled jack-screw is designed for supporting work against the action of cutting tools where the nature of the work requires such support at more than three points. If the thrust of the cutting tool is very great, the jack-screw should be locked with a brass plug and set-screw after being adjusted to the work. The points of knurled screws may be either flat or rounded, according to whether they are used on finished or rough surfaces.

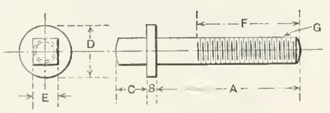
Knurled Thumb-screws

There are four types of knurled-head screws in general use in jig design. These are illustrated and tabulated in Tables

Miscellaneous Screws

Collar-head screws are essentially clamp-screws, and are

TABLE VIII. COLLAR-HEAD SCREWS



A	B	C	D	E	F	G Diameter and Number of Threads per Inch
5/8	1/16	3/16	5/16	3/16	1/2	No. 10—32
7/8	1/16	3/16	5/16	3/16	5/8	No. 10—32
1 1/8	1/16	3/16	5/16	3/16	7/8	No. 10—32
1 3/8	1/16	3/16	5/16	3/16	1	No. 10—32
1 5/8	1/16	3/16	5/16	3/16	1 1/4	No. 10—32
7/8	3/32	1/4	7/16	1/4	5/8	No. 14—24
1 1/8	3/32	1/4	7/16	1/4	7/8	No. 14—24
1 3/8	3/32	1/4	7/16	1/4	1	No. 14—24
1 5/8	3/32	1/4	7/16	1/4	1 1/4	No. 14—24
1 7/8	3/32	1/4	7/16	1/4	1 7/16	No. 14—24
7/8	1/8	5/16	9/16	5/16	5/8	5/16—18
1 1/4	1/8	5/16	9/16	5/16	1	5/16—18
1 5/8	1/8	5/16	9/16	5/16	1 1/4	5/16—18
2	1/8	5/16	9/16	5/16	1 1/2	5/16—18
2 3/8	1/8	5/16	9/16	5/16	1 3/4	5/16—18
1	1/8	3/8	11/16	3/8	3/4	3/8—16
1 3/8	1/8	3/8	11/16	3/8	1	3/8—16
1 3/4	1/8	3/8	11/16	3/8	1 5/16	3/8—16
2 1/8	1/8	3/8	11/16	3/8	1 5/8	3/8—16
2 1/2	1/8	3/8	11/16	3/8	1 7/8	3/8—16
1 3/8	3/16	7/16	3/4	7/16	1	7/16—14
1 3/4	3/16	7/16	3/4	7/16	1 5/16	7/16—14
2 1/8	3/16	7/16	3/4	7/16	1 5/8	7/16—14
2 1/2	3/16	7/16	3/4	7/16	1 7/8	7/16—14
2 7/8	3/16	7/16	3/4	7/16	2 1/8	7/16—14
1 3/4	3/16	1/2	7/8	1/2	1 5/16	1/2—13
2 1/8	3/16	1/2	7/8	1/2	1 5/8	1/2—13
2 1/2	3/16	1/2	7/8	1/2	1 7/8	1/2—13
2 7/8	3/16	1/2	7/8	1/2	2 1/8	1/2—13
3 1/4	3/16	1/2	7/8	1/2	2 3/8	1/2—13

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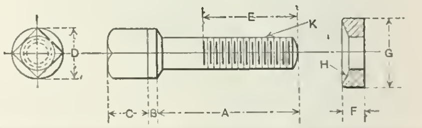
TABLE IX. ROCKING COLLAR SCREWS



A	B	C	D	E	F	G	H	K Diameter and Number of Threads per Inch
5/8	3/32	3/16	11/32	1/2	1/8	7/16	1/4	No. 10—32
7/8	3/32	3/16	11/32	5/8	1/8	7/16	1/4	No. 10—32
1 1/8	3/32	3/16	11/32	7/8	1/8	7/16	1/4	No. 10—32
1 3/8	3/32	3/16	11/32	1	1/8	7/16	1/4	No. 10—32
1 5/8	3/32	3/16	11/32	1 1/4	1/8	7/16	1/4	No. 10—32
7/8	3/32	1/4	7/16	5/8	3/16	5/8	1/2	No. 14—24
1 1/8	3/32	1/4	7/16	7/8	3/16	5/8	1/2	No. 14—24
1 3/8	3/32	1/4	7/16	1	3/16	5/8	1/2	No. 14—24
1 5/8	3/32	1/4	7/16	1 1/4	3/16	5/8	1/2	No. 14—24
1 7/8	3/32	1/4	7/16	1 7/16	3/16	5/8	1/2	No. 14—24
7/8	1/8	5/16	1/2	5/8	3/16	11/16	1/2	5/16—18
1 1/4	1/8	5/16	1/2	1	3/16	11/16	1/2	5/16—18
1 5/8	1/8	5/16	1/2	1 1/4	3/16	11/16	1/2	5/16—18
2	1/8	5/16	1/2	1 1/2	3/16	11/16	1/2	5/16—18
2 3/8	1/8	5/16	1/2	1 3/4	3/16	11/16	1/2	5/16—18
1	1/8	3/8	5/8	3/4	3/16	13/16	1/2	3/8—16
1 3/8	1/8	3/8	5/8	1	3/16	13/16	1/2	3/8—16
1 3/4	1/8	3/8	5/8	1 5/16	3/16	13/16	1/2	3/8—16
2 1/8	1/8	3/8	5/8	1 5/8	3/16	13/16	1/2	3/8—16
2 1/2	1/8	3/8	5/8	1 7/8	3/16	13/16	1/2	3/8—16
1 3/8	1/8	7/16	11/16	1	1/4	15/16	5/8	7/16—14
1 3/4	1/8	7/16	11/16	1 5/16	1/4	15/16	5/8	7/16—14
2 1/8	1/8	7/16	11/16	1 5/8	1/4	15/16	5/8	7/16—14
2 1/2	1/8	7/16	11/16	1 7/8	1/4	15/16	5/8	7/16—14
2 7/8	1/8	7/16	11/16	2 1/8	1/4	15/16	5/8	7/16—14
1 3/4	1/8	1/2	13/16	1 5/16	1/4	1 1/16	5/8	1/2—13
2 1/8	1/8	1/2	13/16	1 5/8	1/4	1 1/16	5/8	1/2—13
2 1/2	1/8	1/2	13/16	1 7/8	1/4	1 1/16	5/8	1/2—13
2 7/8	1/8	1/2	13/16	2 1/8	1/4	1 1/16	5/8	1/2—13
3 1/4	1/8	1/2	13/16	2 3/8	1/4	1 1/16	5/8	1/2—13

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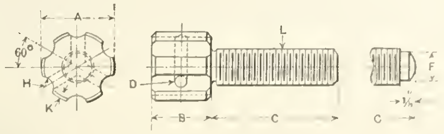
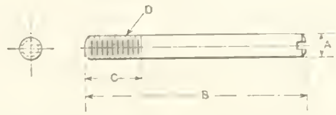
TABLE X. FLUTED CAPSTAN SCREWS



A	B	C	D	F	H	K	L Diameter and Number of Threads per Inch
1/2	13/16	1 to 1 3/4	3/32	3/64	3/32	1/16	No. 10—32
11/16	15/16	1 1/4 to 2 1/4	1/8	1/16	1/8	3/32	No. 14—24
13/16	1 1/8	1 1/2 to 3	3/32	11/64	1/8	1/8	5/16—18
15/16	1 1/4	1 3/4 to 3 1/4	1/16	3/32	1/8	1/8	3/8—16
1	1 3/8	2 to 3 1/2	7/32	11/32	1/16	1/8	7/16—14
1 1/16	1 1/2	2 1/4 to 3 3/4	1/4	23/64	1/16	1/8	1/2—13
1 1/16	1 5/8	2 1/2 to 4 1/2	9/32	1/2	1/4	1/16	5/8—11
1 1/2	1 3/4	3 to 5	1/16	5/8	1/4	1/16	3/4—10

Machinery

TABLE XI. DOWEL SCREWS



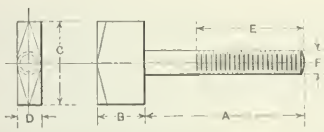
A	B	C	D Diameter and Number of Threads per Inch
0.141	7/16 to 3/4	7/32	No. 6—32
0.166	1/2 to 1	1/4	No. 8—32
0.190	5/8 to 1 3/16	9/32	No. 10—32
0.246	3/4 to 2	3/8	No. 14—24
0.3125	7/8 to 2 1/4	11/32	5/16—18
0.375	1 to 2 5/8	9/16	3/8—16
0.500	1 1/4 to 3	3/4	1/2—13
0.625	1 1/2 to 4 1/2	13/16	5/8—11
0.750	2 to 6	1 1/8	3/4—10

Machinery

used in conjunction with clamps, straps and latches. Rocking collar screws, Table IX, are used with clamps for rough work, since they adapt themselves to any irregularities of the work and give a full bearing on the clamps in any position the work may assume.

Quarter-turn thumb-screws may be rapidly manipulated and are especially of use in box jigs. The only objection to this type of screw is the wear that takes place on the boss on which it acts. In time, the boss wears away sufficiently so that the head of the screw comes in line with the clearance slot in the cover, and then it becomes necessary to finish the boss to a new fit. The great convenience of this type of screw, however, more than makes up for the time required for readjustment, and hence it is extensively used. Half-turn thumb-screws are also used in box jigs when the quarter-turn thumb-screw cannot be used on account of the work or bushing protruding through the end of the jig. These screws are used in pairs, one on each side of the jig cover.

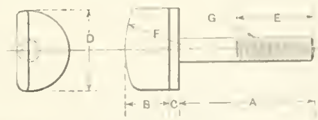
TABLE XII. QUARTER-TURN THUMB-SCREWS



A	B	C	D	E	F Diameter and Number of Threads per Inch
7/16	1/2	11/16	3/16	3/16	No. 10—32
5/8	1/2	11/16	3/16	1/2	No. 10—32
7/8	1/2	11/16	3/16	5/8	No. 10—32
1 1/8	1/2	11/16	3/16	7/8	No. 10—32
1 3/8	1/2	11/16	3/16	1	No. 10—32
1 5/8	1/2	11/16	3/16	1 1/4	No. 10—32
5/8	9/16	13/16	1/4	1/2	No. 14—24
7/8	9/16	13/16	1/4	5/8	No. 14—24
1 1/8	9/16	13/16	1/4	7/8	No. 14—24
1 3/8	9/16	13/16	1/4	1	No. 14—24
1 5/8	9/16	13/16	1/4	1 1/4	No. 14—24
1 7/8	9/16	13/16	1/4	1 3/8	No. 14—24
5/8	5/8	1	5/16	1/2	5/16—18
7/8	5/8	1	5/16	5/8	5/16—18
1 1/4	5/8	1	5/16	1	5/16—18
1 5/8	5/8	1	5/16	1 1/4	5/16—18
2	5/8	1	5/16	1 1/2	5/16—18
2 3/8	5/8	1	3/16	1 3/4	5/16—18
3/4	11/16	1 3/16	3/8	9/16	3/8—16
1	11/16	1 3/16	3/8	3/4	3/8—16
1 3/8	11/16	1 3/16	3/8	1	3/8—16
1 3/4	11/16	1 3/16	3/8	1 5/16	3/8—16
2 1/8	11/16	1 3/16	3/8	1 5/8	3/8—16
2 1/2	11/16	1 3/16	3/8	1 7/8	3/8—16
1	3/4	1 3/16	7/16	3/4	7/16—14
1 3/8	3/4	1 5/16	7/16	1	7/16—14
1 3/4	3/4	1 5/16	7/16	1 5/16	7/16—14
2 1/8	3/4	1 5/16	7/16	1 5/8	7/16—14
2 1/2	3/4	1 3/16	7/16	1 1/4	7/16—14
2 7/8	3/4	1 5/16	7/16	1 7/16	7/16—14
1 3/8	3/4	1 5/16	1/2	1	1/2—13
1 3/4	3/4	1 5/16	1/2	1 5/16	1/2—13
2 1/8	3/4	1 5/16	1/2	1 5/8	1/2—13
2 1/2	3/4	1 3/16	1/2	1 1/4	1/2—13
2 7/8	3/4	1 5/16	1/2	1 7/16	1/2—13
3 1/4	3/4	1 3/16	1/2	1 5/8	1/2—13

Machinery

TABLE XIII. HALF-TURN THUMB-SCREWS



A	B	C	D	E	F	G Diameter and Number of Threads per Inch
7/16	1/2	3/16	11/16	5/16	3/4	No. 10—32
5/8	1/2	3/16	11/16	1/2	3/4	No. 10—32
7/8	1/2	3/16	11/16	5/8	3/4	No. 10—32
1 1/8	1/2	3/16	11/16	7/8	3/4	No. 10—32
1 3/8	1/2	3/16	11/16	1	3/4	No. 10—32
1 5/8	1/2	3/16	11/16	1 1/4	3/4	No. 10—32
5/8	9/16	3/16	13/16	1/2	7/8	No. 14—24
7/8	9/16	3/16	13/16	5/8	7/8	No. 14—24
1 1/8	9/16	3/16	13/16	7/8	7/8	No. 14—24
1 3/8	9/16	3/16	13/16	1	7/8	No. 14—24
1 5/8	9/16	3/16	13/16	1 1/4	7/8	No. 14—24
1 7/8	9/16	3/16	13/16	1 3/8	7/8	No. 14—24
5/8	5/8	3/16	1	1/2	1	5/16—18
7/8	5/8	3/16	1	5/8	1	5/16—18
1 1/4	5/8	3/16	1	1	1	5/16—18
1 5/8	5/8	3/16	1	1 1/4	1	5/16—18
2	5/8	3/16	1	1 1/2	1	5/16—18
2 3/8	5/8	3/16	1	1 3/4	1	5/16—18
3/4	11/16	1/4	1 3/16	9/16	1 1/4	3/8—16
1	11/16	1/4	1 3/16	3/4	1 1/4	3/8—16
1 3/8	11/16	1/4	1 3/16	1	1 1/4	3/8—16
1 3/4	11/16	1/4	1 3/16	1 5/16	1 1/4	3/8—16
2 1/8	11/16	1/4	1 3/16	1 5/8	1 1/4	3/8—16
2 1/2	11/16	1/4	1 3/16	1 7/8	1 1/4	3/8—16
1	3/4	1/4	1 3/16	3/4	1 3/8	7/16—14
1 3/8	3/4	1/4	1 3/16	1	1 3/8	7/16—14
1 3/4	3/4	1/4	1 3/16	1 5/16	1 3/8	7/16—14
2 1/8	3/4	1/4	1 3/16	1 5/8	1 3/8	7/16—14
2 1/2	3/4	1/4	1 3/16	1 1/4	1 3/8	7/16—14
2 7/8	3/4	1/4	1 3/16	1 7/16	1 3/8	7/16—14
1 3/8	3/4	1/4	1 3/16	1	1 1/2	1/2—13
1 3/4	3/4	1/4	1 3/16	1 5/16	1 1/2	1/2—13
2 1/8	3/4	1/4	1 3/16	1 5/8	1 1/2	1/2—13
2 1/2	3/4	1/4	1 3/16	1 1/4	1 1/2	1/2—13
2 7/8	3/4	1/4	1 3/16	1 7/16	1 1/2	1/2—13
3 1/4	3/4	1/4	1 3/16	1 5/8	1 1/2	1/2—13

Machinery

BOOKS ON AUTOMOBILES AND GAS ENGINES*

In the March number of MACHINERY a list of books on scientific management was published in reply to the many inquiries relating to books on this subject that have been received by the editor. A list of books on automobiles and gas engines is given for the benefit of readers interested in the literature relating to this important subject. These books have been recommended by experts as being the best on this subject.

Audel's Gas Engine Manual. 469 pages, 5½ by 8½ inches. Price, $2.
This is a practical treatise relating to the theory and operation of gas, gasoline, and oil engines, including chapters on producer gas plants, marine motors, and automobile engines, written in popular style.

Automobile Repairing Made Easy. By V. W. Page. 1056 pages, 5½ by 8 inches. Price, $3.
This is a comprehensive practical exposition of modern automobile repair practice, completely illustrated.

Carbureting and Combustion. By Ernest Sorel. 269 pages, 5¼ by 8 inches. Price, $3.
This book relates primarily to the carbureting and combustion in alcohol engines, but the fundamental principles relate to all fuels, and the book is recommended to those interested in the theory of carburetion and combustion.

Gas Engine Design. By C. E. Lucke. 262 pages, 6 by 9 inches. Price, $3.
This is a valuable book for designers. It is highly technical in character and is not intended as a primer for those who wish to obtain a knowledge of general principles but as a standard work for those engaged in the actual design of engines.

Gas, Gasoline and Oil Engines. By C. D. Hiscox. 476 pages, 6 by 9 inches. Price, $2.50.
This book is written in popular style, and describes in detail the parts of gas engines and their action. It is recommended for obtaining a general all-around knowledge of gas engines.

Gas Power. By C. F. Hirshfeld and T. C. Ulbricht. 209 pages, 5¼ by 8 inches. Price, $1.25.
This book treats the subject from the students' and designers' point of view; the treatment has been made as simple and unmathematical as possible, and it should be useful to those who wish to obtain a working knowledge of gas engines but who have not had the advantage of a broad technical education.

Gas Power. By F. E. Junge. 548 pages, 6 by 9 inches. Price, $5.
This book is recommended as an excellent treatise for those who want to go deeply into the subject. It deals completely with power production by means of gas engines, having especial reference to large engines.

Handbook on Gas Engines. By H. Haeder. 330 pages, 7 by 9 inches. Price, $5.
This is a translation and adaptation of a standard German handbook which contains a complete collection of data for designers and students of gas engines.

Internal Combustion Engines. By R. C. Carpenter and H. Diederichs. 612 pages, 6 by 9 inches. Price, $5.
This is a work on gas engines for those who wish to study in a complete manner the theory and general design of gas engines.

Internal Combustion Engines. By H. Guldner and H. Diederichs. 690 pages, 11 by 8½ inches. Price, $10.
This is by far the largest, most complete, and possibly one of the most authoritative of the works published on internal combustion engines. It is characterized by the authors as a handbook for designers and builders of gas and oil engines. The work is of German origin and has been translated and augmented by additions on American engines.

Internal Combustion Engines. By R. E. Mathot. 576 pages, 6 by 9 inches. Price, $6.
This work is recommended both for general study of gas engines in the various forms and types, and as a reference work for designers.

Self-propelled Vehicles. By James E. Homans. 597 pages, 5½ by 8 inches. Price, $2.
This is a popularly written book explaining the general principles involved in the design and operation of automobiles and automobile engines. It is recommended for those who wish to get a fairly non-technical description of the automobile and its mechanism.

The Gas Engine. By F. R. Hutton. 562 pages, 6 by 9 inches. Price, $4.50.
This is a popularly written treatise on the gas engine, which contains in addition a scientific treatise on the theoretical analysis of the gas engine. The work is mainly descriptive, and suitable for the average designer.

The Gasoline Automobile. By P. M. Heldt. In two parts, each about 500 pages, 5¼ by 8½ inches. Price, $4 each.
This is a complete and scientific treatise, the first part dealing with the gasoline motor, and the second with the running gear and the transmission. Ignition appliances and radiators are not dealt with, since these apparatus are the objects of special industries and are seldom built in automobile factories.

The Gasoline Automobile. By G. W. Hobbs and B. G. Elliott. 256 pages, 6 by 9 inches. Price, $2.
This book contains a series of lectures intended mainly for men who drive, repair, or sell automobiles. It explains in a popular way the mechanical principles underlying the operation of automobiles.

The Gas and Oil Engine. By Dugald Clerk. Published in two volumes. Part 1, 390 pages, 6 by 9 inches. Price, $4. Part 2, 838 pages, 6 by 9 inches. Price, $7.50.
This is both a scientific and practical treatise on gas, petrol, and oil engines, the first part dealing with the thermodynamics of these engines in a comprehensive yet not too theoretical manner; while the second part deals with the design and construction of gas and oil engines.

The Modern Gasoline Automobile. By V. W. Page, 850 pages, 5½ by 8 inches. Price, $2.50.
Of the books written on the gasoline automobile in a popular style, this is possibly the most complete. It covers practically all the devices used in connection with the automobile power generating and transmission mechanism.

The Gas Turbine. By H. H. Suplee. 262 pages, 6 by 9 inches Price, $3.
This book is especially valuable for reference, as it places in the hands of engineers and experimenters such theoretical and practical data as are available on the solution of the problem of the gas turbine.

The Gas Turbine. By Norman Davey. 262 pages, 6 by 9 inches. Price, $4.
This is a useful work for students of the gas turbine, dealing with both the theory and practice, and giving a list of gas turbine patterns from 1856 to 1913, inclusive.

Diesel Engines. By A. P. Chalkley. 298 pages, 5½ by 8½ inches. Price, $3.
This book is recommended as a complete treatise on engines working on the Diesel principle, covering both the theory and practice, and reviewing the various types developed.

* The books given in the accompanying list are not published by the Industrial Press, but the names of the publishers will be furnished on request, or copies may be obtained from MACHINERY upon receipt of cash accompanying the order.

* * *

MONUMENT TO JOHN ERICSSON

Bills have been introduced both in the United States Senate and in the House of Representatives to provide for the erection of a suitable memorial at the nation's capital to John Ericsson. A hearing was held March 13, before the Committee of Library, House of Representatives, which has the House bill in hand, at which a number of representatives of engineering and other societies in the United States were present to urge the passage of the bill. The American Society of Mechanical Engineers was represented by C. A. V. Carlsson, Washington, D. C.; Gust. Fast, Baltimore; H. G. Gillis, Washington, D. C.; E. Oberg, New York; O. Ohlson, Waltham, Mass.; C. von Philp, Bethlehem, Pa.; and R. H. Raynal, Washington, D. C. These delegates urged the passage of the bill on behalf of the American Society of Mechanical Engineers, because of the eminent position which John Ericsson held as an engineer as well as a scientist, his name being one of the most famous in the history of engineering of the nineteenth century, and also because of the unselfish and patriotic services which he rendered to the United States by the building of the *Monitor*, which saved the nation at a time of dire need. It was urged that it was especially fitting for a memorial to be erected to so great and distinguished an engineer by a nation whose prosperity and greatness has been largely due to the engineering profession, and it was also stated that in the nation's capital there should be a statue to one of the great engineers who have rendered it signal service, as well as to the soldiers and statesmen who have won fame in the service of their country. Colonel W. C. Church, the biographer of John Ericsson, and editor of *The Army and Navy Journal*, was present and pointed out why it was the duty of the nation to honor Ericsson's memory.

* * *

SPRING MEETING OF A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers will be held in New Orleans, La., April 11-14, Hotel Grunewald, headquarters. The society is to be the guest of the local members and of the Louisiana Engineering Society. The New Orleans committee has arranged visits to points of interest and social events. It is pointed out that New Orleans is at its best in April and has many attractions for visitors. Two official excursions have been arranged, one on the river to view the dock facilities and the new cotton warehouse and one to the reclaimed lands. The technical program follows:

"Organizing for Industrial Preparedness," by Spencer Miller.

"Capacity and Economy of Multiple Evaporators," by E. W. Kerr.

"The Evolution of Low-lift Pumping Plants in the Gulf Coast Country," by William B. Gregory.

"Mechanical Equipment used in the Port of New Orleans," by William von Phul.

"Establishing a Standard of Measurement for Natural Gas in Large Quantities," by Francis P. Fisher.

"Deviation of Natural Gas from Boyle's Law," by Robert F. Earhart and Samuel S. Wyer.

"Some Experiments on Water-flow through Pipe Orifices," by Horace Judd.

"The Measurement of Viscosity and a New Form of Viscosimeter," by H. C. Hayes and G. W. Lewis.

"Dynamic Balance," by N. W. Akimoff.

"Disastrous Experiences with Large Center Crankshafts," by Louis Illmer.

"On the Transmission of Heat in Boilers," by E. R. Hedrick and E. A. Fessenden.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

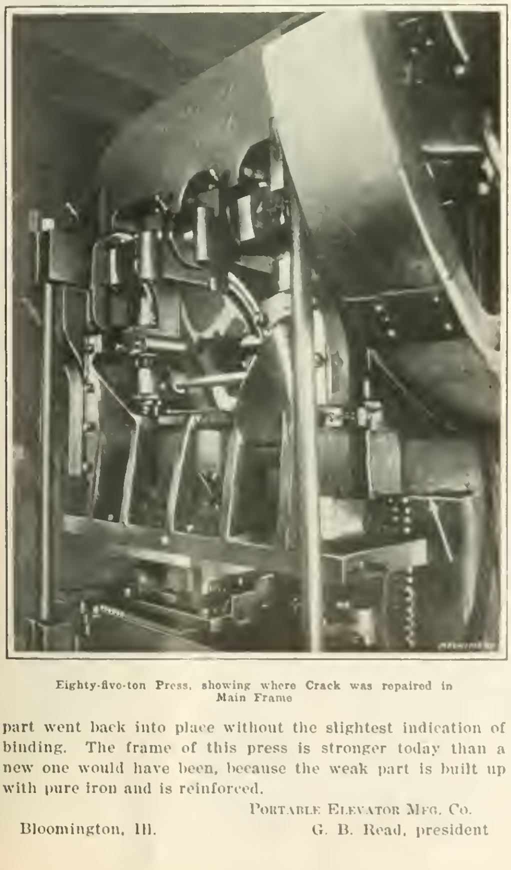
PRACTICAL APPLICATION OF OXY-ACETYLENE WELDING

The October, 1915, number of MACHINERY, which dealt largely with the subject of oxy-acetylene welding, has caused me to send the photograph and following description of a repair job we had done in our shop, which illustrates the advantages of this process. It is submitted for publication with the hope that it may be of interest to some of MACHINERY'S readers.

Last winter, we had occasion to repair a serious break in a large punch press, the capacity of which is eighty-five tons. This press developed a crack in the main frame shortly after it was purchased, as indicated by the white line in the illustration. A new frame would have cost us about $700. The Oxweld Co. of Chicago repaired it for approximately $150.

In repairing, it was necessary to dismantle the entire machine, lay it on its side, and cut away most of the frame at an angle of approximately 45 degrees in the crack. The part was heated by two blow torches to a bright red. Then the process of building it up with the oxy-acetylene flame proceeded, the time required being about twenty hours of continuous work.

After the job had cooled, the press was put back on its foundation and the main shaft, which passes through four solid bearings in the main frame, was found to fit perfectly. Every



Eighty-five-ton Press, showing where Crack was repaired in Main Frame

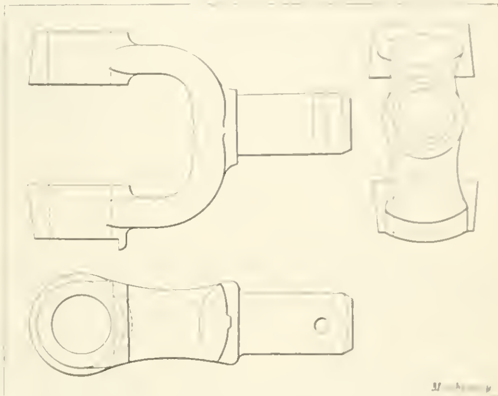
part went back into place without the slightest indication of binding. The frame of this press is stronger today than a new one would have been, because the weak part is built up with pure iron and is reinforced.

PORTABLE ELEVATOR MFG. CO.

Bloomington, Ill. G. B. Read, president

IS CONTINUOUS MILLING ALWAYS THE MOST RAPID METHOD?

I have noticed a growing tendency on the part of some machine tool builders and tool designers to advance the theory that continuous operation is the most rapid method of production on such work as milling. Some years ago I held the same opinion, but subsequent experience has so thoroughly demonstrated the advantages of other methods that I have been prompted to offer the following suggestions. When I



Example of Type of Work that is milled most rapidly in Turret Fixture with Straight Feed

receive a new part for which tools are to be designed, the most important point to be determined, from the standpoint of rapid production, is the position in which the piece must be held while finish-milling in order to secure the shortest possible feed movement; the work-holding fixture is then designed to hold the piece in this position. I have found that it is very seldom necessary to travel *across* a piece of work, for in most cases the feed may be *into* the work. For instance, take the case of the part illustrated on page 998 of the August number of MACHINERY in connection with the article entitled "Fast Continuous Milling"; with bosses $\frac{3}{4}$ inch in diameter and a milling cutter 6 inches in diameter, it is necessary to feed $2\frac{1}{2}$ inches in order to pass across the work, while by feeding straight into the work a feed movement of $\frac{3}{4}$ inch suffices.

This method has another decided advantage which can be explained by considering the same piece. I should mount these pieces in pairs, one above the other, but by bringing the bosses close together and locating the cutters between the two parts it would be possible to mill two pieces at a time with a feed movement of $\frac{3}{4}$ inch. The fixture employed for handling the work in this way would be made to swivel like a turret, so that work could be loaded into one side of the fixture while a cut was being taken on pieces mounted in the opposite side. Using this equipment and method, from [illegible] to 300 pieces could be milled per hour, and the machine and fixture employed would be less expensive than in the case where continuous milling is done.

In order to fully substantiate the claims made for this method, I will give one more example. The accompanying illustration shows a clevis which was formerly milled on four faces by the continuous process, but owing to the length of the work it was impossible to get the bosses as close together as was possible in the preceding case. The bosses were $1\frac{1}{4}$ inch in diameter with more than $\frac{1}{4}$ inch of stock to be re-

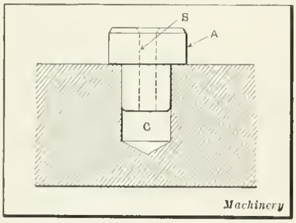
moved from each, so that it was extremely difficult to provide adequate support for the work when a rotary fixture was used. Using the continuous milling process the best rate of production attained was sixty-five pieces per hour. As this was unsatisfactory, we decided to try the swiveling turret type of fixture designed to hold two pieces on each side; the pieces were mounted side by side and two sets of cutters were provided so that both pieces were finished at a single feed movement of the table. The fixture provided ample support under each boss and the feed movement required was only 1¼ inch. Working under these conditions the rate of production was increased to 200 pieces per hour.

This principle can be applied in milling a great variety of work; it takes a shorter feed movement to complete each operation and allows the cutters to work on more than one piece at a time. The evolution of milling fixtures for handling parts of the general type referred to has been about as follows: First, the simple fixture holding one piece; second, the fixture holding a string of pieces; third, a pair of single fixtures, one mounted at each end of the table; fourth, the rotary fixture; and fifth, the swivel indexing fixture, which is the most rapid of all. The method of using a simple fixture at each end of the table is very satisfactory in many cases, but it is open to the serious objection that the loading of work into fixtures at opposite ends of the table requires the operator to walk back and forth, and this introduces the fatigue factor which materially reduces the rate of production.

Detroit, Mich. George H. Cheney

DESIGN OF JIG FEET

A common method of making feet for drill jigs is to turn up shoulder pins somewhat like that shown at *A* in the accompanying illustration; these pins are then driven into reamed holes in the jig body. It frequently happens that jig feet are driven into blind holes, and if the feet are broken off in such holes, it is difficult to remove the broken part. To overcome this difficulty I recently made a set of jig feet similar to the one shown in the illustration, from which it will be seen that the departure from common practice consists of drilling and reaming a hole *B* through the center of each foot. Should it be necessary to remove the broken part of one of these feet from the hole, oil is poured through hole *B* to fill cavity *C* left by the drill. A short piece of drill rod, of such a size that it is a snug fit in hole *B*, is then driven in, and this rod acts like a piston, setting up pressure in the oil to force the broken foot out of the body of the jig.



Jig Foot that is easily removed if broken

New York City. Donald Baker

THE SQUARE CENTER

The excellent advice given by W. E. Butler in the January number of Machinery regarding the use of a square center in preference to a steadyrest in centering round stock reminds the writer—as it must many other "old timers"—of the days when cold-rolled steel was unknown, and when in place of drop-forgings, the machinist was required to handle in the lathe the ordinary blacksmith variety of forgings, which were not straight, round nor accurate in any other respect. In those days if a machinist received a forging of the form shown in Fig. 1, with a hub or collar near the middle which the blacksmith had made unnecessarily large, and that was so far from concentric with the rest of the work that it would not "clean up" to size if the shaft was centered at its end, the machinist put the faithful square center in the tailstock and mounted a crotch in the toolpost; the crotch was then brought up against the collar on the forging and the piece was soon centered up in this way so that it could readily be turned to the required dimensions.

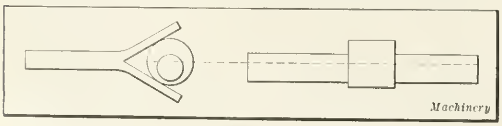


Fig. 1. Method of centering an Inaccurate Forging with a Crotch and Square Center

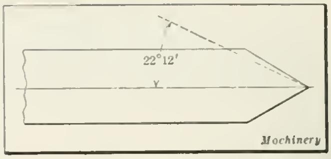


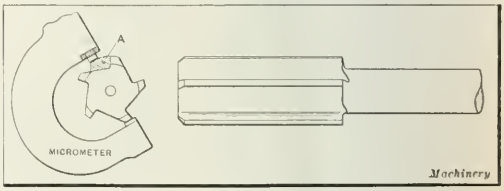
Fig. 2. Diagram showing Proper Angle to grind 60-degree Square Center

During recent years the geographical distribution of the square center is somewhat curious, as is the case with many other tools and methods of doing work. In some shops the square center is in frequent use, while in other parts of the country it is virtually unknown. In one large Eastern shop a man was employed to show from twelve to twenty lathe operators the easiest and quickest ways of doing certain classes of work, and this instructor suggested the use of the square center on such jobs as Mr. Butler mentioned. The instructor found that none of the men under his supervision had ever heard of the square center, these men having been taught to employ the steadyrest exclusively; and further investigation showed that out of about two hundred machinists there was only one who had gained any experience with the use of the tool. Some machinists prefer to make the cutting center triangular instead of four sided, believing that this is the means of obtaining a more efficient and durable edge. Either form of tool is easily made and ground if it is remembered that for a 60-degree center the proper angle to use in milling and grinding is 22 degrees, 12 minutes for the square center, and 26 degrees, 34 minutes for the triangular center.

New London, N. H. Guy H. Gardner

CALIPERING FIVE-FLUTE REAMERS

It is sometimes desirable to make reamers or similar cutting tools with an uneven number of flutes, or with teeth that are staggered so that the spacing is unequal. However, the calipering of such tools, when grinding the diameter, is a difficult matter, because no two flutes are opposite each other, and hence a true reading of the micrometers cannot be readily obtained. The illustration shows a five-flute reamer after it has been hardened, ready to grind. A piece of brass *A* is lightly soldered into place against one of the flutes, and this is ground while the cylindrical grinding is being done, so that the calipers can be used across the brass and on the tooth at the opposite side. After the proper diameter has been reached, it is only necessary to touch the piece of brass with a hot soldering iron or to heat it slightly in order to remove the block from the flute.

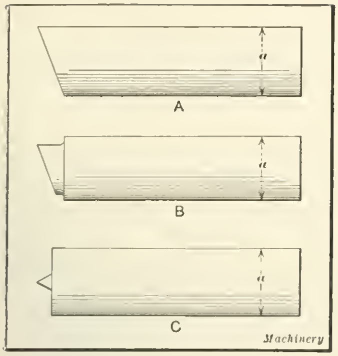


Method of calipering Five-flute Reamers

A. A. D.

PLUG SCRIBERS FOR TRANSFERRING HOLES

A handy style of plug scribers for transferring holes when attaching brackets or other parts to machines is shown in the accompanying illustration. The dimension *a* of the plugs is



Plug Scribers for transferring Holes from One Machine Part to Another

the same as the diameter of the hole to be transferred. Plug *A* is cut off at one end to an angle of about thirty degrees to form a marking point for transferring the size of the hole. Plug *B* is turned down at one end to the diameter of a tap for a screw of the size of the scriber body *a*.

The bracket is held in position against the machine and the scriber *A* or *B* (according to whether a through bolt or a screw is to be used in the hole) is inserted in the hole in the bracket and given a couple of turns, bearing against the end, so that a circle of the desired size is scribed. The plug is then removed and plug *C* is inserted and struck with a hammer, making a punch mark for starting the drill. After the holes are scribed and the punch mark is made, the bracket is removed and the holes are drilled.

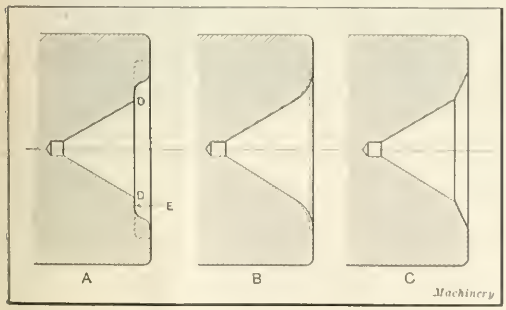
This method is quicker and more accurate than the old method of using scriber, dividers and center punch. A set of these plug scribers was made up ranging from 1/4 to 1 inch in diameter, a small flat being milled near the end on which the size was marked, and these plugs were kept in a tool-crib with the drills.

M. H. Chase

SHAPES OF WORK CENTERS

Now that almost all centers are made with a 60-degree included angle, could we not standardize other details? Much diversity of opinion exists as to the proper size of centers for different classes of work; the chamfer is made in a variety of forms, and the drilled hole varies considerably in both diameter and depth. The writer would like to know what is the best form of chamfer. The centers shown at *A* and *B* are the ones most generally used; the type shown at *A* is the one usually found on tool-room made tools, while the type shown at *B* is employed by manufacturers of arbors and other parts that are likely to experience hard service. It would seem that type *B* is the better form from all viewpoints except that it may cost a trifle more to make; but the form of center shown at *C* is as good as either of the preceding types and costs less.

Some toolmakers prefer the form shown by dotted lines at *A*, but this design really increases the objection to this type of center in that it leaves corners *D* more exposed and increases the liability of the lathe center catching on flat surface *E* when centering the work. When the chamfer is of the form shown at *A*, there is always a possibility for a fin to be raised at *D* which will do away with the usefulness of the chamfer.



Commonly Used Types of Centers A and B, and Third Type C that combines Advantages of A and B

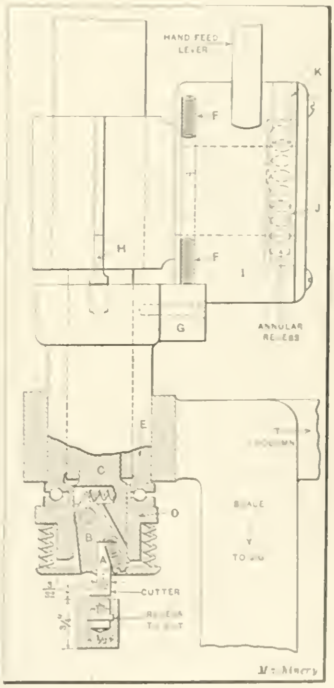
The fin is also likely to be pressed into the center. The combination countersink and drill has been much longer coming into use than is warranted by the merits of this type of tool, but now that it is fairly well established why not have a combination countersink, chamfer and drill? With such a tool, centers of the form shown at *B* could be made at a single operation, and if they occasionally came out as shown by the dotted lines no great fault could be found with the result. The types of combination countersink and drill which are at present available in the market, are provided with drills that are too long to be used conveniently. The makers probably believe that users of these tools think they are getting more for their money if they get a long drill, but if the user has had much experience with these tools he will generally reduce the length by about one-half before starting to use it. Except when working in very soft material, a long drill wastes time and is more likely to be broken than a short one.

Another phase of the subject of centers is the question of lubrication. All agree that the ideal lubricant must be heavier than oil, white or red lead being used in most cases. Practice varies in regard to cutting the oil groove; some provide the groove in the work and others in the lathe center. The latter appears to be the better practice, as a groove along the top of the dead center is always in a fixed and convenient position. The groove should be narrow and not too deep.

Wilkinsburg, Pa. William S. Rowell

EFFICIENT RECESSING TOOL

On a contract for some automobile parts, we were confronted with the problem of developing a method for cutting an annular recess 3/32 inch wide by 3/32 inch deep in a hole 5/16 inch in diameter. As there were 50,000 parts to be machined, the object was to develop tools which would do the work in the most inexpensive way; it was also necessary for the operation to be completed at least as rapidly as the preceding and following operations in order to avoid delay. The jig that we designed was of ordinary construction but provided with a hopper for the blanks and so arranged that a single movement of a hand-lever delivered a block to the jig and clamped it in place. The 5/16-inch hole had already been drilled in the parts before they were delivered to the hopper. The return movement of the lever discharged the block through a chute that dropped it in a suitable receiver. In this way the time of handling was reduced to a minimum.



Tool used for cutting 3/32-inch Recess in a 5/16-inch Hole

The accompanying illustration shows the cutting tool and the manner in which the feed was obtained; a few changes made on the Taylor & Fenn drill press made it possible to obtain the entire feed motion by a single movement of the hand feed lever. The cutting tool *A* is carried in a flat piece *B*

that is supported by a pivot near its upper end and held by a spring so that when the spindle is brought down the revolving tool will just enter the 5/16-inch hole. Tool *A* and swinging block *B* are carried by stem *C* which fits into the taper hole in the spindle of the drill press. The spindle stop governs the depth at which the recess is cut in the 5/16-inch hole, and the depth of the recess is determined by the tool. The method of obtaining the cross-feed of the tool is as follows: Collar *D* is a sliding fit on stem *C* and is normally held up by compression springs; but collar *D* can be pushed down by sleeve *E* which is a close fit on the outside of the spindle. The vertical movement of the sleeve on the spindle is obtained by means of screw *F*, which engages projection *G* on the sleeve, and the sleeve is prevented from rotating on the spindle by means of pin *H*. The downward movement transmitted to collar *D* causes its inner beveled edge to swing piece *B* about its pivot, and results in feeding cutter *A* into the work to cut a recess of the required depth. The difference between the recess cut by this swinging action of the tool and that which would be obtained by a straight cross-feed is practically nil. An upward movement of collar *D* and the action of the compression springs return cutter *A* to the starting position ready to be lifted out of the work.

In order to obtain this combination of movements for tool *A*, the parts of the regular hand feed mechanism were removed from the pinion shaft and a cast-iron ring *I* substituted, which has a turned recess at the outside that is covered by a plate. Two pins project into this recess, pin *J* being connected to the pinion shaft and pin *K* to the ring; there is a compression spring between the two pins. This spring permits the normal vertical movement of the spindle downward until the stop is engaged, at which point the spring is compressed while the ring is turned sufficiently to cause screw *F* to impart motion to the cross-feed mechanism. All working parts are made of hardened steel and ample provision is made for lubrication, the latter being an important matter because the machine was operated at a speed of 1500 revolutions per minute and it was necessary to obtain a fine finish on the work.

It will be noted that a brace is provided between the column of the machine and the jig, and also between the column of the machine and the sleeve surrounding the spindle at the lower end. In this way a rigid construction is obtained, and errors due to vibration are practically eliminated. The average rate of production was 100 pieces per hour, and twelve cutting tools made of carbon steel were found sufficient to complete machining the 50,000 pieces. This method offered an easy means of doing what might otherwise have been a difficult job, and the tool showed itself to be entirely fool-proof. In operation, it was merely necessary to work the left-hand lever for feeding the work into the jig, and the right-hand lever to operate the feed. The work was done at the plant of the Morgans & Wilcox Mfg. Co., Middletown, N. Y.

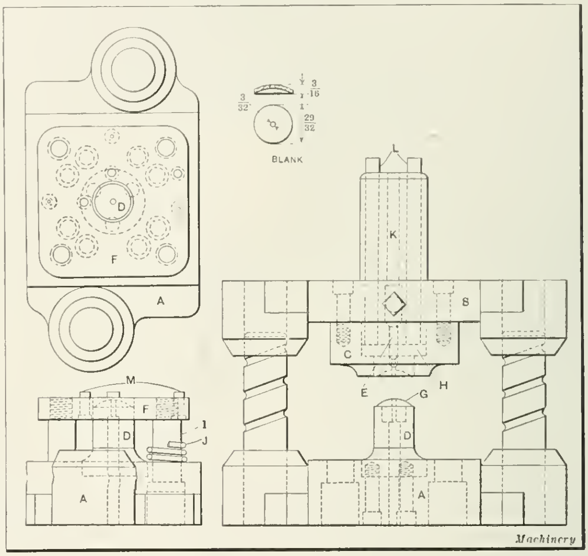
Middletown, N. Y. DONALD A. HAMPSON

PIERCING, BLANKING AND FORMING DIE

The blank shown in the accompanying illustration might be made in any one of several types of dies, but as there was a large number to be made, the writer considered the compound die shown to be best adapted for this job. The number of parts required was 50,000, which seemed to warrant the making of this style of die, as the work was completed in one stroke of the press. The stock from which the blank was made was hot-rolled steel, 0.050 inch thick by 1 inch wide. It was proved eventually that this die, hand-fed, would turn out about 15,000 blanks per day.

The die is of the pillar type, and the punch *D* is carried in what is normally the die-holder *A*, the die being carried in what is normally the punch-holder *B*. The piercing punch *E*, however, is held in its normal position in holder *B* by a set-screw, and it may be pushed out when necessary through hole *K*. The pad *F* is cut out for the punch *D* and is held a little above the top of the punch by the springs *J*, being limited in its upward travel by the headed studs *I*. On pad *F* are pins *M* which guide the stock while it is being fed over the punch.

The punch *D* is bored out to receive the former *G*, which fits it snugly. In former *G* there is a 3/32-inch hole for the piercing punch *E* to enter. Former *G* is made a separate piece so that it can be removed when grinding the die.



Compound Cupped Washer Die

The knock-out *H* is made a sliding fit in the die *C* and has a hole through its center for the punch *E*. The two pins *L* pass through the punch-holder shank and abut against the knock-out *H*. On the upward stroke of the ram the upper ends of the pins *L* come in contact with a fixed stop on the press, ejecting the blank from the die.

In operation, the stock is fed over the punch *D* and former *G*, being guided by pins *M*. As die *C* descends, contacting with the stock, pad *F* descends until the stock is forced against the top of former *G*, when the stock is cupped over former *G* and the cup is blanked out. While the cup is being blanked, punch *E* pierces the 3/32-inch center hole.

The knock-out *H* is cut out on its face to fit the contour of the cup when formed, but this in no way assists the process of cupping the blank. It is simply for ejecting the finished cup from the die. This knock-out virtually floats in its position in die *C*. It might have been better design to have made the face of the knock-out *H* come about 3/16 inch below the face of the die *C*, but as no trouble was experienced in this respect it was made as shown. In other respects this die was made according to ordinarily accepted design.

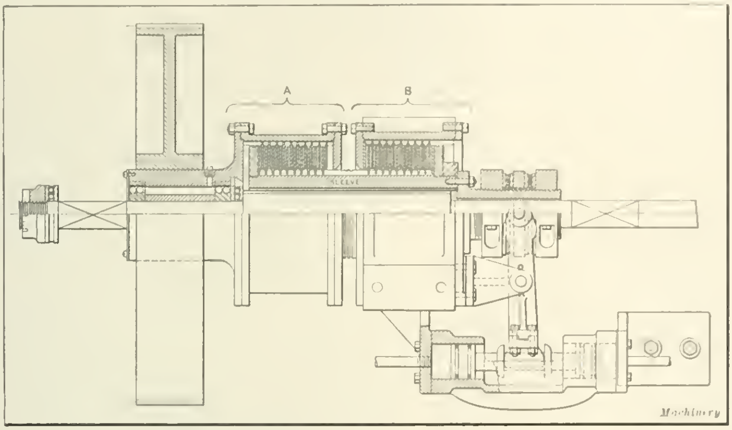
Chicago, Ill. A. H. WILSON

EFFECTIVE CLUTCH MECHANISM

It is sometimes necessary to start and stop machines or certain parts of machines smoothly, with great rapidity, and in synchronism with other moving parts. With light or slow moving apparatus the problem is relatively simple, but the difficulties multiply as weight and speed are increased. The clutch mechanism here described has shown such an unusually efficient and consistent performance during a period exceeding two years, that it is of more than passing interest. One of these machines has been transmitting a load of twenty horsepower, operating about 3600 times per day, under unusually trying conditions, with practically no trouble of any kind except a broken shaft which was found to be due to an imper-

fect forging. This machine picks up its load from dead rest, makes three revolutions and comes to rest again in three-fifths second, or at an average rate of 300 revolutions per minute, without the slightest shock or effort. When it is considered that the clutch drum is driven at only 340 revolutions per minute, and the engagement is only a fraction of a second, it will be seen that the slip is very slight indeed. The absence of shock may be attributed to the perfect cushioning of the pressure applied to the clutch and to the liberal friction area provided, there being close to a square inch for each pound of pull at the average radius of the disks.

The device consists essentially of two multiple disk friction clutches of the dry type mounted tandem on a single sleeve which is fitted to slide but not to turn on a shaft that is directly coupled to the intermittent load. The general construction of the two clutches is shown in the accompanying illustration, in which *A* is the driving clutch, and *B* the brake clutch. The two clutches are built up in the usual form for disk clutches, that is, with two alternate series of disks, one keyed to the driving member and the other to the driven member; one set is preferably faced with friction fabric. One type of disk is provided with internal projections to engage longitudinal slots on the sleeve, while the other disks have external projections loosely fitting the internal slots of the driving and braking clutch drums. The projecting lugs on the disks are reinforced to provide greater bearing surface on the sides of the slots in which they travel. As both clutches are mounted on the same sleeve, and the outer part of the driving clutch is continuously driven, the sleeve becomes the driven member of the driving clutch and the driving member of the brake clutch. The driven member of the brake clutch is solidly bolted to the frame of the machine of which the clutch constitutes a part, so that in reality it is not driven, but acts as a brake to bring the sleeve to rest when this clutch is engaged.



Design of Quick-acting Friction Clutch, operated by Air Pressure

The shaft, which is mounted on two bearings as indicated, is square, for convenience, where it carries the clutch sleeve. Both the clutch drums are built in skeleton form to facilitate the egress of material wearing off the friction facings, and to permit of the easy application of castor oil to the facings. If this treatment is not neglected, a set of facings may be expected to last two years or more in constant service, but if the facings are allowed to become entirely dry their life will be much shorter. It will be seen that the sleeve is provided with a flange on each end so that when it is moved endwise the disks of one of the clutches will be clamped between one of the sleeve flanges and the head of one of the clutch drums, while the pressure on the disks of the other clutch will be released. Movement of the sleeve in the opposite direction will release the disks of the first clutch and clamp those of the second. In the illustration the parts are shown in the position of rest, or with the driving clutch disengaged and the brake clutch set.

The novel part of the device is the controlling mechanism, which is operated pneumatically and may be made automatic by connecting with other moving parts to actuate the valves. It will be seen that the actual movement of the sleeve which engages and disengages the clutches is accomplished by two opposed pneumatic cylinders and the connections shown. It will be apparent that the cylinders must work alternately, that is, when one is under pressure the other must be open or free to exhaust. The distribution of air is controlled by two valves, together with a series of interconnecting pipes. With the valves in the "up" position, compressed air is free to pass through the pipe to one of the cylinders, and to the top of the other valve. This latter connection is for the purpose of forcing the other valve down, cutting off the air supply of the cylinder it serves, and opening it to exhaust. It also leaves the valve in position for further action.

A small hole near the live air inlet leads to the annular space below the valve proper, around the stem, and is open continuously, admitting air to hold the valve in the "up" position when so placed. As the only connections between the controlling valves and the cylinders are pipes, the control may be somewhat remote and placed in any convenient position. Experiments have been made to determine the practicability of operating the valves magnetically, and also of moving the clutch sleeve by means of magnets, but both have been found far less efficient and much slower than air, the slowness of the electrical operation being due to the time required for the magnets to "build up." The drift of the shaft after the operation of the stopping valve has been found to be very small and practically constant, the shaft stopping within a few degrees of the same position every time. It will be noted that any wear on the friction disks or their facings is automatically compensated for by additional travel of the pneumatic pistons, so that mechanical adjustments are rarely required.

Youngstown, Ohio. H. E. WHITE

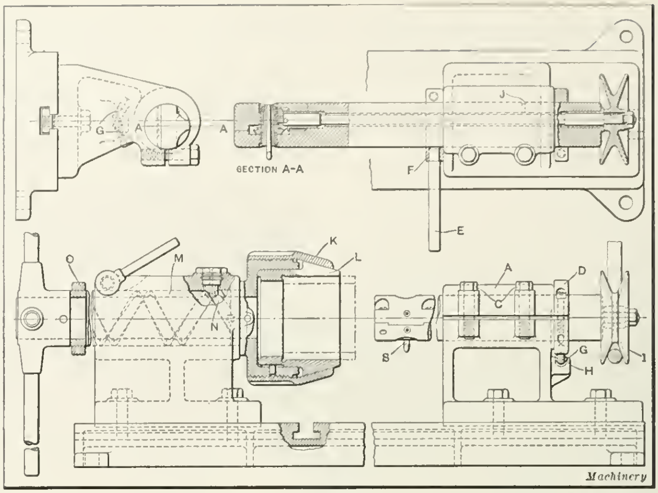
OIL GROOVING FIXTURE

We had a large number of different sizes of bearing liners in which it was necessary to machine oil grooves, and as it was required to have these cut quite accurately it was decided to construct a fixture which would enable the work to be done as rapidly as possible. The device is shown in the accompanying illustration, in which it will be seen that there is a cutter-head *A* carrying a spindle which supports cutter *B*. The position of the spindle may be adjusted to suit the length of bearing liner which is to be grooved, and after the spindle has been set in the required position it is clamped by tightening the nuts *C*, after which collar *D* is set up against the back of the cutter-head to provide for resetting the spindle in the same position for grooving each of the bearing liners.

The cutter-spindle is 1/16 inch out of alignment with the work-spindle, and by releasing screws *C* and revolving the cutter-spindle by means of pin *E* inserted in collar *F*, cutter *B* may be set to obtain the required depth of cut or to clear the work when it is necessary to withdraw the cutter-spindle in order to substitute a fresh blank. Screws *G* are so adjusted in relation to pin *H* that they limit the rotary motion of the cutter-spindle so that cutter *B* is either set to work at the required depth or to entirely clear the work, as the case may be.

It will be evident from the illustration that cutter *B* is carried by an auxiliary spindle contained within the main spindle

of the cutter-head, and that this spindle is rotated by a round belt carried on pulley *I*, from which motion is transmitted to the cutter through the auxiliary spindle and a pair of bevel gears. The auxiliary spindle runs in hardened and ground bushings at each end of the main spindle in the cutter-head, and lubricant is supplied through oil hole *J*, from which it is distributed to all parts that are housed in the main spindle. All rotary parts are provided with oil grooves to facilitate lubrication. The cutter, of the two-lip round-nose form, is made of high-speed steel.



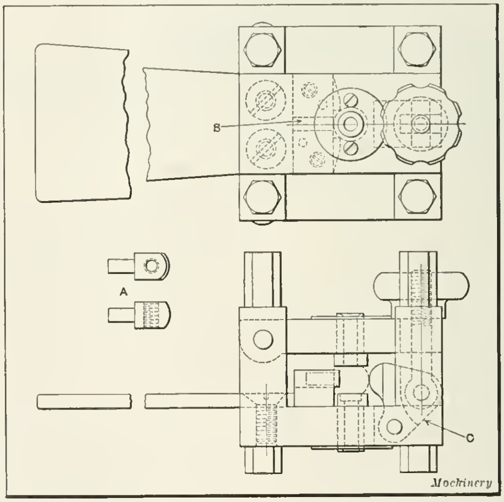
Oil Grooving Fixture for machining Bearing Liners of Various Lengths and Diameters

The work is held in chuck *K* by means of a spring collet *L*, and collets of various sizes are provided to hold the different sizes of bushings which have to be machined. In some cases it was found advisable to employ split bushings inside the collets for use in handling some of the bushings, and this method gave very satisfactory results. At the back of the work-spindle there is a capstan wheel by which the spindle is rotated. It will be seen that bushing *M* has a spiral groove cut in it of the same lead as the oil groove which it is required to machine in the bearing liner, and pin *N* fits into this groove so that when the capstan wheel is turned it results in feeding the spindle and work forward so that the oil groove will be cut in the bearing liner. It will be evident from the illustration that the forward movement of the spindle is limited by an adjustable collar *O*, which is set to give the required travel to the work-spindle. G. E. P.

JIG FOR DRILLING SMALL STUDS

The jig here described is used for drilling and tapping stud *A*, which is made from ¼ by ¼ inch cold-drawn steel. The end of the stud enters hole *B* in the locating block, and this hole is milled to provide clearance for the head of the stud. The work rests on the drill bushing which is slightly counterbored to provide clearance for the tap. The most interesting feature of the jig is that the cover and clamping mechanism are both secured by the same knob; clamp *C* holds the stud securely in place when the knob is screwed down, and the same operation tightens the cover. It will be readily seen that this principle could be employed on jigs and fixtures used for holding a great variety of parts.

JOHN HOFFMAN



Jig in which a Single Screw tightens both Clamp and Hinged Cover

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ACCURACY IN PLANING LONG WORK

The writer was recently given six parallels to plane, which were 5 inches by 5 inches by 6 feet in size. The sides were required to be perfectly straight and parallel. In handling the work the first step was to rough out the pieces, leaving 1/16 inch on each side for finishing. A light cut was then taken over the planer table to insure having it parallel with the cross-rail of the machine.

The first attempt to do the work was made on a planer with a table travel of six feet, but the results obtained were unsatisfactory. The work was finally taken to a planer with a table travel of twenty feet, and on this machine little trouble was experienced.

The cause of the trouble on the short machine was due to the fact that the table had considerable over-hang at each end, with the result that the ways had worn down and caused it to tilt at both extremes of its stroke, as shown by the dotted lines in the illustration. This condition was made worse by the fact that at the points of reversal the driving gear tends to lift the table. But on the long-stroke machine, where the work could be handled without bringing the table near either extremity of its travel, no trouble was experienced in producing accurate work.

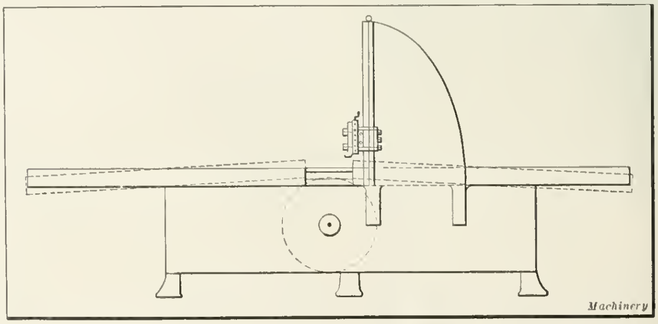


Diagram showing how Ends of Planer Ways became Worn, making it Difficult to plane Long Work and obtain Accurate Results

W. E. BUTLER
Wausaukee, Wis.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TO FIND THE VALUE OF X IN EQUATION

F. E. R.—Please show how to find the value of x to one decimal place in the equation $(1-a)^x = \frac{c-as}{c}$, when $a = 0.02$, $c = 86$, and $s = 1550$.

A.—The easiest way of solving this equation is by the use of logarithms. Substituting the values given, and taking the logarithm of both sides, $x \log (1-0.02) = \log \frac{86 - 0.02 \times 1550}{86}$. Reducing, $x \log 0.98 = \log \frac{55}{86}$. Using a five-place table, $\log 0.98 = \bar{1}.99123 = -0.00877$; $\log 55 = 1.74036$, $\log 86 = 1.93450$, and $\log \frac{55}{86} = \log 55 - \log 86 = 1.74036 - 1.93450 = -0.19414$. Therefore, $-0.00877\,x = -0.19414$, and $x = \frac{0.19414}{0.00877} = 22.13+$, or 22.1 to one decimal place. J. J.

TO DETERMINE CAPACITY OF CYLINDRICAL TANK

H. V. P.—Please give a rough-and-ready rule for finding the number of gallons that a cylindrical tank with flat ends will hold.

A.—Let d = diameter in inches; l = length in inches; L = length in feet; and G = number of gallons. Then, $G = \frac{0.7854\ d^2l}{231} = 0.0034\ d^2l = 0.0034\ d^2 \times 12\,L = 0.0408\ d^2L = 0.04\ d^2L$ approximately $= \frac{(2d)^2 L}{100}$. Hence, for a rough-and-ready rule: Double the diameter in inches, square the result, multiply by the length in feet, and divide by 100. If an accurate result is desired, add 2 per cent of the result obtained by the rule. As an example, suppose that the tank is 60 inches in diameter and 18 feet long. Doubling the diameter gives 120; $120^2 = 14{,}400$; $14{,}400 \times 18 = 259{,}200$; dividing by 100 by pointing off two decimal places, the number of gallons is 2592, approximately. Two per cent of this is $2592 \times 0.02 = 51.84$, and $2592 + 51.84 = 2643.84$ gallons, the same result as would be obtained by substitution in the formula. J. J.

DISTINCTION BETWEEN MASS AND WEIGHT

W. G. C.—What is the difference between the mass of a body and its weight?

A.—Mass is an absolute unit; it measures the amount of matter in a body. Weight, on the contrary, is a measure of the earth's attraction (commonly called gravity) on a body. So long as the amount of matter in a body is not changed, its mass remains unaltered; its weight, however, may change very materially, depending on the latitude of the place where the body is weighed, the altitude (distance above or below sea level), and the temperature and barometric pressure, if weighed in air. If weighed in air under the same conditions, two bodies may weigh alike and still have different masses. For instance, a pound of iron and a pound of wood, both having been weighed in air at the same instant, have different masses, the pound of wood containing more matter than the pound of iron. The wood would weigh more than the iron in a vacuum. The reason the two weigh the same in air is that the wood has a greater volume; this causes it to displace more air than the iron, the result being that it is buoyed up more than the iron. The effect is the same, though not so marked, as if both had been placed in water. The effect of a force in changing the velocity of a moving body depends solely upon the mass; it is independent of the weight of the body. J. J.

TO DETERMINE WEIGHT OF AIR

W. J. W.—How do you find the weight of air at any temperature and pressure?

A.—For all ordinary temperatures and pressures that occur in practice,

$$w = \frac{pV}{0.37\,T}$$

in which w = weight of air in pounds;
p = absolute pressure in pounds per square inch;
V = volume of air in cubic feet;
T = absolute temperature, degrees F.

The absolute pressure is equal to the gage pressure plus the atmospheric pressure as determined by the barometer. For practical purposes, it is sufficient to add 14.7 to the gage pressure. The absolute temperature is obtained by adding 460 to the temperature indicated by the thermometer. As an example, if a cylindrical space is filled with air having a gage pressure of 58 pounds per square inch, a temperature of 118 degrees F., and the space is 80 inches in diameter and 15 inches long, $p = 58 + 14.7 = 72.7$, $V = \frac{0.7854 \times 80^2 \times 15}{1728} = 43.633$ cubic feet, and $T = 118 + 460 = 578$. The weight of the air is $w = \frac{72.7 \times 43.633}{0.37 \times 578} = 14.833$ pounds. J. J.

RELATIVE MOTION OF TOP AND CENTER OF WHEEL

H. D. P.—I have seen it stated that the top of a rolling wheel moves twice as fast as its center; does it?

A.—It certainly does. If by top of the wheel is meant the point which at any instant is diametrically opposite the point of contact with the ground. The center of the wheel has only one motion, that of translation (*i. e.*, motion in a straight line) and its direction is parallel to the ground. The top of the wheel has not only this motion of translation but also an equal one of rotation about the center. Or the entire wheel

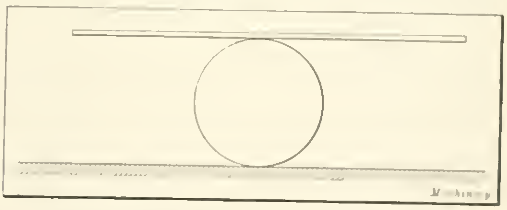


Diagram Illustrating Relative Motion of Top and Center of Wheel

may be considered as rotating about the point of contact with the ground, in which case the top, being twice as far from the ground as the center, moves twice as fast. The point is well illustrated by placing a board on top of a roller, as shown in the illustration. On pushing the board (assuming that there is no slip) both the board and roller will move ahead. If the length of the board is, say, 16 feet, it will be found to have traveled its entire length while the center of the roller was moving 8 feet. As the board is in constant contact with the roller, this proves that the top moves twice as fast as the center. J. J.

RELATIVE FORCE REQUIRED TO PUSH AND PULL A WHEELBARROW

E. F. C.—Why is it easier to pull a wheelbarrow than it is to push it?

A.—There would be no difference on a level surface if the force (push or pull) were exerted in a horizontal direction.

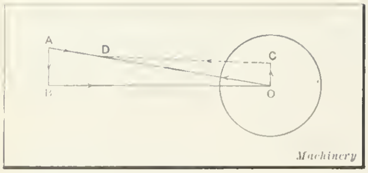


Illustration showing Forces required to push and pull Wheelbarrow

Referring to the diagram, assume that the line AO represents the center line of one of the handles, and assume further that its length represents to some scale the magnitude of the force exerted at a particular instant. If the force is a push, its direction is from A to O, and it may be resolved into two forces, one AB acting vertically downward and the other BO acting horizontally from B toward O. Since AB is perpendicular to BO, it exerts no influence whatever on BO, and BO represents to the same scale as AO the magnitude of the force tending to push the wheelbarrow ahead. AB, on the contrary, represents a force acting downward at the point O, and adds just so much additional weight to be moved. If the force is a pull, the direction is from O to A, and may be represented by OD; this force may be resolved into two forces, one OC acting vertically upward and the other CD acting horizontally from O. Since OC acts vertically upward through O, it counteracts just that much of the weight moved; hence, OD is less than AO, the load moved when pushing being greater than the load moved when pulling by an amount represented by $AB + OC$. J. J.

HORSEPOWER-HOUR DEFINED

D. G.—What is a horsepower-hour? Please explain fully.

A.—The unit of work is the foot-pound; it is equivalent to overcoming a resistance of 1 pound through a distance (space) of 1 foot. The simplest example is the lifting of a weight of 1 pound vertically 1 foot, the resistance in this case being the pull of gravity on the weight. It should be noted particularly that time is not considered. It makes no difference whether the weight of 1 pound is raised 1 foot in 1 second or in 1 year, the work done is 1 foot-pound. Hence, if a weight of 225 pounds falls a distance of 16 feet, the work it could do would be $225 \times 16 = 3600$ foot-pounds. Power, on the contrary, is the rate of doing work, and time is always considered. The unit of power is 1 foot-pound of work performed in 1 second. If the resistance in pounds be represented by r, the distance (space) in feet through which the resistance is overcome by s, the time in seconds during which the work is done by t, and the number of power units developed by p, $p = \dfrac{r \times s}{t}$. One horsepower is 550 power units; hence, dividing both sides of the equation by 550, $\dfrac{p}{550} = \text{H. P.} = \dfrac{rs}{550\,t}$. Dividing both terms of the fraction by 60, $\text{H. P.} = \dfrac{rs \div 60}{550\,(t \div 60)}$. But the time in seconds divided by 60 is the time in minutes, and letting $t \div 60 = T$, $\text{H. P.} = \dfrac{rs}{60 \times 550\,T} = \dfrac{rs}{33{,}000\,T}$. Dividing both terms of the last fraction by 60, $\text{H. P.} = \dfrac{rs \div 60}{33{,}000\,(T \div 60)}$. But the time in minutes divided by 60 is the time in hours; hence, letting $T \div 60 = T_1$, $\text{H. P.} = \dfrac{rs}{60 \times 33{,}000\,T_1} = \dfrac{rs}{1{,}980{,}000\,T_1}$. In other words, when $T_1 = 1$ hour, the product rs must equal 1,980,000 for H. P. to equal 1; and since rs is the number of foot-pounds of work performed, a horsepower-hour is 1,980,000 foot-pounds of work performed in one hour. Note that horsepower-hour is a unit of work and not a unit of power. J. J.

CALCULATION OF PARTIAL PAYMENTS

B. D.—In order to buy out a business, it is necessary to incur a debt of \$5000. The creditor is willing to accept equal monthly payments at an annual interest rate of 5½ per cent, provided the debt is paid, together with the interest, in not over eight years. How much must be paid monthly?

A.—Let p = principal;

r = rate of interest for one of the equal intervals;

n = number of payments, or number of intervals;

x = amount paid at end of each interval.

Then, by the United States rule for partial payments,

$$x = \frac{pr(1+r)^n}{(1+r)^n - 1} = \frac{pr}{1 - \dfrac{1}{(1+r)^n}}$$

In the present case, $p = \$5000$, $r = 0.05\tfrac{1}{2} \div 12 = \dfrac{11}{2400}$, and $n = 8 \times 12 = 96$, since the interval is one month. Substituting in the formula, and noting that $1 + r = 1 + \dfrac{11}{2400} = \dfrac{2411}{2400}$,

$$x = \frac{5000 \times \dfrac{11}{2400}}{1 - \left(\dfrac{2400}{2411}\right)^{96}} = \$64.496$$

Assuming that \$65 is paid each month, the debt will be cleared off in n months. Solving the formula for n,

$$n = \frac{\log\left(\dfrac{x}{x - pr}\right)}{\log(1+r)} = \frac{\log\left(\dfrac{65}{65 - 5000 \times \dfrac{11}{2400}}\right)}{\log\left(\dfrac{2411}{2400}\right)} = 95.067 \text{ mos.}$$

Six-place logarithms were used in these solutions. J. J.

METHODS OF CHECKING MULTIPLICATION

N. R. M.—I have a great deal of multiplying to do. Is there any safe method of determining whether the product is correct or not without repeating the work?

A.—The method ordinarily used is that of casting out 9's. This is effected by dividing the multiplicand and multiplier by 9 and noting the remainders, which are then multiplied together and divided by 9; if the remainder thus obtained is the same as the remainder obtained by dividing the product by 9, the work is probably correct; but if it is not, the work is wrong. Thus, $7854 \times 2905 = 22{,}815{,}870$. Here $7854 \div 9$ gives a remainder of 6; $2905 \div 9$ gives a remainder of 7; $6 \times 7 = 42$, and $42 \div 9$ gives a remainder of 6; $22{,}815{,}870 \div 9$ gives a remainder of 6, and the work is probably correct. This test is not always certain, since the remainder when dividing by 9 may always be obtained by adding the digits, then adding the digits of the sum, etc., until a single figure is obtained; hence, if one or more mistakes are made whereby the sum of the digits (reduced to a single figure) is unchanged, the test fails. Thus, the remainders obtained by dividing the foregoing numbers by 9 are, respectively, $7 + 8 + 5 + 4 = 24$, and $2 + 4 = 6$; $2 + 9 + 5 = 16$, and $1 + 6 = 7$; $4 + 2 = 6$; and $2 + 2 + 8 + 1 + 5 + 8 + 7 = 33$, and $3 + 3 = 6$. If the product obtained had been 22,815,780, 23,805,870, 22,814,970, or any one of numerous other combinations in which the sum of the digits when reduced to one figure is 6, it is evident that the test would fail. When adding the digits, no 9's or figure combinations that obviously make 9 should be added. In 7854, $5 + 4$ obviously make 9; hence, say $7 + 8 = 15$, and $1 + 5 = 6$. In 22,815,870, $8 + 1$ is obviously 9; hence, say $2 + 2 + 5 = 9$, and reject it; then say $8 + 7 = 15$, and $1 + 5 = 6$. A much better test, and one that is practically certain, is to divide by 7. Thus, $7854 \div 7$ gives a remainder of 0; here without proceeding further it is known at once that the product when divided by 7 must give a remainder 0, since one of the factors being a multiple of 7, the product is a multiple of 7. Dividing 22,815,870 by 7, the remainder is 0, showing that the work is correct. Consider the product $7853 \times 2904 = 22{,}805{,}112$. Here $7853 \div 7$ gives a remainder of 6; $2904 \div 7$ gives a remainder of 6; $6 \times 6 = 36$, and $36 \div 7$ gives a remainder of 1. Since $22{,}805{,}112 \div 7$ gives a remainder of 1, the work is correct. The reader should apply the 7 test to the preceding numbers that were apparently correct by the 9 test, but were wrong in reality. J. J.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

ROOT & VAN DERVOORT LINE OF SHELL MACHINERY

This line of special machinery for use in performing various machining operations on shells has been developed to give satisfactory service under the unusually severe conditions which exist in munition factories. In working out the designs, each machine has been made as simple as possible because it is realized that the scarcity of experienced machine operators will make it necessary to employ much unskilled labor. It will be noticed that the designs of all machines have been standardized as far as possible, and the most noticeable features are simplicity of design combined with exceptionally heavy construction.

The Root & Van Dervoort Engineering Co., East Moline, Ill., has designed a line of special machinery for use in the manufacture of 6-inch, 8-inch and 9.2-inch howitzer shells. These are single-purpose machines which are constructed on exceptionally heavy lines to adapt them for the severe service required of machines used in munition making factories; and as the design of each machine has been simplified as far as possible, it takes only a short time to teach a man possessing some mechanical knowledge how to operate these machines. Naturally this is an important matter in factories which are building up an organization to turn out a large shell order which must be completed by a specified time, and on which there is likely to be a bonus for completion ahead of the date called for in the contract.

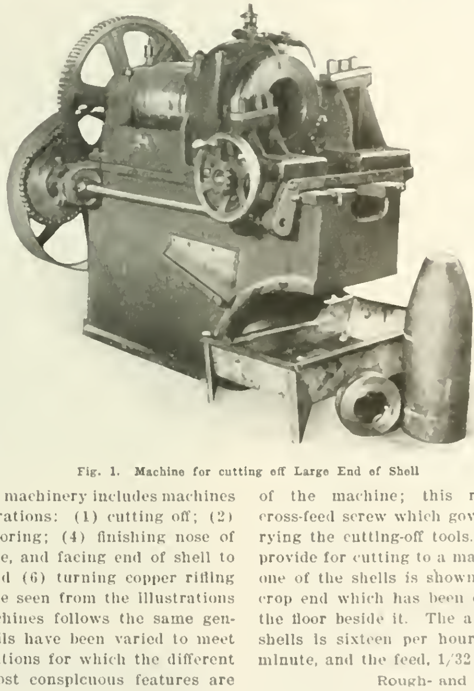


Fig. 1. Machine for cutting off Large End of Shell

This line of shell manufacturing machinery includes machines for performing the following operations: (1) cutting off; (2) rough- and finish-turning; (3) boring; (4) finishing nose of shell; (5) machining band groove, and facing end of shell to reduce it to standard weight; and (6) turning copper rifling band to required form. It will be seen from the illustrations that the design of all these machines follows the same general lines, although certain details have been varied to meet the requirements of special operations for which the different machines are intended. The most conspicuous features are the exceptionally heavy construction and the simplicity of design. Having been designed with special reference to the work for which they are intended, these machines are capable of giving highly satisfactory results, both as regards their rate of production and the quality of the finish which it is possible to obtain on the shells.

Cutting-off Machine

Fig. 1 shows the cutting-off machine which is employed for removing the excess metal from the open end of the shell. As in all the Root & Van Dervoort machines, the spindle is made of semi-steel and is of exceptionally large size. It is 32¾ inches long, and is supported by a front bearing 14 inches in diameter by 8¾ inches long and a rear bearing 7 inches in diameter by 7 inches long. The bearings are babbitted, hammered and scraped to fit the spindle which is hollow, the hole being 12 inches in diameter. Longitudinal adjustment of the spindle is afforded by a lock ring located immediately behind the front bearing. The shells have been drilled through the nose and the nose has been faced at the time they are delivered to the cutting-off machine. To provide for performing the cutting-off operation, the shell is centered in the spindle from the drilled hole in the nose and its longitudinal position is located by the faced end of the nose. The open end of the shell is clamped by four screws which extend through the hollow spindle.

The machine is driven by a constant-speed single pulley, 30 inches in diameter, which carries an 8-inch double belt. From this pulley the power is transmitted through gears which are 3 inches face width and 3 pitch. Motion for the cross-feed of the cutting-off tools is provided by a roller chain which runs over a sprocket bolted direct to the gear on the spindle and drives a feed-rod located at the front of the machine; this rod transmits the power to the cross-feed screw which governs the movement of the slide carrying the cutting-off tools. These tools are 3/8 inch wide and provide for cutting to a maximum depth of 4 inches. In Fig. 1 one of the shells is shown standing by the machine, and the crop end which has been cut off from this shell is shown on the floor beside it. The average rate of production on 8-inch shells is sixteen per hour; the cutting speed is 52 feet per minute, and the feed, 1/32 inch per revolution.

Rough- and Finish-turning Lathes

The lathe shown in Fig. 2 was developed for performing the rough- and finish-turning operations on 8-inch and 9.2-inch high-explosive shells. Comparing the design of this machine with that of the cutting-off machine shown in Fig. 1, it will be seen that the bed is the same in both cases except that the bed of the turning lathe is longer and provided

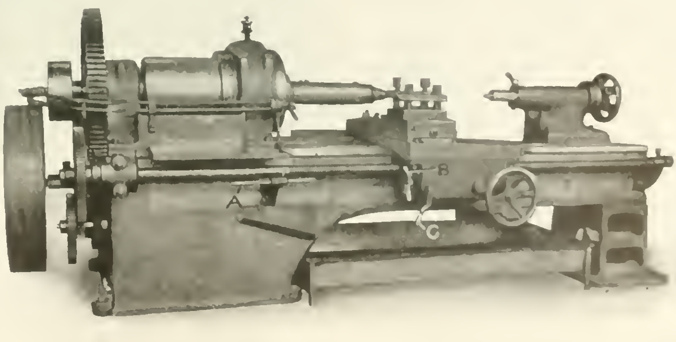


Fig. 2. Type of Lathe developed for performing Rough- and Finish-turning Operations on High-explosive Shells

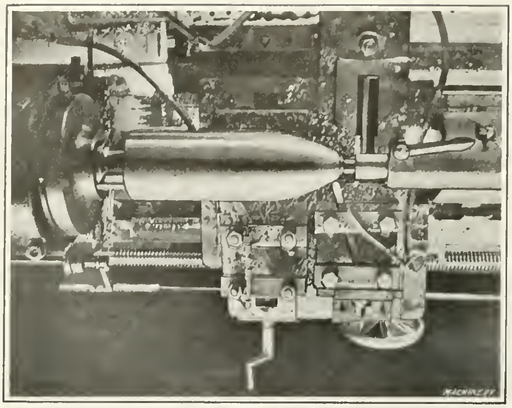


Fig. 3. Close View of Tools used for performing Rough-turning Operation

with a pedestal to support it at the tailstock end. In this respect, the cutting-off machine and turning lathe represent the two typical forms of bed construction employed in all the Root & Van Dervoort machines. As in the case of the cutting-off machine, the drive for the turning lathe is provided by a 30-inch single pulley which carries an 8-inch double belt. The spindle is also of similar design, except that it has an expanding mandrel bolted to its face which is operated by a Hannifin air chuck, instead of having the end of the spindle open as in the case of the cutting-off machine. The end of the mandrel on the turning lathe carries a bearing that extends through the 1 11/16-inch hole which was drilled in the nose of the shell at the first operation. This bearing is centered to receive the tailstock center, and provides ample support for the work while the turning operation is being performed.

It has been mentioned that this type of lathe is used for both rough- and finish-turning operations, but the design of the carriage on the machines used for these two operations is slightly different. On the machine used for rough-turning, the carriage is made exceptionally wide and is fitted with two toolposts. The tool in one of these posts turns the straight wall of the shell; the second toolpost is carried on a slide that is guided by two rollers which run in contact with a formed plate at the back of the lathe bed, and the transverse movement of the tool afforded in this way provides for rough-turning the nose of the shell to the desired shape. In performing the finish-turning operation, the carriage is provided with a single toolpost which supports a circular high-speed steel tool. The transverse position of the slide that carries this toolpost is governed by a formed plate which extends the entire length of the shell. This plate is the same shape as the shell so that the finish-turning operation can be done at a single traverse of the carriage. Fig. 3 shows the lathe tooled up for rough-turning, and Fig. 4 shows a machine used for performing the finish-turning operation.

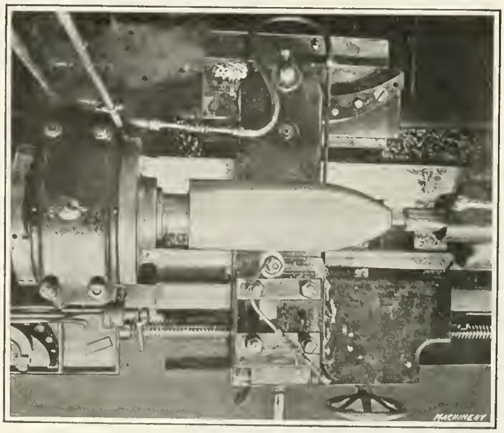


Fig. 4. Close View of Lathe tooled up for performing Finish-turning Operation

The method of chucking provides for eliminating all eccentricity of the forging by the roughing operation, so that the bore is brought concentric with the outside of the shell. An automatic trip throws the feed out when the turning operation has been completed. For this purpose a bracket *A*, Fig. 2, is bolted to the bed of the machine, and this carries an adjustable rod which engages lock lever *B* when the turning operation has been completed. Engagement of rod *A* and lever *B* results in allowing lock-nut lever *C* to fall and open the split nut in the apron, thus stopping the feed of the carriage. After the trip has once been set it operates automatically, it being merely necessary to reengage the feed by lifting lever *C*. In rough-turning, the average rate of production is four shells per hour; the machine operates at a cutting speed of 45 and 70 feet per minute with a feed of 1/16 inch per revolution. For finish-turning the rate of production is also four shells per hour; the machine operates at a cutting speed of 50 and 75 feet per minute with a feed of 1/16 inch per revolution of the spindle.

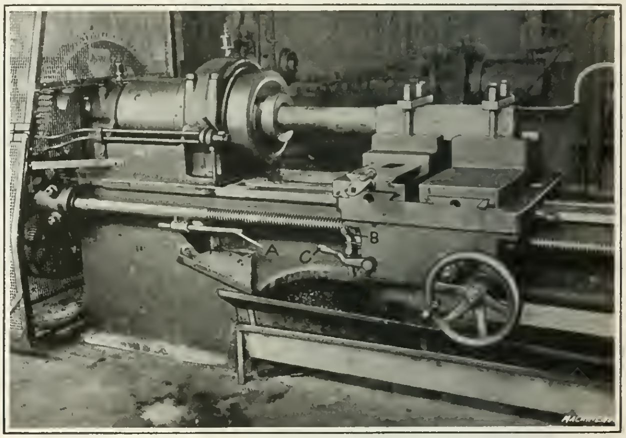


Fig. 5. Machine developed for performing Boring Operation on Shells

Shell Boring Lathe

For performing the rough- and finish-boring operations on the shells, use is made of machines of the type shown in Fig. 5, and reference to this illustration will make it apparent that the description which has already been given of the bed, headstock and spindle of the cutting-off and turning machines, also applies to the boring machines; it will also be evident that the carriage on the boring machines is furnished with the same feed trip mechanism that is used on the turning lathes. The hollow spindle is provided with a three-jaw collet, shown in Fig. 6, which is operated by a Hannifin air chuck. The shells are pushed into this collet and the drilled nose is located over

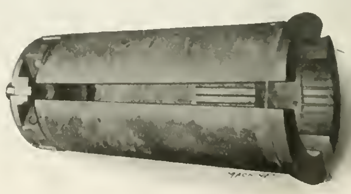


Fig. 6. Type of Collet used to hold Work on Boring Machine

a plug, while the faced end of the nose strikes against a distance stop; then when the air chuck closes, the shell is automatically centered at both ends, ready for the boring operations to be performed.

The advantage gained by removing all eccentricity from the outside of the shell becomes apparent when the work has progressed to the point where the shells are ready to be bored, as having a uniform outside surface enables the shell to be held rigidly and reduces the amount of metal which must be removed during the boring operation. Reference to Figs. 5 and 7 will make it evident that an unusually heavy boring-bar is used, the bar being made from a cast steel section, 4 by 4 inches in size. It will also be noticed that two cross-slides are provided on the carriage to afford a rigid support for the bar; the front slide is guided by a master plate at the back of the lathe which provides for obtaining the required contour for the inside of the shell, and the rear slide simply serves to steady the boring-bar. The cutting tool is mounted at the extreme end of the bar and a stream of cutting compound is directed against the work, the volume being sufficient to wash away all chips.

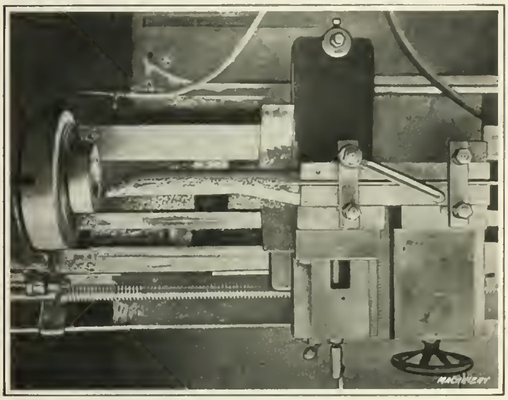


Fig. 7. Close View of Boring-bar set up on Machine

The preceding description applies to the machine used for the rough-boring operation, but a similar type of machine is employed for finish-boring the shells. The two boring operations follow each other and come between the rough- and finish-turning operations on the outside of the shell. This provides for removing the marks made by the serrated jaws of the collet. The average rate of production for rough-boring is four shells per hour and the work is done at a speed of 50 and 75 feet per minute, with a feed of 1/16 inch per revolution. For finish-boring, the rate of production, cutting speed and feed are the same as for rough-boring.

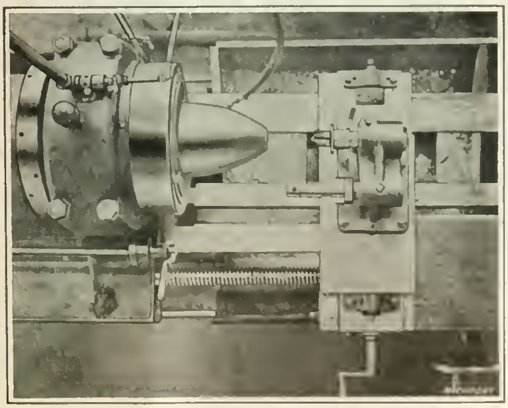


Fig. 9. Close View of Tools on Machine for boring, reaming, facing and tapping Nose of Shell

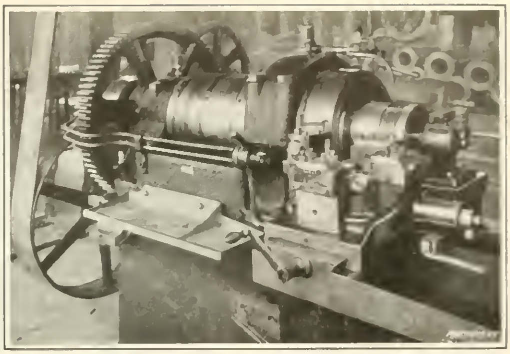


Fig. 9. Machine for turning, under-cutting and waving Band Seat, and facing Shell to Required Length

Nose Finishing Machine

A close view of the tools on the machine developed for use in finishing the nose of the shells is shown in Fig. 8. This machine is of almost exactly the same general design as the cutting-off machine, except that the cantilever bed is about twelve inches longer. The spindle is fitted with the same type of three-jaw collet that is used on the boring machine, as shown in Fig. 6, and provides for holding the shell with the nose out. The carriage carries two tools, mounted on a cross-slide which has two stations. The first tool finish-bores, reams, and faces the nose of the shell, after which the slide is moved over to bring the second tool into the operating position. This is a Murchey collapsible tap used for threading the hole in the nose of the shell to receive the fuse. The average rate of production on this machine is ten shells per hour, the cutting speed is 25 feet per minute, and the feed 1/14 inch per revolution.

Band Seat Turning, Waving and Under-cutting Machine

The Root & Van Dervoort machine for turning, waving and under-cutting the band seat in shells is shown in Fig. 9; it is of the same general design as the nose finishing machine shown in Fig. 8, except that a four-station hand-operated turret

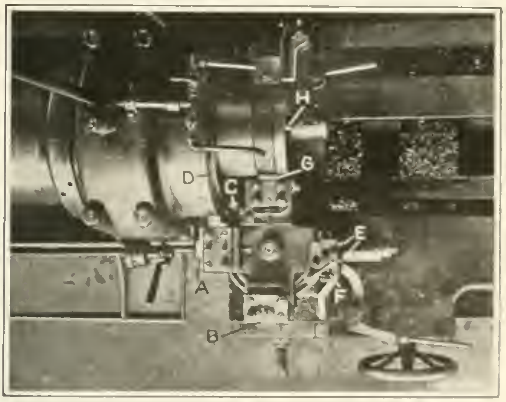


Fig. 10. Close View of Tools used on Machine shown in Fig. 9

is provided in place of a two-station cross-slide. The tools for machining the band seat, which are carried on the turret, are supplemented by a tool on the carriage which is used for cutting off the shell to exactly the required length. There are four sets of tools in the turret for operating on the band groove, and the method of chucking the shell is exactly the same as that used in the rough- and finish-boring operations. A close view of the tool equipment is shown in Fig. 10, and the operations performed on these tools are (1) cutting the band seat, which is done by a cutter *A* of the required width; (2) removing excess metal between waves, which is done by a set of six tools *B*, the form of the waves being ob-

tained by a hardened roller *C* on the turret which runs in contact with cam *D* on the face of the spindle; (3) under-cutting, which is done by two tools *E* mounted on the toolpost and formed to the required angle of the under-cut, the in and out movement of the tools being effected by turning a small worm and worm-wheel *F*; (4) finishing the waves, which is done by a formed tool *G*, the movement of which is controlled by a hardened roller which runs against the cam on the face of the spindle. It was mentioned in the foregoing that a tool was provided on the carriage for the purpose of cutting off the shells to exactly the required length. This tool is shown at *H* in Fig. 10. For the entire sequence of operations performed on this machine, the average rate of production is five shells per hour. The machine operates at a cutting speed of 40 feet per minute and the feed is controlled by hand.

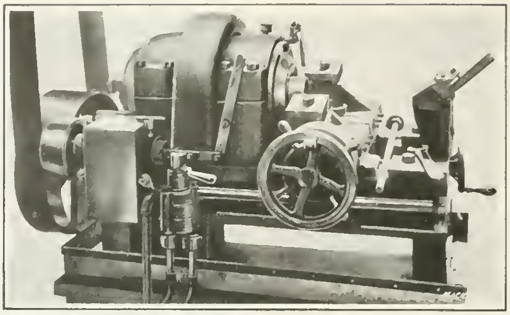


Fig. 1. Machine for cutting off Open End of Shell Forgings

HORNE-DALE-BROWN SHELL MANUFACTURING MACHINERY

The machines described in the following article were originally developed by a well-known firm of machinery builders for use in working on a contract for shells which it has taken from one of the European belligerents. But the results obtained with the machines have been so satisfactory that it has been decided to place them on the market. The design of each machine is quite simple, so that an unskilled operator can soon be taught to run it, and all of the machines are rigidly constructed to stand up under the severe service which is usually met with in munition factories.

This article describes a line of single-purpose shell manufacturing machines which have been designed to withstand the wear and tear of continuous service in munition factories. As a large part of the machining operations on shells are likely to be performed by unskilled labor, these machines have been made as simple and as nearly fool-proof as possible. They are manufactured by a well-known firm of machinery builders which is working on a large contract for shells; and this concern decided to build special machines for its work, because of the difficulty of securing early deliveries from manufacturers of machine tools. The experience of this firm in building machinery, combined with the study which its engineers have made of the problems connected with shell manufacture, has resulted in the development of machines which are particularly well suited to the requirements of the work for which they are intended.

The Horne, Dale, Brown Co., Inc., 545 W. Washington Boulevard, Chicago, Ill., has the sales agency for this line of shell machinery, which includes tools for (1) cutting off shell forgings to length; (2) rough-turning and facing; (3) machining, waving and under-cutting band seat; (4) boring and reaming powder pocket; (5) boring, facing and threading nose of shell; (6) finish-turning body and nose of shell; (7) pressing on copper band; (8) turning copper band; and (9) marking shell. The machines are made in different sizes and have capacities for handling shrapnel and high-explosive shells up to 6 inches in diameter. The average rate of production for each machine is given in the accompanying table, these production figures being taken from the time sheets of a plant which has been using the machines continuously over a period of three months.

Fig. 1 shows the machine used for cutting off the end of the shell forgings to reduce them to standard lengths; the machines developed for machining the band groove, facing the end of the shell to reduce it to standard weight, machining the nose of the shell, and finish-forming the outside of the nose are also of the same general design. In other words, the designs of all the machines in which the work is held in the chuck are the same. It must be understood, however, that the designs of the carriage and cross-slide on the different machines are varied to meet the requirements of the particular operations for which each is intended. It will be evident from Fig. 1 that these machines are of compact design and massive construction, and that all parts are built without overhang so that chatter and vibration are practically eliminated. The entire operating mechanism is governed by a centralized control, and is so simple that an unskilled workman may soon be taught to operate the machine.

PRODUCTION ON 3.3-INCH BRITISH SHRAPNEL SHELLS

Operation	Machine	Average Time, Minutes
Cutting off end..........	Cutting-off machine	1.3
First rough-turn face.....	Roughing lathe	6.0
Second rough-turn, finish-face end and finish-turn from base end up to end of band groove	Roughing lathe	10.0
Groove, wave and under-cut	Grooving machine	3.0
Bore and ream..........	Drill press	3.0
Bore, face and tap nose...	Nose end lathe	3.0
Finish-turn body and nose	Finish-turning lathe	4.0
Press copper band on shell	Banding machine	0.5
Turn copper band........	Copper band turning machine	0.4
Stamp	Stamp rolls	0.1

Machinery

Fig. 3 shows the type of spindle construction which is employed, and reference to this illustration will show that the spindle, chuck and air control—with the exception of the piping—are of unit construction. The spindle is made of steel, and by having the driving gear located at a point mid-

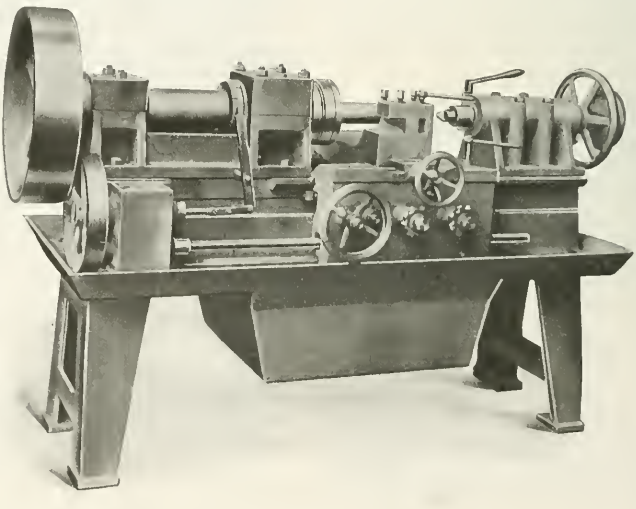


Fig. 2. Machine for rough-turning Outside of Shells

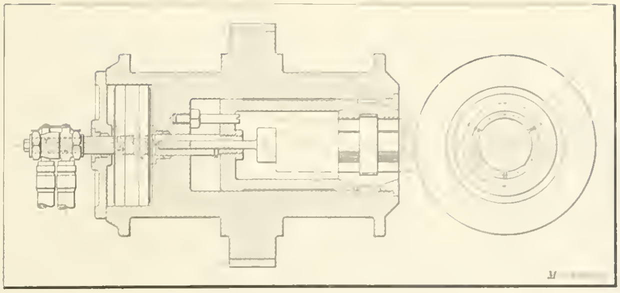


Fig. 3. Spindle of Cutting-off Machine and other Machines of this Type

way between the bearings, the strain is equalized as far as possible. The bearings are 9½ inches in diameter by 6 inches long and are lined with babbitt. The chuck is of the double-acting type, and is instantaneous and positive in operation. All parts subjected to exceptionally severe service are made of tool steel and hardened. The machine is driven by a pinion which is located beneath the driving gear, and the driving shaft runs in bronze bushed bearings. All working parts are carefully protected from chips and dirt, but the guards are designed in such a way that the mechanism is accessible for oiling; all parts which are subjected to wear are provided with means of making adjustment.

The cutting-off machine is equipped with two cross-slides actuated by means of a right- and left-hand screw, which may be operated by hand or driven by power, three rates of power feed being available. The toolpost on each of these slides is cast integral with the slide, and is designed to give exactly the proper angle to the tool. The clamps are made of hardened tool steel with a spring release. The position of the carriage on the bed is adjusted by means of the handwheel at the end of the bed. A fixture is shown at the end of the machine which is used for quickly setting the shell to the proper distance in the chuck. It will be seen that the machine is furnished with a lubricant pump which is of the geared type and is located beneath the cast-iron pan that forms an integral part of the feet and legs of the machine. The time required for cutting off the 3.3-inch shells is 1.3 minute.

Roughing Lathe

For performing the rough-turning operations on the shells, the type of machine shown in Fig. 2 is employed. It will be evident that this lathe is rigidly constructed to meet the severe service for which it is intended. The spindle is 6 inches in diameter in the front bearing and 4 inches in diameter in the rear bearing; and it has a hole 1½ inch in diameter bored through it. The tailstock is provided with two screws for adjusting the center; one of these has a coarse thread for fast movement and the other a fine thread for tightening. Three traverse and three coarse feeds are provided, and provision has been made for hand feed in both directions. All gears in the apron are made of steel with the exception of the worm-gear which is made of bronze.

The turning is done in three operations and the machines for taking the roughing, intermediate and finishing cuts are practically the same. The chief difference lies in the fact that the lathes for roughing are provided with one gear reduction on the spindle, while the lathe for performing the second roughing operation is driven direct by means of a pulley on the spindle. The floor space occupied by these machines is 7 feet by 3 feet, 6 inches. In turning 3.3-inch British shells, the roughing cut requires six minutes and the intermediate cut ten minutes, while the finishing cut is done in four minutes. In this connection it may be mentioned that the finishing cut is taken after the various operations have been performed on the band groove, powder pocket and nose end of the shell.

Machine for Boring and Reaming Powder Pocket

For use in boring and reaming the powder pocket a single-spindle drill press has been developed which is illustrated in Fig. 6. In working out the design of this machine particular attention has been paid to the development of a rigid construction which would be capable of preserving the alignment of the spindle and table under exceptionally severe conditions of service. It will be seen that the machine is built with a one-piece column and base casting; and the spindle is made of chrome-vanadium steel, carefully heat-treated to take full advantage of the physical properties of the metal. The spindle bearings are lined with phosphor-bronze, and the spindle is driven by a single pulley 31 inches in diameter, which carries a 6-inch double belt, so that ample bearing is provided Both

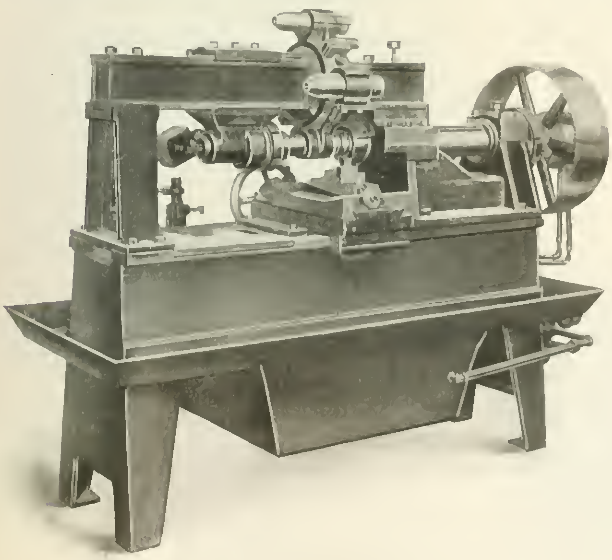


Fig. 4. Machine for turning Copper Band on Shells

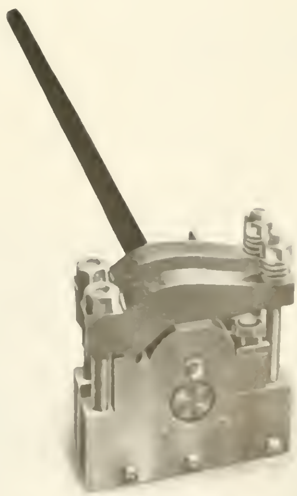


Fig 5 Marking Machine for stamping Shells

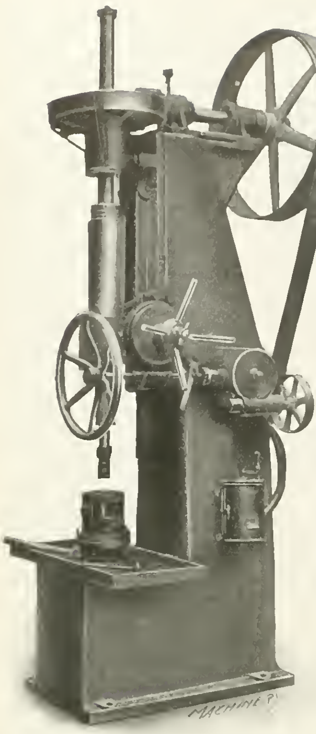


Fig. 6. Vertical Drill Press designed for boring and reaming Powder Pocket

hand and power feed are furnished, the power feed being of the friction type so that it may be quickly engaged and released; hand feed is controlled by a wheel 24 inches in diameter. Automatic trips provide for releasing the power feed. On 3.3-inch British shells the boring and reaming of the powder pocket can be completed in three minutes.

Finishing the Nose

It will be recalled that in referring to the general characteristics of the Horne-Dale-Brown shell machinery, the statement was made that the machine for boring, facing and tapping the nose of shells was of the same general design as the cutting-off machine illustrated in Fig. 1. This will be readily understood by comparing Figs. 1 and 7, which show these two machines. Reference to the latter illustration will reveal the fact that a vertical turret is provided on the cross-slide; this turret has three stations and the turret tools divide the work as follows: (1) bore hole and face end of nose; (2) form inside radius; and (3) tap hole. The turret has been designed in such a way that it operates rapidly and is sufficiently rigid to maintain accurate alignment. The machine is equipped with both hand and power feed, the former being operated by large handwheels, while any of three rates of power feed are available. A geared pump furnishes lubricant for the tools; it is located beneath the cast-iron pan on the machine. The average time required for machining the nose of British 3.3-inch shells is three minutes.

Copper Band Turning Machine

For turning the copper rifling band on the shells, the machine shown in Fig. 4 has been developed. This is of the continuous turning type; the operator loads and unloads the machine while the copper band is being turned. The formed turning tool is held in a vertical position on the carriage, and it can be quickly taken out for grinding; special means are provided for rapidly resetting the tool after it has been sharpened. During the operation of turning the copper band and loading the machine, it is unnecessary for the operator to leave his position at the front of the carriage. The magazine which has a capacity for four shells, is rotated in a vertical position and stops automatically when the shell is in alignment with the chuck and centering device. With his right hand the operator raises the lever on the centering device, and this pushes the shell into the chuck; then with his right hand, he operates an air valve and the shell is chucked ready for turning the band groove. A single turn of the handwheel on the carriage then brings the turning tool into the working position, after which the cross-feed is thrown in.

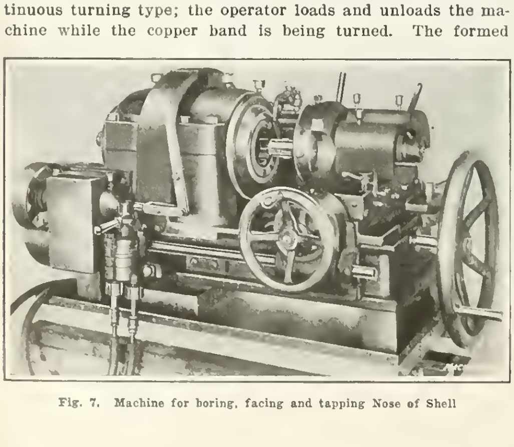


Fig. 7. Machine for boring, facing and tapping Nose of Shell

While the band is being turned on this shell, the operator removes the finished shell and places an unturned shell in the magazine. When the copper band has been turned on the shell held in the chuck, the feed is thrown out by an automatic trip, after which the tool is run back by hand, the chuck opened, and the centering device pushed back; the magazine is then rotated to bring another shell into the operating position. The chuck jaws are made of hardened steel and the end of the shell engages a centering device which assists in locating it properly in the chuck. This cycle of operations has been performed five times a minute when making a test run on 3.3-inch shells, but the average rate of production is 0.4 minute per shell.

Marking Machine

For marking the shells, the equipment shown in Fig. 5 has been developed. The bed of this tool consists of two parts, *i. e.*, a base and top which are joined at the center line of the shell and held together by four bolts. Two of these bolts are furnished with springs adjusted to the proper tension to raise the top when the bolts are released. The main shaft of the machine carries a stamping roller and operating lever, and two lower shafts carry rollers upon which the shell rests. The shafts, bearings and rollers are made of tool steel, hardened and ground. The machine operates rapidly; the operator puts in a shell with one hand, and with the other he pulls down the lever which rotates the marking roller that stamps all required notations on the wall of the shell. On this operation, the average rate of production for 3.3-inch shells is 0.1 minute.

BRYANT RADIATOR NIPPLE TURNING MACHINE

O. Bryant, Sons & Co., Buffalo, N. Y., specialists in radiator manufacturing machinery, have recently perfected the machine shown in the accompanying illustrations for the automatic turning of radiator nipples. These nipples are made of malleable iron castings, varying from $1\frac{3}{4}$ inch to $2\frac{1}{4}$ inches diameter, and from $1\frac{1}{4}$ to $1\frac{1}{2}$ inch in length. They are cored out so that the walls are about 3/16 inch thick. Fig. 1 shows the approximate proportions of one of these nipples, and the turning operation consists of machining the cylindrical outside surface, which is usually slightly convex or "crowned" like a pulley. The amount of metal removed is from 1/16 to 3/32 inch on the diameter. The nipple castings are fed into a chute and are automatically chucked, turned and ejected at the rate of from 1200 to 1800 a day, the output of the machine varying with the size of the nipples and the quality of the iron. Figs. 2 and 3 show the front and rear views of the machine, and Fig. 4 shows a partial end view.

The spindle that carries the nipple to be turned runs lengthwise of the machine in the two bearings that may be seen in Figs. 2 and 3, and the entire drive of the machine is received on this spindle from an overhead countershaft belted to the large spindle pulley. From the extreme end of this spindle, rotation is carried to the worm-shaft below, and from this worm-shaft power is taken for performing the entire cycle of operations. Referring now to Fig. 3, it will be seen that on the worm-shaft there is a clutch to start or stop rotation. Midway of the length of this shaft is a pulley that drives a lubricant pump beneath it. On the extreme left end of this shaft

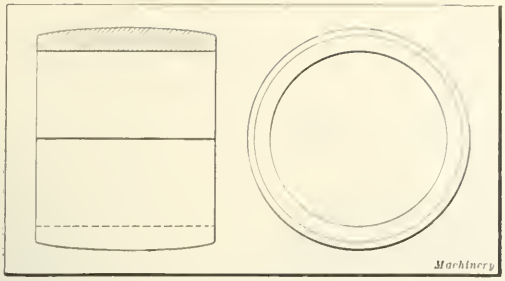


Fig. 1. Type of Radiator Nipple turned on Machine

is the worm that meshes with a worm-wheel mounted on a shaft at right angles to the front shaft. From the latter shaft the carriage traversing and chucking mechanisms are operated.

The turning slide is located on the wide bracket that may be seen bolted to the column of the machine at the center in Fig. 3. On the shaft that is driven by the worm-wheel, there is a cam that acts on one end of the bell-crank that may be seen just above it. The upper end of this bell-crank carries a link that is attached to the tool-slide. A spiral spring, that may also be seen in this view, serves to keep the slide as far to the left as possible when it is not being operated by the cam. Thus, under the action of the cam, the slide is carried to the right; and by means of the spring, it is withdrawn.

From this point the operation of the machine can best be followed by referring to Fig. 4. The nipples run down a chute from the front, and they are prevented from dropping into the working position by the feed slide shown in Fig. 2 directly at the center of the upper part of the machine. This slide is kept normally forward, intercepting the string of nipples except when it is withdrawn to permit a new nipple casting to be fed. This slide is actuated by a lever at the front of the machine, and its action is secured from a segment cam that may be seen on the worm-wheel shaft in Fig. 2. The tool is clamped in a tool-block at the top of which there is a roll bearing against a former plate. A concealed spiral spring keeps the block up against the former plate, and this plate is shaped to give any degree of crowning desired.

It is necessary, at the end of the turning operation, to provide means for removing the tail-center from the work, and allowing the nipple to drop out. This is done by the square column that may be seen extending above the frame of the machine in Figs. 2 and 3. The column carries a cylindrical weight at the top and is raised by a cam on the worm-wheel shaft. The column is slotted to receive a stud passing at right angles through the tail-center, and as this slot is inclined, the raising of the column causes the stud, and hence the center, to be withdrawn. When it is dropped, the center is advanced quickly into the nipple, holding it firmly for the turning operation. The weight on the square column that operates the tail-center helps to "seat" the work quickly on the centers. Both centers are cone shaped; the live center is toothed for driving and the tail-center is mounted on ball bearings.

When the nipple drops from the centers, it falls into a chute and runs out at the left-hand side of the machine, as viewed from Fig. 2. This chute is perforated so that the chips turned from the nipple drop through into a drawer that may be seen through the rectangular opening at the sides of the machine.

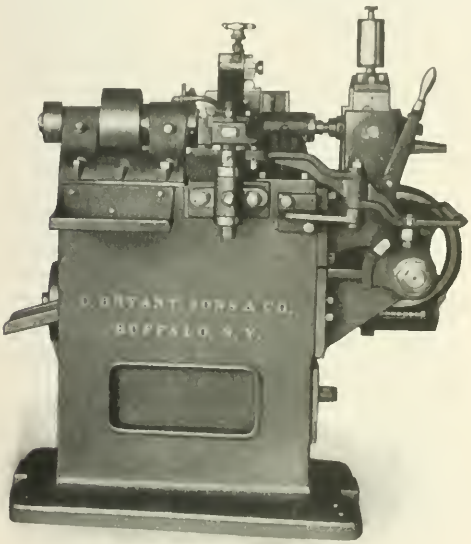


Fig. 2. Front View of Bryant Radiator Nipple Turning Machine

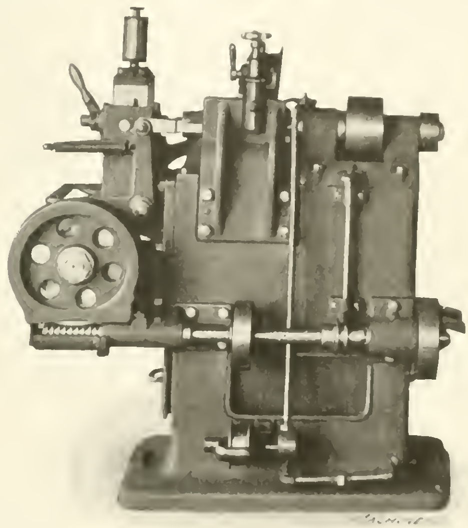


Fig. 3. Opposite Side of Machine shown in Fig. 2

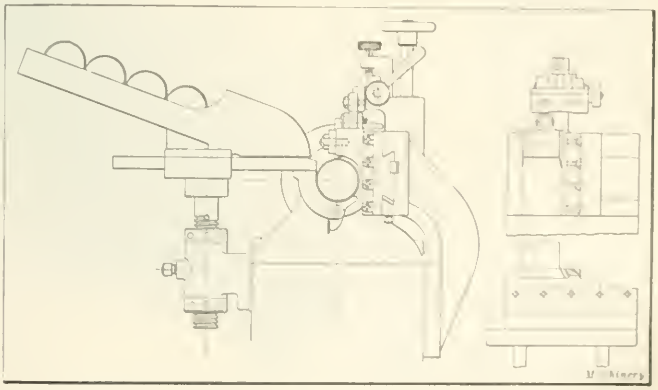


Fig. 4. Partial End View of Machine, showing Arrangement of Feed Chute to deliver Castings to Machine

This drawer may be removed and emptied of chips from time to time, thus promoting the maintenance of a cleanly condition and neat appearance with a minimum of care and attention.

This machine is entirely automatic in operation except for the filling of the feed chute with the nipple castings. The rate of production is very high, varying, of course, with the size and character of the nipples which are being turned, but the average is from 1200 to 1800 nipples per day.

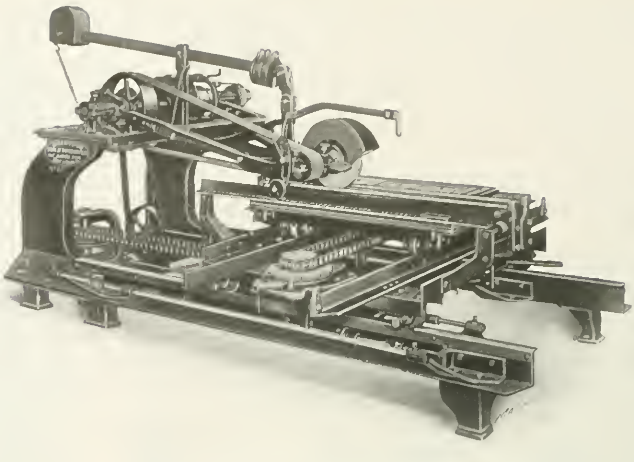


Fig. 1. Excelsior Automatic Grinding and Polishing Machine working on Stove Tops

EXCELSIOR GRINDING AND POLISHING MACHINE

For use in grinding, surfacing and polishing flat or convex castings or metal plates, or for performing these operations on pipe, the Excelsior Tool & Machine Co., E. St. Louis, Ill., has recently placed on the market the machine shown in the accompanying illustrations. While it can be used for finishing a variety of products, it is especially adapted for the work of stove manufacturers. Fig. 1 shows the machine engaged in grinding stove tops, and for this purpose use is made of both the upper and lower carriages which provide longitudinal and transverse feed to pass the work under the wheel. Fig. 2 shows the machine equipped with a pipe polishing attachment. Fig. 3 shows an end view of the machine, which illustrates the way in which the feed mechanism and the exhaust fan are connected to the driving shaft.

In working out the design of the machine, attention has been paid to the combination of efficiency and flexibility, and while all parts of the mechanism have been constructed to withstand severe service and to prevent damage from abrasive dust, these results have been obtained without reducing the efficiency of the automatic features in any way. The starting and stopping of the carriages, shifting them to any desired location, altering the speed, stroke or feed, regulating the pressure of the wheel on the work, lifting the wheel off the work or adjusting it to any desired height, are changes that can be instantly made while the machine is in motion.

Each movable part is so constructed that when the machine is started and the feeds engaged, they will be automatically released at the end of the travel, which avoids damage from carelessness on the part of the operator. The main swing frame is supported on roller bearings which allow a free and easy movement over the work. Adjustments for regulating the belt tension are provided, and the pressure of the grinding wheel on the work—which should be about 25 pounds—is regulated by a slotted weight mounted on a balancing bar. The grinding wheel on the machine should be carefully balanced in order that it may run true without a tendency to set up vibration; the size of the wheel is 12 inches in diameter by 2 inches face width, and it is 60 grain, O grade. It will be seen that a dust hood is provided to carry away all dirt and dust. Means are provided for accurately setting the wheel so that it will not drop below a specified minimum level, and when the machine has been properly adjusted in this way the wheel may be lifted off the work and locked without stopping the machine.

An adjustable slotted roller casting on the left-hand end of the spindle is used to raise the grinding wheel off the work at the end of each stroke by rolling on suitable wedges which are adjusted for the travel of the lower carriage. The travel of the lower truck can be adjusted anywhere from 12 to 60 inches by setting the reverse stops on the right-hand rod under the truck; the rod on the left-hand side has similar stops which provide for regulating the feed of the upper truck. These stops should always be released and adjusted last; otherwise the pins on the ratchet will interfere. These pins are made to bend before sufficient strain is applied to break the ratchet casting. Beneath the ratchet feed there is a "bumper" mechanism which engages the spring stops on both sides; this "bumper" must always be released and set after the proper travel of the carriage has been established, after which the stops may be set.

Fig. 2 shows the machine equipped with a pipe polishing attachment which is constructed in such a way that it may be put in place or removed from the machine in twenty minutes. It consists of an angle iron support to which are clamped the headstock and tailstock. The machine is adapted for working on ½, ¾ or 1 inch pipe in lengths from 6 inches to 60 inches. Two rest brackets hold the pipe in line with the centers and assist in quickly inserting or removing the pipe; and two clamp brackets are set to release the feed at each end of the work. After the attachment has been set for working on pipe of a specified length and the feed has been started in either direction, the feed is stopped and the wheel raised automatically.

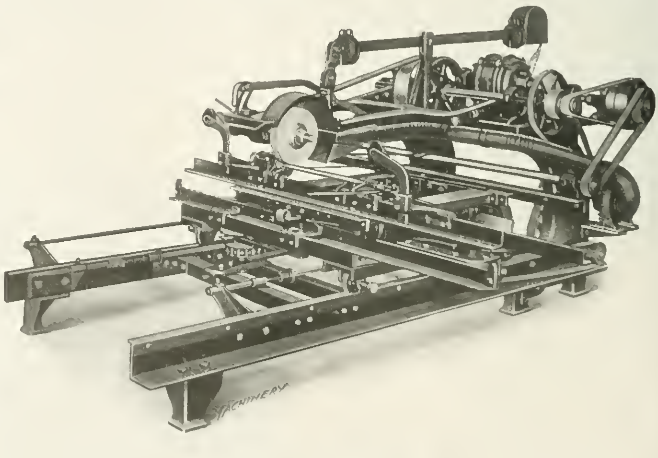


Fig. 2. Excelsior Automatic Grinding and Polishing Machine equipped with Pipe Grinding Attachment

The upper carriage is operated by the set of worm-gears belted to the lower shaft, and to hold the lower carriage in the proper position a lock bracket is fastened to a large angle iron that clamps the lower carriage wheel. The engaging shifter in front, which operates the lower carriage, should always be locked when polishing pipe. In grinding pipe, the work revolves at 350 revolutions per minute in a direction opposite to that in which the grinding wheel runs; the feed across the pipe is at the rate of $9\frac{1}{2}$ inches per minute. The travel of the lower truck is 58 feet per minute. These speeds may be cut in half by shifting the driving belt on the cone pulley. The cross-feed of the upper truck is changeable, rates of $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 inch feed for each stroke of the truck being available. The quantity of work produced on the machine naturally depends on the area and shape of the castings, the smoothness of finish required, and the type of grinding wheel with which the machine is equipped.

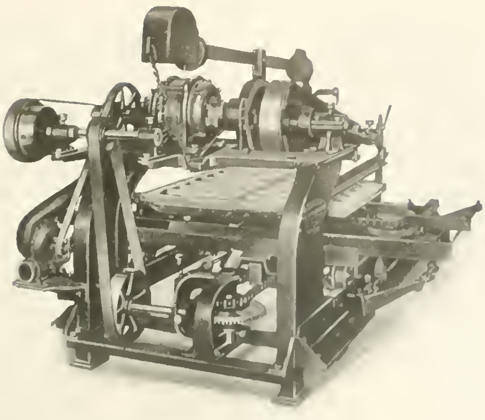


Fig. 3. End View of Machine showing Arrangement of Drive to Feed Mechanism and Exhaust Fan

MANNING, MAXWELL & MOORE MACHINERY FOR RIFLE MANUFACTURE

To meet the requirements of factories engaged in the manufacture of military rifles, Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City, is now marketing a line of machines, the designs of which have been carefully worked out to make them suitable for performing machining operations on various rifle parts. Machines of this type are in use in the Eddystone plant of the Remington Arms Co., which is probably one of the most efficiently equipped rifle factories in the world, as the engineers who directed the selection and installation of the equipment were able to benefit by experience gained in organizing other factories for producing the same product. The machines are being manufactured by the Reed-Prentice Co., Worcester, Mass.

Single-tool Rifle Barrel Turning Machine

The machine used for turning rifle barrel forgings is of the form shown in Fig. 1. It will be evident from this illustration that its general features are those of a lathe, so that the present description may properly be confined to the means provided for automatically turning the barrel to the required shape. This is accomplished by having a master plate at the back of the lathe, which moves the cross-slide in and out so that the tool always takes a cut of just the required depth to provide for turning the barrel to the required form. As the barrel forgings are more than 30 inches long and quite slender, it will be evident that the use of a steadyrest is necessary to prevent deflection, and that the transverse position of this steadyrest must also be controlled from the master plate at the back of the lathe. The machine is capable of finish-turning a rifle barrel in twenty minutes.

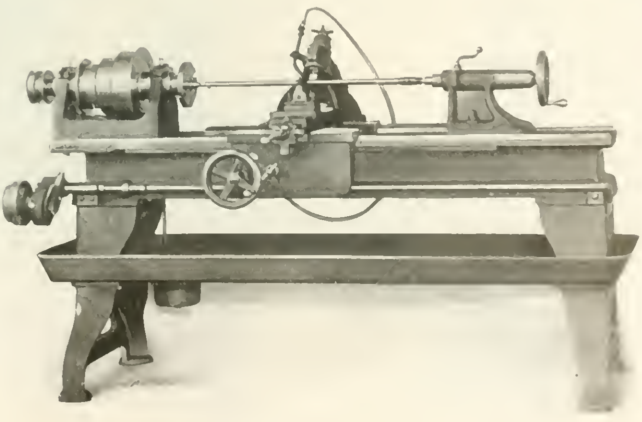


Fig. 1. Single-tool Rifle Barrel Turning Machine

Multiple-tool Rifle Barrel Turning Machine

In the manufacture of military supplies of all kinds, the necessity for employing labor saving devices and means for turning out the work as rapidly as possible is even more important than in general lines of manufacture, because of the time clauses which exist in most contracts, and on account of the scarcity of labor which has been created by an abnormal demand. With the view of cutting down the time required to turn rifle barrel forgings, it was decided to produce an automatic lathe equipped with a multiple system of tool-blocks. Reference to Fig. 2 will make it evident that this machine has five tool-blocks, and as a result, it is only necessary for each tool to travel a distance slightly in excess of six inches to complete the operation of turning a 30-inch rifle barrel. As in the case of the single-tool machine, the form of the work is controlled by a master cam which governs the transverse movement of the tool-slides, but the use of this multiple-tool system reduces the time of turning a barrel from twenty minutes to approximately two and one-half minutes. On the Lee-Enfield-Remington rifle barrel, after the bore has been drilled and countersunk, it is put in a grinding machine and spotted in the center to form a bearing for the roll on the steadyrest used on the lathe shown in Fig. 2. For rough-turning, the work is rotated at 335 R. P. M., with a feed of 0.026 inch per revolution and a cut of $\frac{1}{8}$ inch on the diameter. The actual time required to turn one barrel is two and one-half minutes, which includes putting in the work and setting the machine.

In a general way, the design of the machine follows standard practice in lathe construction, but the carriage supporting the tools is fitted with an automatic trip, and when the tools have been fed to a point where the turning operation is completed, this trip automatically releases the carriage so that a counterweight may return it to the starting position, and the automatic feed is stopped. The machine has a pump for delivering lubricant to the work, five delivery tubes being provided for supplying oil to each of the tools. As in the case of the single-tool machine, provision is made for supporting the work with backrests, and it will be seen that two backrests are provided, although one is ample, except in the case of very long barrels.

External Thread Milling Machine

For threading the breech end of a rifle barrel to screw into the receiver an external thread milling machine has been developed which is illustrated in Fig. 3. This illustration shows the different

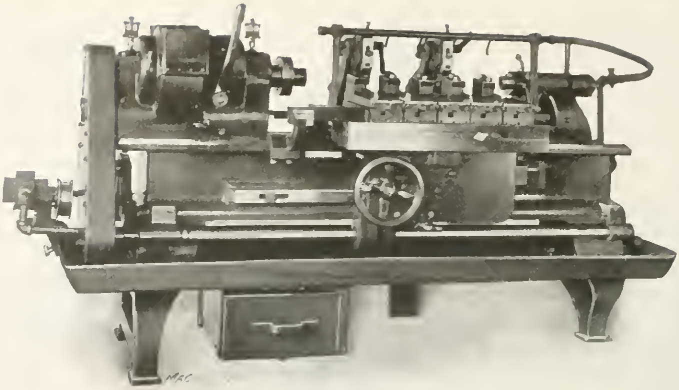


Fig. 2. Multiple-tool Rifle Barrel Turning Machine

parts of the mechanism so clearly that a brief description will suffice to give the reader a clear understanding of the machine. It will be seen that in general the design follows that of a lathe, the machine being provided with a geared head and lead-screw for traversing the carriage along the bed. Supported on the carriage there is a single thread milling cutter, and the work is held in a collet in the spindle so that it may be rotated at the required speed. A swing stop is provided for locating the barrel in the correct position in the collet. The rate of production is eight to ten barrels per hour. It will of course be evident that by gearing the machine to obtain the proper relation between the speed of rotation and rate at which the carriage is traversed along the bed, a thread of the desired lead will be obtained; also, provision is made for setting the cutter-spindle at any required angle to mill the thread.

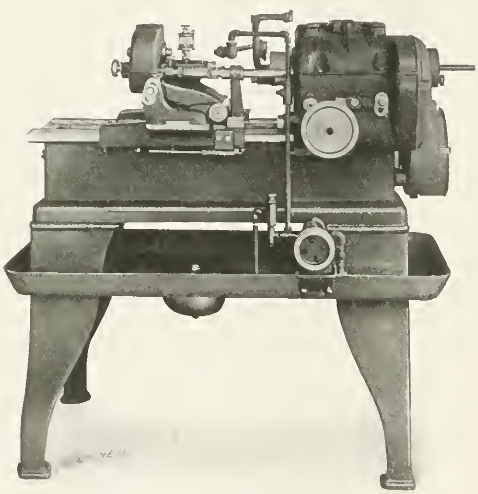


Fig. 3. External Thread Milling Machine for threading Rifle Barrels

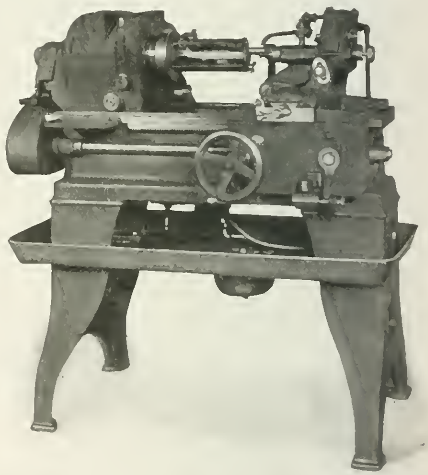


Fig. 4. Internal Thread Milling Machine for threading Rifle Receivers

Internal Thread Milling Machine

The machine shown in Fig. 4 is of essentially the same design as the external thread milling machine shown in Fig. 3, but this machine is used for milling the internal thread in rifle receivers to provide for screwing the barrel into place. Except for the fact that the spindle is furnished with a suitable fixture for holding the receiver — instead of having the breech end of the barrel extend through the spindle—the design is the same as that of the external threading machine. In this machine the work is rotated at $3\frac{1}{4}$ R. P. M., and the cutter runs at 800 R. P. M. The rate of production on this operation is sixteen to twenty per hour.

Barrel Chambering Machine

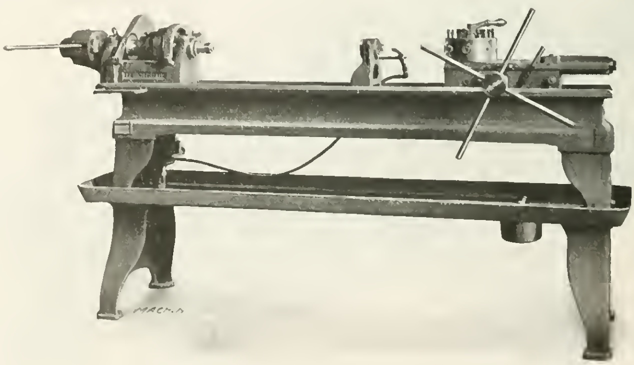


Fig. 5. Machine designed for Use in machining Chamber in Rifle Barrels

Hand screw machines have been commonly used for chambering rifle barrels, and in many ways they were capable of giving very satisfactory results; but for doing this work a set of eight turret tools is required and the ordinary hand screw machine is fitted with a turret containing only six holes. Of course it would be an easy matter to substitute a suitable turret, but in building a machine for chambering large numbers of rifle barrels, other

modifications of design suggested themselves, and the machine shown in Fig. 5 represents the result of an effort to construct a special tool for doing this work. It will be evident from the illustration that the muzzle end of the barrel is secured in a collet in the spindle, which is operated by the long hand-lever at the extreme left of the machine. The breech end of the barrel is supported in a bushing in the steadyrest and the turret provides for holding eight tools. The arrangement of the pump and piping for delivering cutting compound to the tool is clearly illustrated.

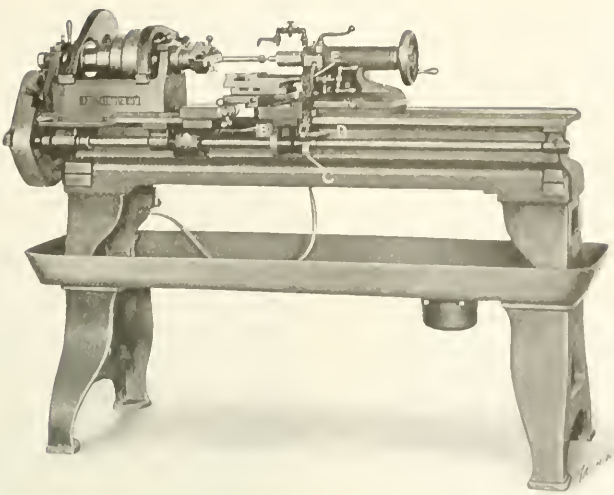


Fig. 6. Machine for turning Cam on Rifle Bolts

Light Automatic Lathe for Bolt Turning and Squaring

After the rifle bolt has been centered it is sent to the automatic lathe for turning the body and squaring down the inside of the lever portion. This work is performed by the use of a special tooling arrangement whereby two tools are simultaneously used on the body, while a single tool supported in a back arm tool-holder is operating on the side of the lever. This machine is of the automatic type, the only attention it requires from the operator being that of replacing the work between centers and engaging the feed. The machine then does the turning and facing, automatically disengages the feed, and withdraws the tools from the work to prevent scoring while the carriage automatically returns to its starting position. The compact design has made the machine very rigid, which is essential to successful operation on this class of work.

Cam Facing Lathe

The work of facing the cams on rifle bolts can be advantageously done on the machine shown in Fig. 6, which has been developed for this purpose. A special mechanism is used for controlling the movement of the cutter that produces the locking-cams on the bolts, and a special feeding mechanism moves the cutter through the required distance per revolution of the work. As shown in Fig. 6, the cross-slide which carries the cam facing tool is operated by means of a cam *A* held on the rod passing along the front of the machine. This cam has two projections corresponding with the two lugs on the bolt, and the cross-slide is kept in contact with it by heavy springs, one of which is shown at *B*. The facing of the cams is accomplished by a wide parting tool held in the toolpost of the lathe and operated by a cam also held on the lead-screw. This cam is shown at *C* and runs in contact with a roller *D* that operates a series of fulcrum levers which, in turn, act upon a ratchet feeding finger that rotates the ratchet dial *E*. This dial is connected to the tool-slide screw and moves the tool in against the work at the rate of about 0.0005 inch per cut, that is, the tool-slide is moved over 0.001 inch per revolution of the work. As there are two cam surfaces to cut, the cut on each cam surface would be, of course, half that amount. The work is rotated at 30 R. P. M. and the rate of production is from twenty to twenty-five per hour.

Semi-automatic Lincoln Type Miller

A number of the parts of military rifles are finished by milling, and for performing this work, the semi-automatic Lincoln type miller shown in Figs. 7 and 8 is now being built. The design of this machine is practically standard, with the exception of the table mechanism by means of which the work is fed under the cutter, after which the table is dropped sufficiently so that the work clears the cutter as the table is automatically returned to the starting point. After the table is returned, it again rises to the operating position and then stops until the

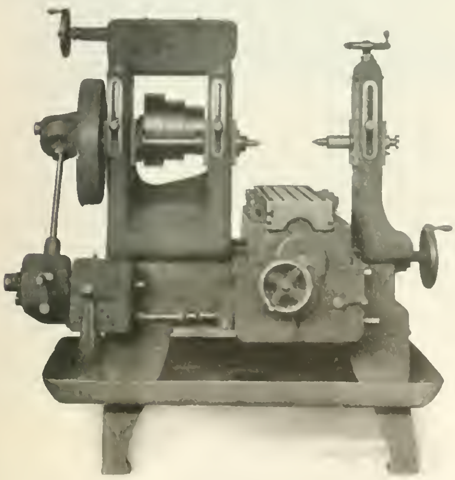


Fig. 7. Lincoln Miller with Automatic Feed and Table Return

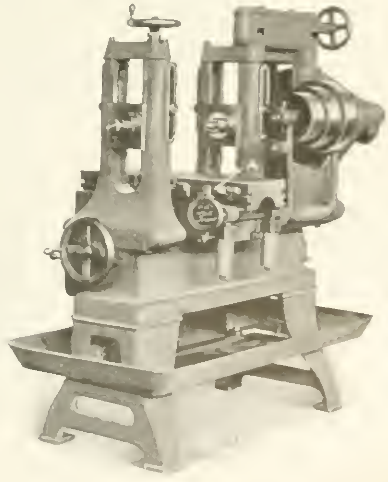


Fig. 8. Opposite Side of Lincoln Miller shown in Fig. 7

operator, who is in charge of a battery of machines, has removed the finished piece, substituted a fresh blank, and thrown in the feed trip to reengage the feed gears. Lubrication is taken care of by means of a pump and piping.

The best understanding of the way in which the machine operates will be gained by referring to Fig. 8, which shows the rear view of the machine shown in Fig. 7. In this illustration, stop *A* is used for limiting the distance through which the table travels, this stop being set to allow the table to drop just after the work has passed from under the cutter. The table is pivoted at the front end, and the dropping of the rear end to enable the work to clear the cutter is effected by means of a cam mechanism located beneath the table. Then when the table has been returned to the starting point, it engages another stop which brings the cam once more into operation, with the result that the table is lifted back into the working position.

All gears are completely guarded so that danger of injury to the operator is avoided. An improvement has been made in the method of adjusting the position of the head spindle and cone pulley, the design being such that when a change is made in the setting, the belt tension is automatically regulated to the desired point. The fixtures are usually designed to hold two rows of pieces and the cutters are mounted on an arbor supported on centers, so that the whole set of cutters can be removed and ground and then put back on the machine without loss of time in resetting the tools.

These are manufacturing machines which have been designed to take advantage of principles that have proved their efficiency by the successful results obtained with machines of similar construction used in manufacturing automobile parts and other products where rapid production and accuracy are points of primary importance.

PERSONS-ARTER MAGNETIC CHUCKS

The increasing use of grinding machinery and the greater demand for magnetic chucks for holding work, has led the Persons-Arter Machine Co., Worcester, Mass., to place a line of magnetic chucks on the market. In this article the rotary style magnetic chuck is shown in Fig. 1, and the construction is well illustrated in Fig. 2. In addition to the rotary style chuck, a flat type of chuck is also being brought out. The rotary chuck can be furnished in diameters from 6½ to 24½ inches; and the flat style chuck is made in sizes varying from 5 by 5¾ inches to 13 by 51 inches. The principal features claimed for the Persons-Arter magnetic chuck are simplicity of construction, low current consumption and high magnetic power.

Fig. 1. Rotary Magnetic Chuck made by Persons-Arter Machine Co.

From the illustration Fig. 2, it will be seen that there are but two poles in the entire chuck face. This face formation of the chuck is a strong feature, and comprises one of the reasons for its high magnetic power. The air gap between the two poles is filled with a non-magnetic expanding metal composed of bismuth, antimony and lead. The chuck consists of but three principal parts, namely, the baseplate, the shell which comprises one of the poles, and the core that forms the second pole. The two pole castings are made of a special magnetic steel that is cast to the desired shape. This metal has a permeability nearly equal to the best Swedish iron.

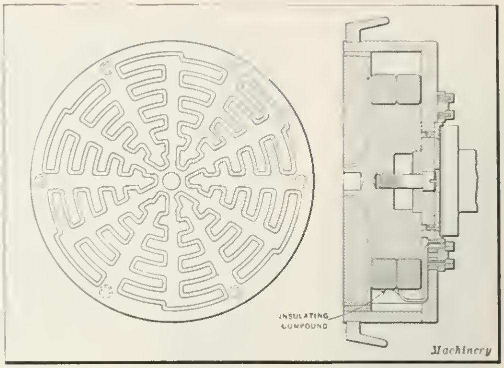


Fig. 2. Cross-sectional View showing Construction of Chuck

The coils are two in number, as may be seen in the cross-sectional view, Fig. 2, and are very nearly the same diameter as the chuck. By using but two coils, it is possible to wire them in series for 220-volt current or in parallel for 110-volt current. These coils, after being wound and covered, are dipped in a high insulating compound and made water-proof. The leads from the coils run through a cored section of the baseplate to the collector rings on the bottom of the chuck, as shown in Fig. 2. The space around the magnetic coils is filled with an insulating compound of wax; and the ends of the leads are soldered into bushings that are driven into the collector rings, thus giving a good connection. The collector rings are mounted in a fiber ring, which, in turn, is fastened to the chuck base. The chuck is mounted on the spindle of the grinding machine through a spindle plate that is screwed to the under side of the chuck.

Between the spindle plate and the baseplate of the chuck there is a brass insulator disk that prevents any magnetism from leaking into the chuck spindle. Surrounding the entire chuck near the top face is a water guard or flange whose purpose it is to keep the lubricating compound away from the chuck and grinding machine spindle. In recent tests that were made with a 12-inch rotary chuck taking 60 watts, it was found that a disk having an area of 1 square inch, resisted a pull of 190 pounds. It was also found that this pulling power was equally well exerted either at the edge of the chuck or at the center.

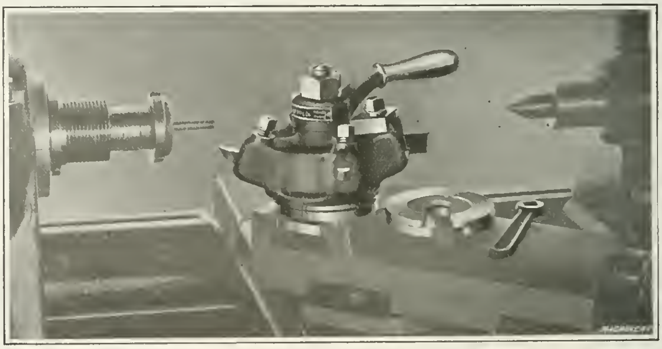


Fig. 1. F-P-M Style C Turret Tool-holder set up on a Lathe

F-P-M TURRET TOOL HOLDER

Reference to Figs. 1 and 2 will make it evident that the F-P-M turret tool-holder, which has recently been placed on the market by the McCrosky Reamer Co., Meadville, Pa., is vir-

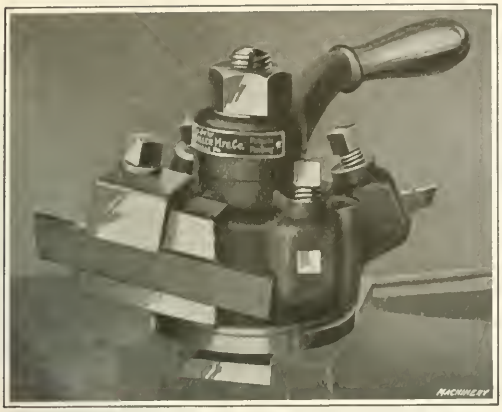


Fig. 2. Close View of Style C Turret Tool-holder with Cut-off Tool at Front

tually a combination of four tool-holders into a lathe turret. Small bits are employed, which are made of high-speed steel, so that advantage is taken of the economy obtained through the use of tool-holders; and the provision of mechanism for indexing the F-P-M tool-holder to bring successive tools into the operating position enables it to perform the function of a lathe turret. The tool-holder is made in two types known as styles C and D. Style C is provided with three square bits and a cut-off tool, and style D is furnished with two square bits and a cut-off tool; each style is made in four different sizes which

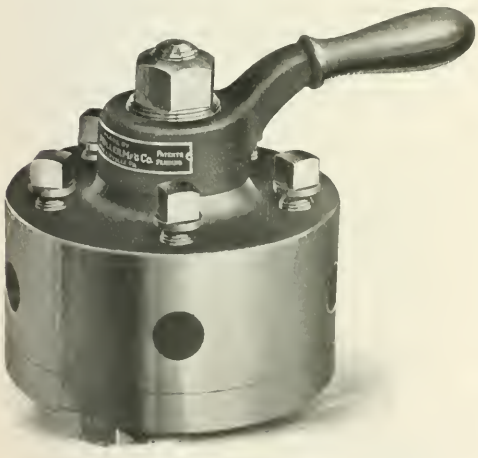


Fig. 3. F-P-M Style E Turret for Internal Work

take square bits 5/16, 3/8, 7/16 and 1/2 inch in size. The attachment is mounted upon the compound rest in the same way that an ordinary toolpost is secured, making it unnecessary to remove the compound rest from the cross-slide.

Fig. 3 shows what is known as the F-P-M style E turret which is designed to meet the requirements of inside work such as drilling, boring and reaming. This attachment may be quickly secured to the compound rest in the same way that the styles C and D turret toolposts are attached. The indexing plunger operates automatically when the clamping handle is tightened or loosened. Unless otherwise specified, the turret is furnished with five holes. The turret is $6\frac{1}{2}$ inches in diameter and the holes are $1\frac{1}{4}$ inch in diameter.

NEW BRITAIN TOTE BOXES

An addition to the line of shop furniture made by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn., is the type of tote box shown in the accompanying illustration. The primary requisites of a tote box are strength, durability and a shape that permits of close nesting for convenience in transportation and storage. The New Britain tote boxes are made from 18 gage sheet steel and are of one-piece construction except for the handles which are of 16 gage stock, folded double to afford a comfortable hand-hold and welded in place.

The box is constructed of a single piece of sheet metal, the sides being folded over onto the end, which is formed by turning up the bottom. The edges of the stock at the sides and ends are turned over to form hems, which precludes the possibility of injury to a workman's hands through careless handling. By folding the edges of the stock over to form the top edge of the box, the corners are much stronger because the metal is of quadruple thickness at these points. This quad-

Tote Boxes made by the New Britain Machine Co.

ruple thickness is obtained because the side hem is continuous and runs under the end hem at each corner. The high location of the handles permits close nesting, and a hole is punched in each handle for convenience in pulling the box along the floor with a hook. On account of the one-piece construction, the box is liquid-tight; all laps and folds on the ends are electrically welded, forming a box that will be found very convenient and of unusual durability.

FENN TAPPING MACHINE

The No. 1 tapping machine which forms the subject of the following description is a recent product of the Fenn Mfg. Co.,

No. 1 Fenn Tapping Machine with Friction Drive

516 Asylum St., Hartford, Conn. This little machine is suitable for tapping holes up to 3/16 inch in diameter. A feature of the design is that the spindle is driven forward and reversed by friction, making the operation so sensitive that the breakage of taps is reduced to a minimum. The position of the friction rolls is adjustable, which affords a simple means of making speed changes and allows the operator to back out the tap at a greatly increased speed. With a countershaft speed of 300 R. P. M., the minimum speed of the spindle is 225 R. P. M., and the maximum speed, 600 R. P. M. Any speed may be obtained by adjusting the position of the friction rolls. The principal dimensions of the machine are as follows: maximum distance from chuck to table, 3⅞ inches; distance from upright to center of spindle, 3 inches; speed of countershaft, 300 R. P. M.; available spindle speeds, from 225 to 600 R. P. M.; and weight of machine and countershaft, 62 pounds.

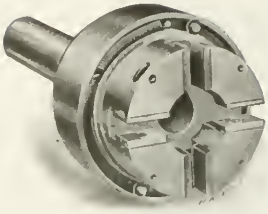


Fig. 2. Arrangement of Chaser Guides in Rickert-Shafer Threading Die

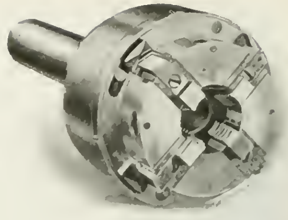
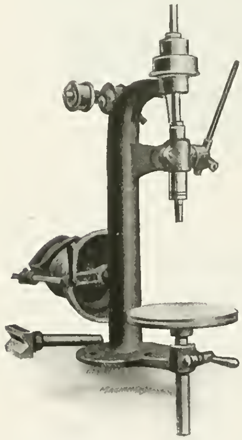


Fig. 3. View of Chaser Guides with Chasers and Carriers in Place

ENTERPRISE BENCH DRILL

The No. 1 "Emco" bench drill which has recently been developed by the Enterprise Machinery Co., 32-34 South Clinton St., Chicago, Ill., is particularly adapted to the requirements of shops doing tool and experimental work, although it is also suitable for many lines of light manufacturing work. The spindle is supported in double bearings, and the feed rack and pinion have cut teeth. The spindle is counterbalanced by a weight inside the column of the machine. The illustration shows the standard equipment furnished, and it will be seen that this includes an attached countershaft and a V-block which is substituted for the table when the machine is used for drilling transverse holes in shafts or other cylindrical work. This drill is adapted for running at speeds from 1500 to 5000 revolutions per minute. The principal dimensions are as follows: maximum travel of spindle, 3¾ inches; maximum adjustment of table, 4 inches; swing, 9¾ inches; capacity, for driving drills up to ⅜ inch; and weight, 48 pounds.



No. 1 Bench Drill built by Enterprise Machinery Co.

RICKERT-SHAFER AUTOMATIC THREADING DIE

The Rickert-Shafer Co., 1302 Peach St., Erie, Pa., has recently added to its line the Boehm automatic threading die illustrated and described herewith. The chasers have the necessary radial movement to enable the die to open after the threading operation has been completed, and they are supported by a cam ring throughout their entire length and width. The chasers slide between hardened and ground guides, and are supported by carriers which have a groove in the outer end for the positive opening cam. This cam is of the face type and is milled on the under side of the cam ring which is located in the closed position by two hardened locking pins that slide in hardened bushings and engage hardened plugs. The action of the locking pins is entirely independent of the rest of the die mechanism so that the die-head is allowed to come to the back position before closing. The die-head is driven by three hardened rollers which are located at the extreme outside of the shank head in order to eliminate torsional strains.

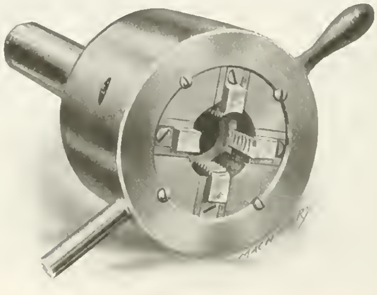


Fig. 1. Rickert-Shafer Automatic Threading Die

The floating die has a lateral float of from ⅛ to ¼ inch according to the size of the die, and is provided with an adjusting ring by means of which all the float may be taken up and the die made to cut threads as short as 3/32 inch. By means of this float, any error in the camming of automatic or semi-automatic machines is taken up by the die-head; and when used in hand machines, the operator is able to watch the float and so tell when he is forcing the die or when he is letting it drag. In this way a conscientious operator will be able to prevent spoiling any work, as well as opening the die

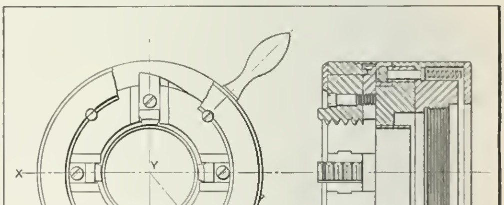
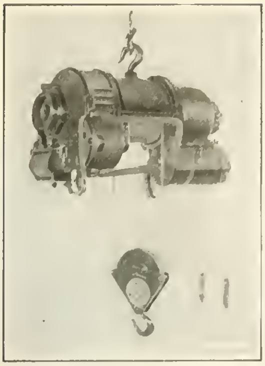


Fig. 4. Views showing Arrangement of Cam, Driving Rollers, Opening Springs, etc.

before the proper length of thread has been cut. These die-heads are made in eight sizes which have capacities for threading work from ⅜ inch up to 2½ inches in diameter. They may be provided with or without float, and a taper attachment may be furnished.

FRANKLIN MOORE ELECTRIC HOIST

The Franklin Moore Co., Winsted, Conn., is now manufacturing a line of motor-driven hoists which are built in sizes



Electric Hoist made by Franklin Moore Co.

having capacities of from 500 up to 10,000 pounds. A noteworthy feature is that each size of hoist is furnished with a different size of motor which gives exactly the required amount of power to lift the maximum load at an efficient speed, but does not add unduly to the weight. The mechanism of these hoists has also been very carefully designed so that they are capable of operating at a high efficiency. The hoist is compactly built, thus effecting a material saving in space, particularly in the amount of head room required.

The hoist built with a plain trolley has a complete weight of 225 pounds, which makes the operation of the trolley very easy. It has steel gears with cut teeth, which operate in an oil bath so that ample lubrication is insured. The rope drum is supported on roller bearings, and the hoist is supplied with a floor-operated controller, an automatic stop, and both mechanical and solenoid brakes.

Owing to certain mechanical features, the DC type of hoist is capable of giving exceptionally satisfactory results in foundries. The method of control makes it possible to raise and lower the load to within a small fraction of an inch of the required position, and the control operates without the least shock which would have a tendency to destroy molds. This hoist is of the hook type, but can be furnished with a plain, geared, or motor-driven trolley, with either floor or cab control.

RIVETT SELF-CENTERING BUSHING CHUCK

The difficulty of securing a chuck for adequately holding thin bushings for boring or internal grinding has led to the development of a self-centering bushing chuck by the Rivett Lathe &

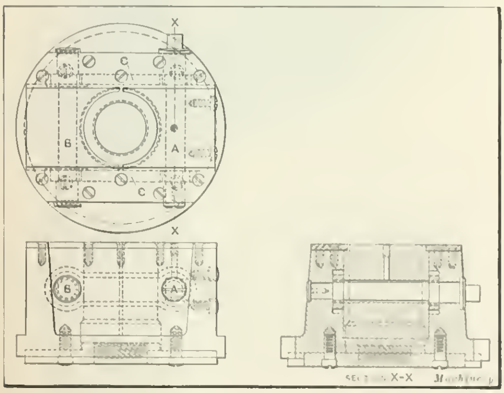


Fig. 1. Plan, Side and Cross-sectional Views of Self-centering Chuck

Grinder Co., Brighton, Boston, Mass. This chuck, which is shown in the accompanying illustrations, is designed to take a bushing of a given size and hold it from the outside in such a manner that distortion is impossible. It has two jaws, the total travel of which is not over 1/16 inch. Turning the chuck wrench moves both jaws simultaneously, and the bushing is thus automatically centered and powerfully gripped by the chuck.

Referring to Fig. 1, the construction and operation of this chuck may be followed. The body is of cast iron; and the two chuck jaws are very deep, having in the case of the chuck shown, a bearing of 2¾ inches on the bushing to be held. The jaws slide in the wide slot cut through the body of the chuck. At right angles to the travel of the jaws are the two spindles through which the movement of the jaws is secured. Spindle *A* is the one from which the chuck jaw operation is secured. This spindle is turned through the medium of the socket wrench shown beside the chuck in Fig. 1. The outer ends of this spindle are fitted closely in the body of the casting, while the central section is slightly eccentric, so that as the spindle is turned, the jaw through which this spindle passes will be reciprocated. It should be explained that the hole through this jaw is relieved vertically so that the eccentricity of spindle *A* moves the chuck in a longitudinal direction only.

The reciprocation of the second jaw is secured through spindle *B*. This spindle, it will be noted, is a short one and fits closely in the jaw, extending a slight distance on each side. The ends of this spindle *B* are connected with spindle *A* by means of links *C*. The sections of spindle *A* over which links *C* fit are eccentric but in an opposite direction from the eccentricity of the central portion of spindle *A*. As these links fit closely over the eccentric portion of spindle *A*, any rotation of this spindle imparts a longitudinal movement to links *C*. Because the eccentricity of the link bearings is opposite to that of the central section of the spindle, it is obvious that when the eccentric section of spindle *A* throws the jaw forward, the links *C*, and consequently spindle *B*, are pulled toward spindle *A*, and thus the second jaw is closed in simultaneously with the first one.

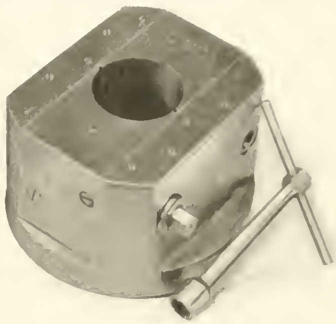


Fig. 2. Rivett Self-centering Bushing Chuck

The jaw opening motion is, of course, exactly the opposite in action. In the finished chuck, this mechanism is entirely enclosed, as Fig. 2 shows, so that there is no chance for injury or misuse. The features of this chuck are simplicity of operation, compact and foolproof form, and powerful and nondistorting grip upon the work. The chuck is intended for use on any lathe or grinder, and is fitted by means of threads that engage the spindle nose of the machine on which it is to be used. Two sizes are at present on the market, the maximum of which is the one shown, that takes bushings up to 2 9/16 inches external diameter. The smaller size accommodates bushings up to ¾ inch diameter. It is apparent that this chuck will not hold work that does not run uniform in diameter. For sizes smaller than the minimum size of the chuck, split cast-iron bushings are employed.

PAJARO MAGNIFYING MIRROR

For the use of toolmakers and machinists, the Pajaro Mfg. Co., Erie, Pa., has developed a magnifying mirror that is used in obtaining a clear view of work or tools which cannot otherwise be seen without straining the eyes or getting into an uncomfortable position. The mirror is 2 3/16 inches in diameter

Fig. 1. Pajaro Magnifying Mirror for Toolmakers and Machinists

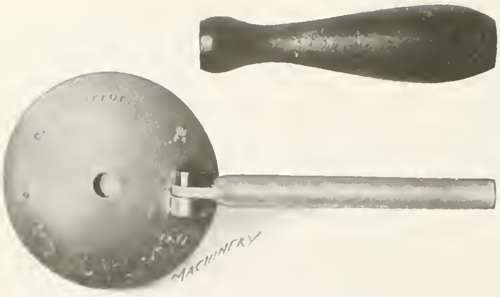


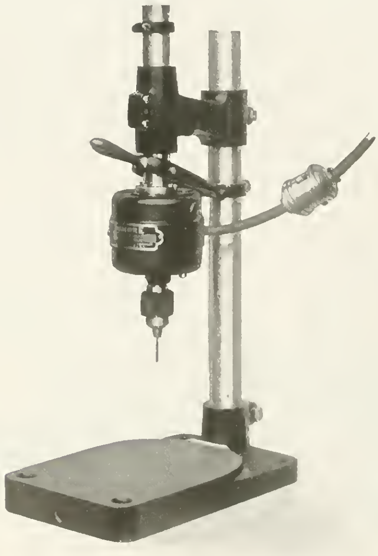
Fig. 2. Back View of Mirror showing Handle removed

and ground concave to give a high magnifying power; it is mounted in a white metal die-casting, and provided with a hardwood handle.

Among the uses of this mirror the following may be mentioned. Suppose you wish to see the cutting edge of a forming tool mounted in the lathe or shaper. It is merely necessary to hold the glass in front of or under the tool. Similarly, in cutting an internal thread which is not plainly visible, the mirror may be held in such a position that it will reflect sufficient light into the hole to give a clear view. In short, the tool is used whenever it is required to get a clear view of the work, and when the light, position or other circumstances make the obtaining of such a view a difficult matter.

WISCONSIN SENSITIVE DRILL

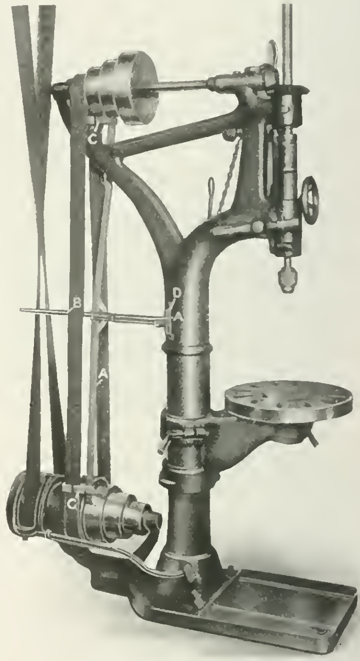
For the performance of drilling operations which require the use of a high-speed sensitive drill press, the Wisconsin Electric Co., Racine, Wis., has added to its line of "Dunmore" tools the bench drill which is illustrated and described herewith. This drill is especially adapted for the work of jewelers, watchmakers, instrument manufacturers, goldsmiths and silversmiths. It is driven by a direct-connected motor and equipped with a 13/64-inch Jacobs drill chuck. The feed control is equipped with a spring balance and is extremely sensitive, making the machine suitable for operation on the most delicate classes of work. The drive is from a high-speed universal motor capable of operating satisfactorily on either direct or alternating current, and it is equipped with S. K. F. ball bearings. The principal dimensions are as follows: height, 18 inches; maximum spindle stroke, 2 inches; swing, 6 inches; capacity for drilling in steel, up to 3/32 inch; capacity for drilling brass, bronze and soft alloys, up to 13/64 inch; and weight, 15¾ pounds.



High-speed Sensitive Bench Drill made by Wisconsin Electric Co.

LARSON BELT SHIFTER

It will be evident from the illustration which accompanies this article that the belt shifter shown on an upright drill press provides a quick means of shifting the belt from step to step of the cone pulley; the shifter is equally applicable for use on all classes of cone-driven machine tools. It is of simple construction, consisting of only five parts: the vertical shifter rod and handle *A* are a single unit; pivot rod *B* is screwed into the rear of the drill press column; belt loops *C* are secured to the shifter rod by set-screws; retaining strap *D* is secured to the column of the machine and limits the movement of the handle. Viewed from the top of the machine, pivot rod *B* is parallel with the corners of the cone steps on the belt entering side and by sliding the handle on this rod, the shifter loops are moved in a way that enables them to move the belt easily from one step of the pulley to another. It will be seen that the handle *A* projects beyond the shifter rod and this handle is bent over to form a shoulder in which is drilled a hole to admit the pivot rod *B*.



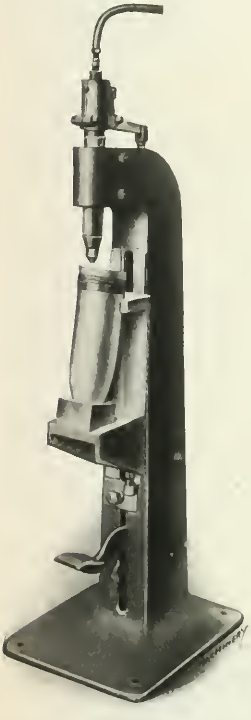
Drill Press equipped with Larson Belt Shifter

In operation, a slight pull forward and upward causes the belt to shift from the lower large cone step, and a second pull forward and downward shifts the belt onto the corresponding small step on the upper pulley. It will be obvious that this device is the means of saving time because it can be worked with one hand and is within convenient reach of the operator when he is at the front of the machine. If it is desired to shift the belt from one end of the cone pulley to the other, it is unnecessary to shift it from step to step; in such a case the operator simply pulls or pushes the handle to the limit of its movement in the proper direction, stops being provided so that the handle cannot be moved far enough to throw the belt off the pulley. This belt shifter is made by Nils E. Larson, 226 N. Hamlin Ave., Chicago, Ill.

GRANT PNEUMATIC SHELL RIVETER

For use in securing the gas check plug in shells which have an annular rim turned on the base of the shell to provide metal for closing down over the edge of the gas check plug before the base of the shell is faced off, the Grant Mfg. & Machine Co., N. W. Station, Bridgeport, Conn., has added to its line a stationary type of pneumatic riveter which is illustrated and described herewith. The operation performed on this particular type of shell requires the displacement of a considerable quantity of metal in order that the plug may be firmly held after the base of the shell has been faced off, without the joint being visible. The Grant riveting machine is equipped with a special supporting table and fixture which receives the nose of the shell, so that the base is supported in the proper position under the hammer.

The riveter is of the stationary type, and is fitted with a foot treadle which is used to bring the riveting hammer into action, leaving both of the operator's hands free for handling the work. After the shell has been placed in position, the treadle is depressed to start the hammer and the shell is then rotated by hand through one complete revolution. The hammer delivers about 1000 blows per minute and the plug can be riveted perfectly tight in about twenty seconds. These machines are built for handling 4.5, 5 and 6 inch shells, and are also adapted for ordinary riveting operations on rivets up to ½ inch in diameter. The principal dimensions are as follows: diameter of piston, 1 1/16 inch; length of stroke, 4 inches; volume of air taken per minute, 18 cubic feet; pressure of air, 80 to 100 pounds per square inch; speed, 1000 blows per minute; and weight of machine, 300 pounds.



Grant Pneumatic Riveter for closing in Metal around Gas Check Plugs

PLIMPTON TRANSFER TRUCK

The Plimpton Transfer Truck, 70 Fifth Ave., New York City, is now manufacturing the transfer truck shown in the accompanying illustration. It will be seen that this truck is constructed to take advantage of the elevating principle, the work being stacked on rough wooden platforms preparatory to being moved. As previously pointed out in these columns, this type of truck saves a considerable part of the investment for equipment required to transfer work from one department of the factory to another, as it is only necessary to provide the number of trucks which are actually required for moving the work.

In elevating the truck, a link on the elevating mechanism is hooked over a pin on the handle, after which the handle is pulled forward to a horizontal position. This results in raising the load and locking the mechanism in the raised position, after which the handle may be lifted to the position which is convenient for pulling the truck. To release the load, the handle is raised and pressed against projecting cam rods on the elevating mechanism, which results in releasing the check and permitting the load to descend slowly to the floor without the least shock. The truck is said to be rigidly constructed to adapt it for successful operation under severe conditions

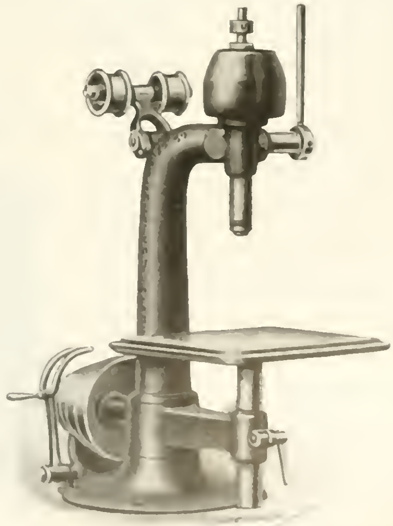
Plimpton Elevating Transfer Truck

of service. The Plimpton transfer truck is made in six different sizes, with capacities for handling loads ranging from one to three tons.

BLOMQUIST-ECK SENSITIVE DRILL

One of the latest additions to the line of machines manufactured by the Blomquist-Eck Machine & Mfg. Co., Cleveland, Ohio, is the No. 1 sensitive bench drill shown in the accompanying illustration. The following are features of the machine which give it extreme sensitiveness, and that add to its rigidity and freedom from vibration. All bearings are accurately ground to size and the pulleys are ground on the crown. The spindle is made of 40-point carbon steel and the end thrust is taken by a ball bearing. The spindle is carried by long bearings, which insure holding it in perfect alignment; and it is bored No. 1 Morse taper.

The surface of the table is accurately ground so that it is within 0.001 inch of true in all places. Two changes of spindle speed are provided, and the machine is driven by a 1½-inch belt. The principal dimensions are as follows: maximum distance from spindle to table, 12 inches; vertical movement of spindle, 3½ inches; hole in spindle, No. 1 Morse taper; vertical movement of table, 6 inches; size of table, 11½ inches square; distance from center of spindle to frame 7¾ inches; driving



No. 1 Sensitive Drill made by Blomquist-Eck Machine & Mfg. Co.

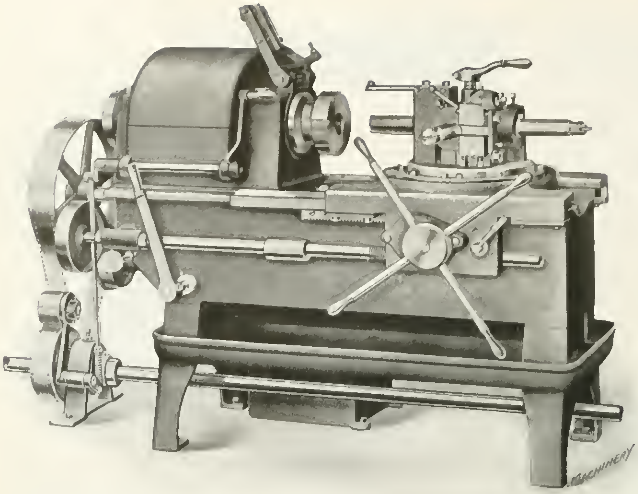


Fig. 1. Blood Turret Lathe for machining 3-inch Shrapnel and High-explosive Shells

capacity, for drills up to ½ inch in diameter; speed of driving pulley, 550 revolutions per minute; weight of bench drill, 110 pounds; and weight of machine arranged with floor column, 215 pounds.

DODGE SHELL TURNING LATHES AND TOOLS

One of the latest additions to the long list of special machinery for use in manufacturing shells is the line of machines that has recently been placed on the market by H. C. Dodge. It consists of a turret lathe for machining 3-inch shells; a turret lathe for machining shells up to 6 inches in diameter; a machine for performing filing, burring and polishing operations on shells; and a vise for holding shells while lapping, reaming, inspecting, etc. These are simple, rigid machines adapted for the conditions commonly met with in munition factories, and a general conception of their features will be readily obtained by reference to the illustrations.

H. C. Dodge, 175 Old Colony Ave., South Boston, Mass., has designed and placed on the market for use in the shell manufacturing trade, the lathes and tools described in this article. They were designed from experience secured in actual shell manufacturing, and their characteristics are stiffness and freedom from all features not actually required for the work to be done.

The first of these lathes, which is called the Blood single-purpose lathe, was designed by Charles Blood and is manufactured under his patents. A front view of this machine is illustrated in Fig. 1, and a rear view in Fig. 2. This lathe is intended for the sole purpose of machining high-explosive or shrapnel shells of the 3-inch or 75 millimeter size. It is essentially a single-purpose machine, and therefore does not include many of the features of the ordinary lathe. In designing this machine, special attention was paid to securing the greatest strength possible for the operations to be performed, keeping the machine as compact as possible. This will be understood when it is stated that the machine occupies a floor space of only 6 feet by 2 feet, 6 inches. The weight is 2300 pounds.

While this machine can be driven from an overhead lineshaft if desired, a more compact method, especially when the machines are used in batteries, is the one illustrated in Fig. 1. Here the lineshaft is shown beneath the machine and it will be evident that a large number of machines can be operated in a small space. From the driving shaft, rotation is transmitted to the main spindle by direct gearing. The lathe is started or stopped by pulling down on the crank that may be seen directly in front of the headstock, which operates an idler acting directly upon the driving belt. The drive gears are two in number, so that two speeds are obtainable, the ratio of the speeds being 4 to 1. The driving gears are of steel with faces 2¼ inches in width, thus supplying plenty of power for the spindle drive.

The spindle is 5½ inches diameter, has a 3-inch hole running through it, and runs in long bearings that are lined with babbitt which is pressed into dovetail slots and scraped to fit the spindle. The spindle nose is fitted with a draw-in type of chuck that is very powerful in its operation. The feed is obtained from the feed shaft at the front of the machine, and this receives rotation from feed gears within the machine that are direct-connected with the driving shaft. The ways are very widely spaced and the carriage bearings are extremely long. The carriage is power-traversed by engaging a worm on the feed shaft with a worm-wheel within the apron which operates in the usual way. The travel of the turret is limited to 15 inches, as this covers the greatest tool travel required on any 3-inch shell. For hand operation, a large pilot wheel is used.

The circular bearing of the turret upon the carriage is of large size, giving ample support to the cutting tools. The withdrawal of the turret on the carriage automatically releases a locking pin, so that the turret may be revolved from station to station. The tools for performing turning or boring operations are located on the turret; and in manufacturing shells it is customary to use the machines tooled for outside turning, for inside boring, and for machining the nose. In each case the machine is the same, but the chuck and turret equipment is suited to the operation to be performed. As an example of the way the Blood single-purpose lathe is being used in one large shell manufacturing plant, it may be stated that in rough-turning shells, taking ¼ inch off the diameter, the length of 6¼ inches is turned in forty-five seconds.

Dodge Special Single-purpose Lathe

The shell manufacturing lathe illustrated in Fig. 3 is known as the Dodge single-purpose lathe and is intended for machin-

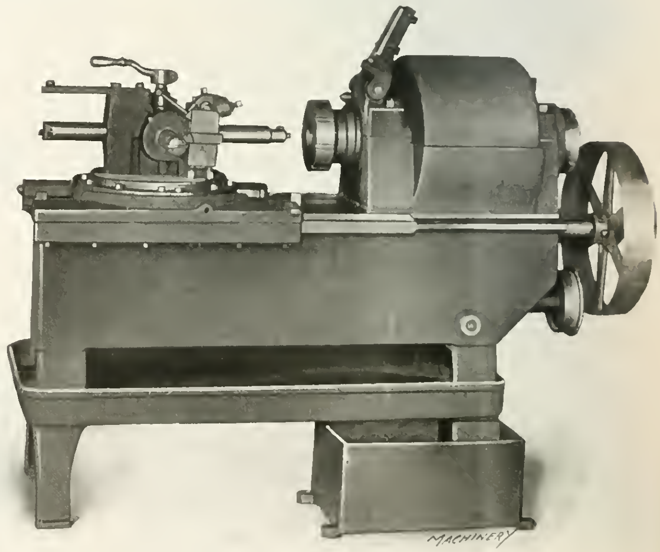


Fig. 2. Opposite Side of Blood Turret Lathe shown in Fig. 1

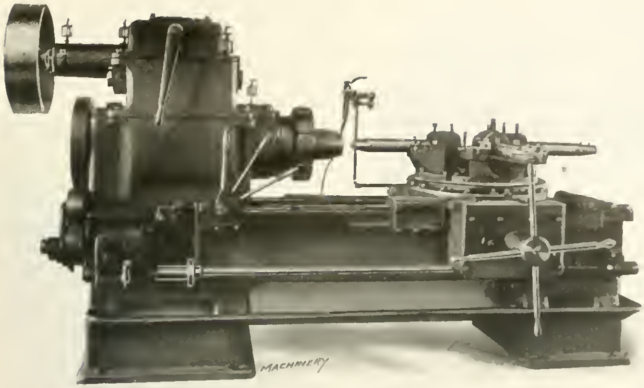


Fig. 3. Dodge Turret Lathe for machining Shells up to 6 Inches in Diameter

ing shells in any diameters up to 6 inches. It will be seen that this lathe is of the turret type, and as it is for the sole purpose of shell manufacturing, all the usual lathe features not required for this class of work have been omitted. In the design of this machine the principal objects strived for were strength and power for carrying heavy cuts, and convenience of operation.

The drive is through a 16-inch pulley having a $5\frac{1}{2}$-inch face, from which power is transmitted through direct gearing to the spindle. The spindle bearings are of ample size, the one at the front being $9\frac{1}{2}$ inches diameter by 8 inches long, and the one at the rear, $7\frac{1}{2}$ inches diameter and 7 inches long. The spindle bearings are lined with babbitt which is compressed into dovetail grooves. The spindle is provided with a hole large enough to receive a 6-inch shell at the front end; and the headstock in which the spindle is mounted is extremely heavy and bolted to the bed. Two changes of speed are provided in the head, and by using a two-speed countershaft, four speeds are obtainable. A collet chuck of heavy design is employed for holding the shell while machining the inside, and for outside work the proper type of expanding mandrel is supplied.

The bed is comparatively short, being 8 feet, 6 inches in length; it is designed on extremely heavy lines, and is ribbed and provided with a chip pan for catching chips and lubricant. The base of the machine at the forward end contains an oil tank for lubricant. The floor space required for the machine is 4 by 10 feet. The ways are spaced 27 inches apart; the front way is of the V-type and the rear way is flat. The carriage has a bearing 40 inches long on the ways, and it is securely gibbed at the back to prevent lifting. The extreme travel of the carriage is 30 inches. The circular bearing of the turret on the carriage is 24 inches in diameter, and the turret is held at the various stations by a hardened steel locking pin that fits in tapered steel bearings. Owing to the large diameter of the turret, there is plenty of room for mounting the various tools, regardless of whether they are used on inside or outside work. The locking pin is disengaged by a conveniently located lever. The lathe swings 24 inches over the ways and 6 inches over the turret.

The feed is secured from the gear-box at the left-hand end of the machine. From the feed-shaft at the front, a worm engages a bronze worm-wheel in the apron of the carriage, which runs in oil. This drives a pinion that meshes with a rack which is inverted so that it does not become clogged. This rack is located well under the edge of the bed, thus counteracting any twisting tendency of the carriage. Three changes of speed may be secured, control being provided by a lever which actuates a sliding gear in the feed-box so that the feed changes may be made without stopping the spindle. An adjustable stop for each station of the turret automatically disengages the feed clutch just before the fixed stop is reached. This enables the operator to feed the last few thousandths inch by hand and guards against the breakage of tools, in addition to insuring exact duplication of limits. The Dodge single-purpose lathe is supplied fully tooled to perform any of the following operations: (1) outside turning of the shell; (2) inside boring, reaming and facing; (3) base forming, including turning and threading of the recess for the gas plug; (4) nose forming after the cap has been fitted in the nose of the shell.

Dodge Shell Filing and Polishing Lathe

The lathe illustrated in Fig. 4 is used for performing filing, polishing or burring operations upon shells of any diameter within its range. This machine is mounted on a bench and driven from beneath, as shown in the illustration. The lathe is stopped or started by the hand-lever shown at the left, which operates an idler beneath the bench; and the operation of this hand-lever also applies a brake to the spindle to stop rotation quickly. The tailstock is lever-controlled and the whole apparatus was designed for the rapid handling of shells on short filing and polishing operations for removing tool marks, cleaning up the copper band, polishing the nose, etc.

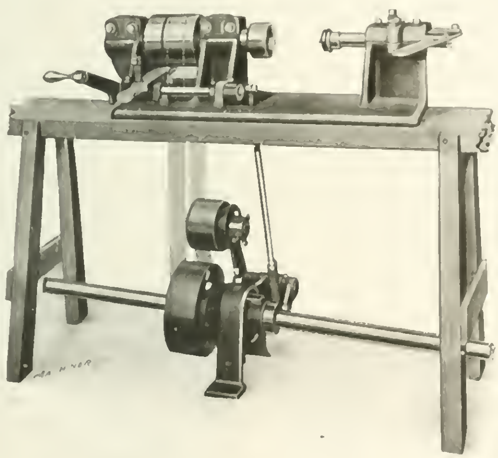


Fig. 4. Machine for performing Filing, Burring and Polishing Operations on Shells

Vise for Holding Shells

The vise illustrated in Fig. 5 was placed on the market for use in holding shells while reaming, tapping, inspecting, loading or performing other operations that require the shell to be held in a vertical position. It will be seen that the vise is intended to be screwed to a bench and that it is of the split type with the two halves hinged and held together by a bolt that has a nut operated by a handwheel. This vise is made for holding 3 inch shells and will grip them sufficiently for the heaviest tapping or reaming operations on the nose.

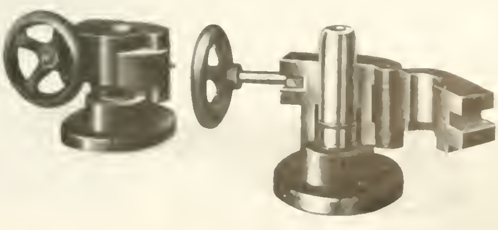
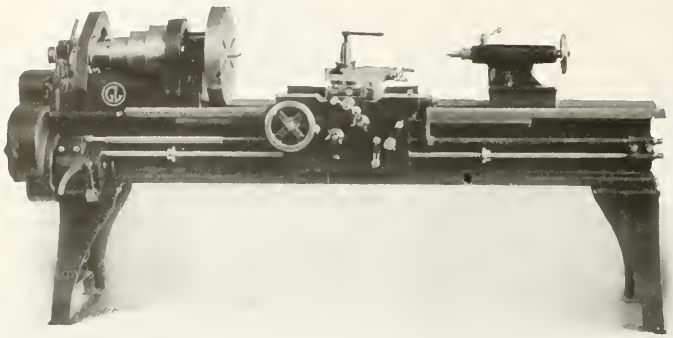


Fig. 5. Vise for holding Shells while reaming, tapping, inspecting, etc.



Giddings & Lewis 16-inch Lathe equipped with Four-step Cone Pulley and Single Back-gesrs

GIDDINGS & LEWIS LATHE

The Giddings & Lewis Mfg. Co., Fond du Lac, Wis., is now manufacturing a 16-inch heavy pattern lathe which is equipped with either a four-step cone pulley and single back-gears, or three-step cone pulley and double back-gears. Both types of lathes are built with positive geared feed. These are said to be strong and accurate lathes which are capable of giving satisfactory service in the tool-room or manufacturing departments of a factory, and they are adapted for handling either light or heavy work.

The spindle is turned from a crucible steel forging which provides ample strength and resistance against wear; it has a hole bored through it and is accurately ground to size. The spindle bearings are lined with phosphor-bronze and furnished with wick oilers that dip into a reservoir from which they deliver a constant supply of clean oil to the bearings at all times. Anti-friction thrust bearings are provided with a nut for adjusting them from time to time. The tailstock is designed in such a way that the compound rest may be set at right angles to the cross-slide; and the tail-spindle is made of steel, accurately ground and graduated in inches for the convenience of the operator when performing drilling operations on the lathe. Means are provided for setting over the tailstock for performing taper turning operations.

The carriage is gibbed to the bed at the front, center and back, and is scraped to provide a solid bearing over its entire length. The carriage is flat on top so that work may be clamped to it. Power longitudinal and cross feeds are provided, and the cross-feed screw has micrometer adjustment. When the cross-feed is in use, the carriage can be quickly clamped to the bed. The thread chasing dial is graduated to indicate the rotation of the lead-screw and enables the operator to throw in the nut at the proper moment, thus permitting him to return the carriage by hand. The compound rest is fitted with the usual form of taper gibs which require the use of only one screw in making adjustments.

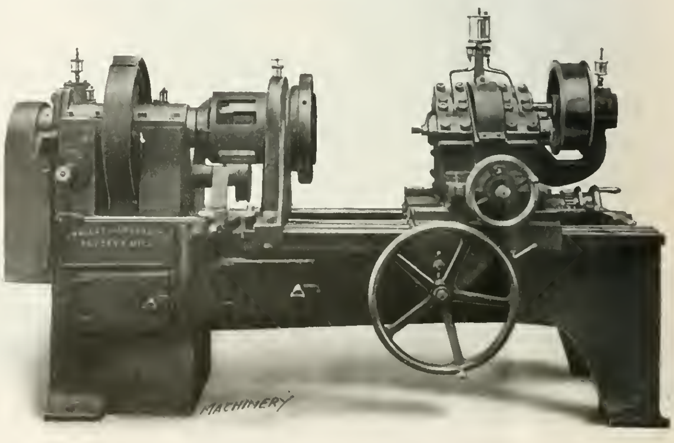
The apron is shouldered into the carriage and all parts are strongly constructed. The longitudinal and cross feeds are reversible from the apron, and the former is so arranged that it is impossible for the lead-screw and feed-rod to be engaged simultaneously. Both longitudinal and cross feeds are friction-driven and can be instantly thrown in or out, the frictions also serving as safety devices to protect the mechanism from damage. The automatic stop and feed reverse are controlled by a lever located near the bottom of the apron at the right, these mechanisms being used only for the turning feed; the reverse for screw cutting is obtained by shifting a lever located at the end of the headstock. The quick-change feed-box provides eight positive geared feeds, any of which may be instantly obtained.

The principal dimensions are as follows: swing over bed, 18¾ inches; swing over rest, 11 inches; capacity between centers for lathe with six-foot bed, 29 inches; diameter of hole through spindle, 1½ inch; diameter of tailstock spindle, 2 1/16 inches; traverse of tailstock spindle, 7½ inches; range for screw cutting, 2 to 24 threads per inch; range of feeds, 0.010 to 0.051 inch per revolution; size of tools, ⅝ by 1⅛ inch; weight of machine with six-foot bed, 2281 pounds. The preceding dimensions apply to both the machine with a four-step cone and single back-gears, and to the machine with a three-step cone and double back-gears. On the machine with a four-step cone, the available speeds are from 6 to 385 R. P. M., the width of the driving belt is 3 inches, and the ratio of the single back-gears, 10 to 1. On the machine with the three-step cone, the available spindle speeds are 10 to 222 R. P. M., the width of the driving belt is 3½ inches, and the ratio of the double back-gears, 9 to 1 and 3 to 1.

SMALLEY-GENERAL THREAD MILLING MACHINE

The thread milling machine which forms the subject of the following article can be used on any kind of work where a straight thread is to be cut, although the machine is at present being used almost entirely on shell work. It is capable of handling pieces with from four to twenty threads per inch. The illustration shows the machine equipped with a collet chuck of the type used in threading the nose of 8-inch shells, but various other types of chucks can be furnished with the machine, the selection depending upon the size of shells to be threaded and the way in which the work is handled in the shop.

In working out the design, great care was taken to produce a machine which would be entirely free of vibration, and as simple as possible. With this object in view the main head is cast solid with the bed to insure permanent alignment. The cutter-head has broad ways with gibs for taking up wear. All bearings are lined with bronze and all gears are made of steel with teeth of ample size for the service. In order to avoid vibration in the cutter-spindle, herringbone gears are provided for transmitting the power from the pulley shaft to the spindle, and these gears run in oil. The head is oiled from a large sight-feed oiler, and all principal bearings have liberal sized oil cups. The oil holes are provided with self-closing covers wherever it is possible to apply them. For the purpose of keeping the ways clear of chips, wipers are provided which



Thread Milling Machine built by the Smalley-General Co.

can be seen in the accompanying illustration.

One of the principal features of the machine is the two-speed mechanism which is operated by throwing a lever located at the back of the steadyrest. This provides for instantly changing the speed from 6 inches per minute, which is the speed used for thread milling, to 25 feet per minute, which is the speed employed for scraping the plug seat to insure its alignment with the thread. For performing the scraping operation, a tool is provided at the back of the thread milling cutter so that the plug seat is scraped without removing either the scraping tool or the threading cutter from the cutter-head. The diameter of the thread is regulated by a micrometer screw. The feed-screw is furnished with a trip which throws out the clutch and prevents the slide from coming back against the shoulder, should the operator let the machine run too long.

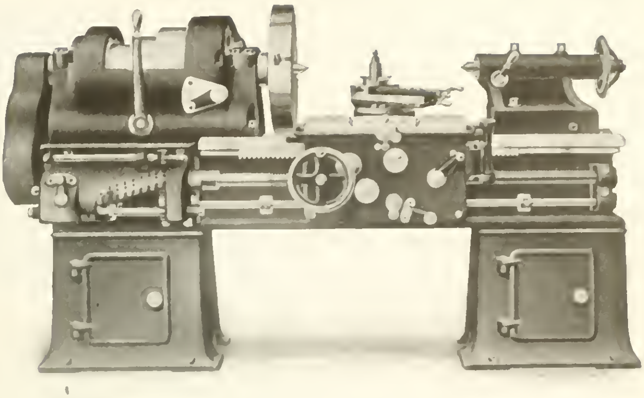


Fig. 2. Rahn 18-inch Engine Lathe equipped with Three-step Cone Pulley and Double Back-gears

Located in the base are a tank and lubricant pump which provide for delivering a copious supply of cutting compound to the cutter. After being delivered to the work, this cutting compound drops into a trough from which it drains back to the main reservoir. Three settling chambers are provided so that all chips and other foreign matter are removed from the cutting compound before it is again passed through the pump. It will be seen that there are doors at the front of the bed which permit of cleaning out the chips. In operating the machine, a milling speed of 6 inches per minute is usually recommended for handling work with eight threads per inch; but there are machines in successful operation on which the speed has been increased to 9 inches per minute, and they are said to be producing perfectly satisfactory results.

It will be evident from the illustration that the machine employs the so-called "hob" or multiple type of thread milling cutter which only requires the work to make one revolution to complete the milling operation. This type of machine has recently been described in these columns. The machines are built for any size of shells up to 16 inches; and they may be arranged for belt drive or individual motor drive, as required. The Smalley-General Co., Inc., Bay City, Mich., is the manufacturer of this thread miller.

RAHN ENGINE LATHES

The 18-inch engine lathes illustrated and described herewith have recently been placed on the market by John Rahn, Cincinnati, Ohio. It will be evident from the illustrations that the design of these two machines is the same with the exception of the headstocks; each type of headstock will be described in detail and the remainder of the description applies to both machines.

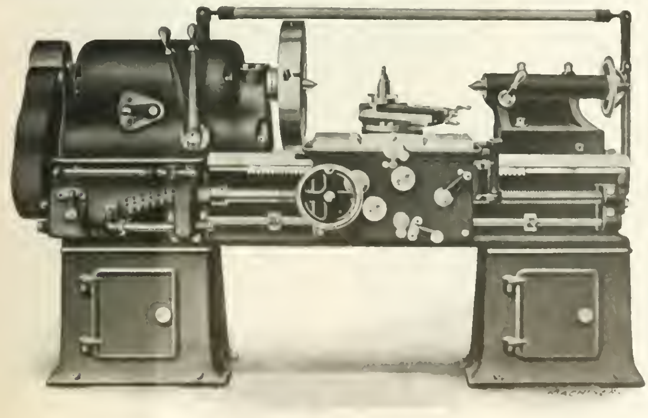


Fig. 1. Rahn 18-inch Engine Lathe equipped with Single-pulley Drive and All-geared Head

It will be seen that the lathe shown in Fig. 1 is equipped with single-pulley drive and a geared head. The gears run in oil so that they are thoroughly lubricated, and sixteen changes of speed are provided when the machine is driven by a double friction countershaft. The gears run in one direction, and the changes of speed are obtained through friction clutches and levers on the outside of the headstock, which enable the operator to change instantly from one speed to another without stopping the machine. The direction of rotation of the spindle is also reversed by means of a friction clutch connected to the spindle and controlled by the lever and rod which runs the entire length of the bed. The spindle is hollow and made of high carbon steel; it is supported in bearings lined with phosphor-bronze and provided with means of compensating for wear. The centers are No. 4 Morse taper, and they are hardened and ground to run perfectly true.

Fig. 2 shows the same lathe equipped with a three-step cone pulley and double back-gears. The spindle and spindle bearings are the same as in the geared-head lathe. The driving cone is of large size and transmits the power through back-gears which are constantly in mesh, thus obviating the necessity of throwing them in when it is required to use the back-geared drive. A steel pinion which engages the large spindle gear is thrown into mesh when it is desired to bring the back-gears into operation. Levers at the front of the headstock provide for instantly changing the speed, and these levers are within easy reach of the operator.

The tailstock is of the offset type which provides for setting the compound rest parallel with the bed, and is furnished with means of setting it over for turning taper work. The compound rest is rigidly constructed and has the usual arrangement of taper gibs for compensating for wear. The carriage is gibbed to the bed at front and back, and provided with a liberal sized bearing for the tool rest. Felt wipers assist in lubricating the bearings, and provision is made for applying a taper attachment. The apron is of the double-plate type and designed in such a way that all feed and screw cutting mechanism is conveniently controlled. All gears in the apron, as well as the rack, are made of steel. The lead-screw has Acme threads and the thrust is taken by ball bearings. All shafts in the apron are supported at both ends and run in bronze bearings. The pinion that meshes with the rack is supported at both sides and can be drawn out of mesh when the lathe is engaged in screw cutting. For performing the latter operation, a screw chasing dial is provided, which obviates the necessity of reversing the spindle when chasing threads. A safety device makes it impossible for the feed and screw cutting mechanisms to engage simultaneously.

The quick-change feed-box is of simple and

substantial construction, providing a range of thirty changes of feed by operating two levers on the outside of the box, which can be manipulated while the lathe is running. Means are provided for introducing the usual form of "translating" gears into the drive for cutting threads of any desired metric pitch which come within the range of the lathe. The lathe is driven by a countershaft with double friction clutch pulleys, ample oiling facilities being provided for the countershaft bearings. The regular equipment includes a countershaft, steadyrest, follow-rest, large faceplate, driving belt, screw cutting dial, and the necessary wrenches. When desired, a taper attachment, turret on the carriage, chucks, chuck plates, and any desired forms of turning tools may be furnished as extra parts.

The principal dimensions of both machines are as follows: diameter of hole through spindle, 1¾ inch; diameter of tail-spindle, 2⅛ inches; traverse of tail-spindle, 8½ inches; width of driving belt, 3 inches; range of threads that can be cut, 4 to 40 per inch; range of feeds, 0.010 to 0.110 inch per revolution; length of bed, 6½ feet; maximum distance between centers, 2 feet, 6 inches; swing over bed, 18½ inches; swing over carriage, 12 inches; swing over steadyrest, 11 inches, travel of compound rest, 6½ inches; size of tools used, 1¼ by ⅝ inch; floor space occupied by lathe with six-foot bed, 6 feet, 6 inches by 18½ inches; and weight of machine with six-foot bed, 2600 pounds.

PAWLING & HARNISCHFEGER CENTERING MACHINE

For centering shafts and other cylindrical work, the Pawling & Harnischfeger Co., Milwaukee, Wis., has placed on the market the duplex centering machine illustrated and described herewith. That the machine has a capacity for handling a wide range of work is well brought out by these illustrations. Figs. 1 and 2 show front and rear views of the machine working on a shaft 7¼ inches in diameter by 9 feet, 8 inches long, and Fig. 3 shows a partial rear view of the machine centering a shaft which is only 1⅛ inch in diameter by 30 inches long. This shows in a forcible manner the range of work for which the machine is adapted, although it does not represent the extreme range, as shafts varying in size from ⅞ inch in diameter by 10 inches long up to 7½ inches in diameter by 12 feet long can be centered. It will be seen from the rear views that the machine is equipped with individual motor drive, the motor being direct-connected to a driving shaft at the back of the machine. This shaft, in turn, is belted to the geared heads. When so desired, the machine may also be equipped for belt drive.

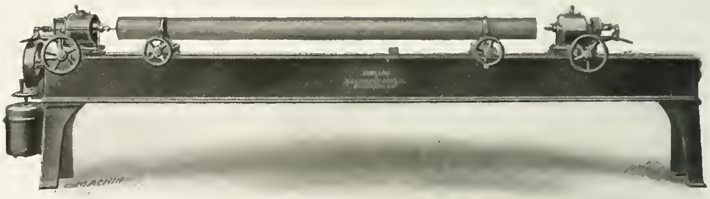


Fig. 1. Front View of Pawling & Harnischfeger Centering Machine working on Shaft 7¼ Inches in Diameter by 9 Feet, 8 Inches Long

The principal dimensions of this Pawling & Harnischfeger centering machine are: length over all, 16 feet, 6 inches; spindle bore, No. 2 Morse taper; drill spindle speed, 600 R. P. M.; reamer speed, 240 R. P. M.; speed of driving shaft, 400 R. P. M.; size of driving pulley for belt drive, 8 inches in diameter by 2¼ inches face width; capacity of motor used for individual motor drive, ½ horsepower; and weight of motor-driven machine, 2200 pounds. The regular equipment of the machine includes two drill chucks for ¼-inch drills, two three-lipped center reamers 1 inch in diameter, and one supporting jack.

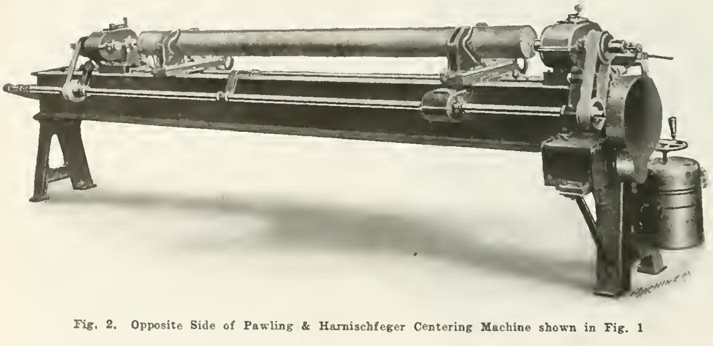


Fig. 2. Opposite Side of Pawling & Harnischfeger Centering Machine shown in Fig. 1

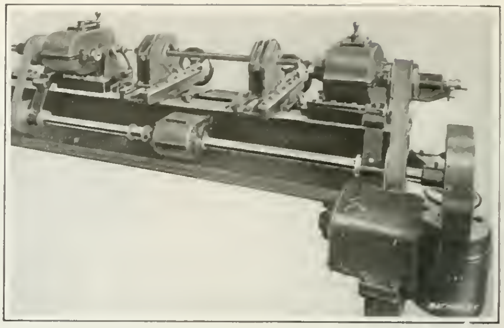


Fig. 3. Close View of Pawling & Harnischfeger Centering Machine working on Shaft 1⅛ Inch in Diameter by 30 Inches Long

CHAIN BELT PICKLING CONVEYOR

For some time the manufacturers of tubular brass goods and other metal products have felt the need of some form of mechanical conveyor for carrying the work through a series of pickling and rinsing baths, to remove the grease and oil which has collected during the process of manufacture. The accompanying illustrations show a conveyor for this purpose made by the Chain Belt Co., Milwaukee, Wis., which is said to be giving excellent service in a well known factory. It will be seen that the conveyor consists of two strands of what are known as "Griplock" roller chain belt, which is a product of the Chain Belt Co. Between the two strands of chain are attached steel bars with the ends bent up at right angles, and with semicircular recesses punched to suit the diameter of the tubes which have to be handled. These recesses are so formed that the tubes lie slightly on an incline to facilitate draining off the water or pickling fluid as the work leaves the bath.

The upper track is made of steel angle irons which are bent into a series of curves to suit the length and depth of the tank in which the work is to be immersed, and also to suit the length of time during which it is desired to have the work submerged in the different baths. Hold-down guides are provided at the curves and as the chain is fitted with rollers of large diameter, frictional resistance caused by the pull of the chain at the curves is reduced to a minimum. The track is a self-contained unit, constructed in such a way that it can be removed or placed in the tank without disturbing the fittings. The return "run" of the conveyor is over straight angle iron tracks, beneath the tanks. There are four shafts—one main driving shaft and one idler shaft at the delivery end, and one

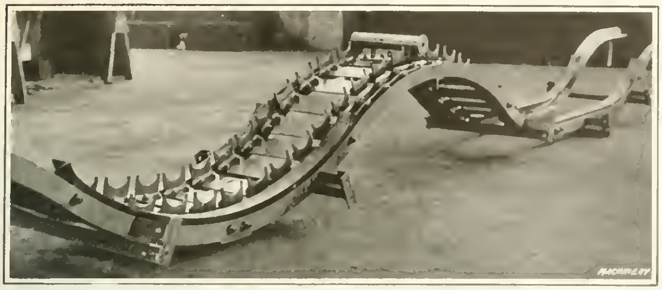


Fig. 1. Chain Belt Conveyor for carrying Shells through Pickling Bath

take-up shaft and one idler shaft at the receiving end of the conveyor. The idler shafts are necessary on account of the depth of the tanks. On each shaft are mounted two cast-iron sprocket wheels, the teeth of which are fitted to the chain links to insure a steady pull and a free movement of the conveyor.

To give an idea of the size in which these conveyors are built, it may be mentionod that the particular installation which is illustrated measures 34 feet from the center of the head shaft to the center of the take-up shaft. This conveyor is motor-driven, the power being transmitted through spur gearing connected to the head shaft; but equally satisfactory results may be obtained by using a belt drive from a lineshaft if conditions make it desirable to employ this type of drive.

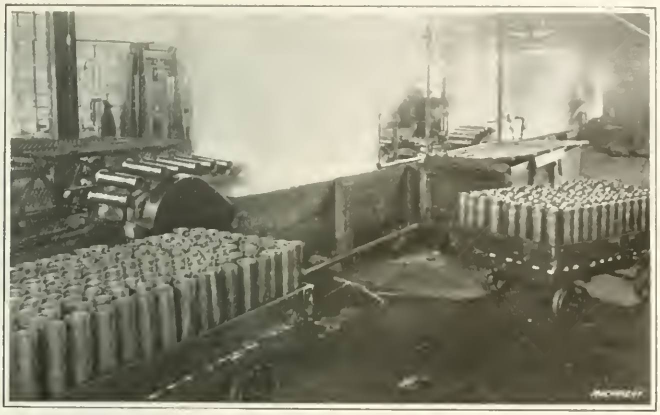


Fig. 2. Chain Belt Conveyor set up in a Pickling Bath

The apparatus is designed in such a way that the tubes to be pickled are loaded onto the conveyor at one end and automatically discharged at the opposite end after they have been passed through the pickling baths and rinsing tanks. The conveyor is capable of passing the tubes through the bath at the rate of 1200 per hour when traveling at a speed of ten feet per minute, but in actual practice the carrying capacity of the conveyor is so utilized that it handles approximately 3000 tubes per hour. The saving effected in the cost of handling tubes by this device is so obvious that the conveyor should readily commend itself to manufacturers of products on which it could be used to advantage.

GIBB "I-RITE" PYROMETER

The chief claim made for the "I-Rite" pyrometer which has recently been placed on the market by the Gibb Instrument Co., Highland Bldg., Pittsburg, Pa., is that it makes a direct measurement of the temperature of the work which is being heat-treated. This is an important point because tests have shown that the temperature of furnaces used for the heat-treatment of metals may vary considerably in different parts of the furnace. For instance, a certain furnace used for annealing sheet metal was found to have a temperature of 900 degrees F. in one place and 1800 degrees F. in another, these extreme temperatures representing the results of a series of twelve readings taken at different points in the furnace. As a further example, reference may be made to a certain installation of furnaces with heating chambers 3 by 2 by 6 feet in size, which are used by a well known automobile manufacturer. The work did not come uniform from these furnaces and to determine the reason, six recording pyrometers were installed at different points in one of the furnaces. The results of the investigation showed that the temperature fluctuated 50 degrees F. from the normal temperature which was required.

Obviously, it is impossible to obtain the best results with work which must be heat-treated at a specified temperature, if the heating is done in a furnace where the temperature varies considerably. But if it is possible to observe the actual temperature of the work so that it is withdrawn when it has reached exactly the required heat, satisfactory results are almost sure to be obtained. This condition is fulfilled with the new Gibb pyrometer; and other claims made for this instrument are its simplicity and convenience, coupled with the fact that it is of such a size that it may readily be slipped into a man's pocket.

The highly satisfactory results in the heat-treatment of steel obtained by the older generation of metallurgists, who depended entirely upon the color method for determining the proper quenching and annealing temperatures, were largely due to the fact that this method depended upon making an estimation of the actual temperature of the metal rather than bringing the furnace to an average temperature corresponding to that required for the process of heat-treatment. The limitation of the color method was that some men using it were unable to carry in mind the exact color corresponding to the temperature they wished to obtain; and the use of pyrometers for measuring temperatures has failed in some cases because the indication of the instrument is accurate

Fig. 1. Gibb "I-Rite" Optical Pyrometer in Use

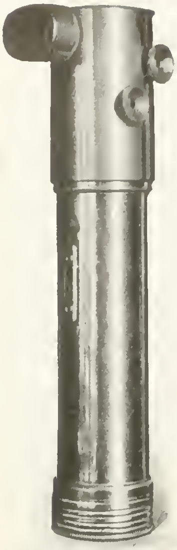


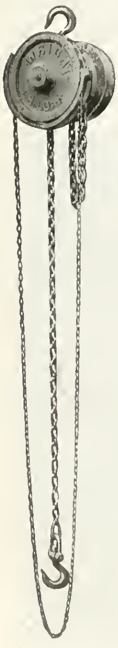
Fig. 2. Gibb "I-Rite" Optical Pyrometer

for a particular point in the furnace, but does not indicate that the temperature of the furnace is uniform throughout. With the Gibb "I-Rite" pyrometer, a scale is provided which exactly duplicates the color of heated bodies at different temperatures and it is claimed that the instrument makes it possible to read the temperature of the work within a limit of accuracy of two per cent, regardless of the temperature of the furnace. The use of the pyrometer enables the metallurgist to ascertain instantly whether or not the piece is at the required temperature for quenching or annealing.

As the use of this instrument depends upon the sensitiveness of the eye and its ability to distinguish shades of color, the following results of an experiment conducted by Prof. E. L. Nichols of Cornell University are of interest. He placed ninety-two shades of blue before fifty-four observers and the general average of efficiency in placing these shades in the proper relation to each other was over 95 per cent. An interesting fact in connection with this sensitiveness of the eye is that a man who is color blind can still read the Gibb pyrometer with the same accuracy as one who distinguishes colors properly, because although the color may not appear of the proper shade, he is still able to compare it with a standard of the desired color and intensity.

The operation of the Gibb "I-Rite" pyrometer is said to be so simple that it may be used with almost equal facility by an unskilled workman or by an experienced metallurgist; and the construction is so simple that the instrument is not likely to get out of order. The instrument is primarily intended for the precise measurements of temperatures of steel during the process of heat-treatment, and is made in two sizes with capacities for measuring temperatures from 1000 to 1800 degrees F., and from 1800 to 2300 degrees F., respectively. It is suitable for use in determining the temperature of heated metal, either before or after its removal from the furnace; consequently, it is possible to use the instrument for obtaining temperatures of heated steel in the form of ingots, billets, rails, armor plates, forgings, or castings.

WRIGHT CHAIN HOIST



Wright Chain Hoist

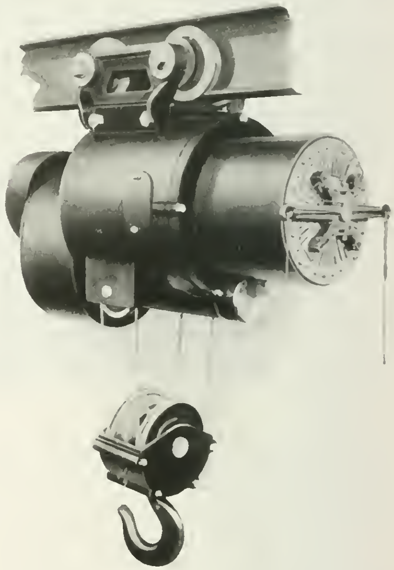
One of the latest additions to the line of hoists made by the Wright Mfg. Co., Lisbon, Ohio, is the chain hoist illustrated and described herewith. It is furnished with a system of planetary gearing which gives a mechanical efficiency of 80 per cent; and the use of steel or malleable iron for the construction of every working and load-supporting part makes the hoist capable of handling exceptionally heavy loads. These features of construction also give long life to the hoist and practically eliminate the breakage of parts.

The non-fouling hand-chain guide provided permits of raising or lowering the load by a chain pull from any direction, and all tendency for the chain to jerk or catch is said to be positively eliminated. With a one-ton hoist of this type a man can lift the full load by overhauling 30 feet of hand chain with a pull of 82 pounds; and with the two-ton hoist it requires 120 pounds pull with an overhaul of 120 feet of chain to lift the load.

ECONOMY ELECTRIC HOIST

In designing the electric hoist which forms the subject of this description, the Economy Engineering Co., Willoughby, Ohio, has paid particular attention to the development of a mechanism combining the features of simplicity and compactness, with all parts readily accessible. By removing steel cover plates, the commutator brushes are exposed for inspection or adjustment, and taking off the end frame renders all parts accessible. The construction is such that any unit may be removed without disturbing other parts, which is a feature that greatly facilitates the making of repairs. The mechanism is completely enclosed, making the hoist adaptable for outside service or in places where trouble would otherwise be experienced from dust and acid fumes. No additional covering is required.

The hoisting unit lends itself readily to any one of several mountings. The one shown in the illustration, using a plain trolley to run on the lower flange of an I-beam rail, is traversed by simply pushing against the load. This is the type recommended for hoists up to two tons capacity. The same trolley can be fitted with a hand chain for racking, or with motor drive for use on high-speed installations or on long runs and on hoists which have an operator's cab attached to them. The hoist can be furnished mounted at right angles to the position shown, or with hook suspension; and it may be mounted in many special ways to suit unusual conditions. The hoist and cables are so arranged that the hoist is always in perfect balance regardless of the type of suspension or the magnitude of the load being handled.



Electric Hoist manufactured by Economy Engineering Co.

The hoist frame is made of cast iron, cylindrical in form and so constructed that the operating mechanism is rigidly supported. The drum is centrally located within the frame, and only a small opening is required for the rope to pass through; consequently, very little of the drum is exposed. The portion of the frame containing the gearing and mechanical brake is separated from the drum and motor in such a way that the gears may be packed with grease. The hoist is equipped with standard Hyatt roller bearings which reduce power consumption and increase the life of the hoist. On account of the comparatively slow movement, the drum bearings are bushed with bronze. Spur gearing is used throughout, the gears and pinions being cut from steel blanks which are heat-treated to bring out the most desirable physical characteris-

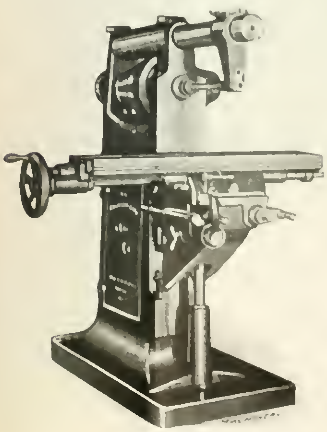
ties of the metal. The bearings are provided with ample facilities for lubrication. The drum is made of cast iron and is grooved to receive the full amount of rope without overlapping. Special attention is called to the fact that the drum replaces the motor frame and revolves around the motor armature, which represents a departure from established practice in hoist design. This form of construction enables the drum to be made of an unusually large diameter without increasing the size of the hoist.

The hoist cable is made of plow steel, and the load block consists of a cast frame containing sheaves of large diameter, which are fitted with roller bearings. The hoist is equipped with a mechanical load brake which automatically stops and holds the load when the motor is stopped; and this brake can only be released by revolving the motor in the lowering direction. The brake is of the friction disk type and has no intricate parts which are likely to be broken. The solenoid brake is capable of holding the full load of the hoist and will instantly stop the motor when the current is shut off. Motors can be provided for use on either alternating or direct current; and either a rheostat or single-speed control can be furnished, according to the requirements of the shop in which the hoist is being used. The rheostat control is used where delicacy or accuracy in the handling of the load is required, as in the case of foundries where sand molds are to be lifted by the hoist; and the sole function of the single-speed control is to start and stop the motor. All hoists are equipped with an automatic limit switch which is operated by the block when it has reached its highest position, and instantly stops the hoisting motor. These hoists are made in sizes that have lifting capacities ranging from 1000 to 10,000 pounds.

DOW MILLING MACHINE

The Dow Mfg. Co., Braintree, Mass., has placed on the market the plain milling machine shown in the accompanying illustration. This machine is designated as the No. 1 size and is intended for general manufacturing milling operations—in fact, for any plain milling within its range. While no radical features are incorporated in the design of the machine, it has been the aim of the manufacturers to produce a very rugged manufacturing miller that will produce accurate work. The drive of the machine is to a four-step cone pulley on the spindle, and through back-gearing eight spindle speeds may be obtained.

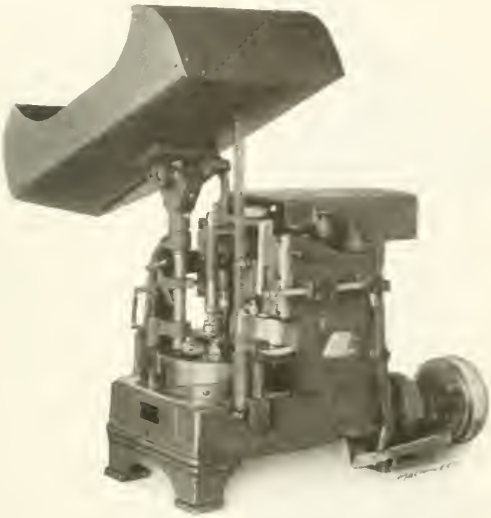
The table of the machine is supported on a knee with long bearings on the column. The table is 37 inches long by 8 inches wide; and it may be fed 21 inches longitudinally, and 8 inches in a cross direction. The knee of the machine has a vertical travel of 16 inches on the column. While the table is only provided with power feed in a longitudinal direction, the cross and vertical feeds can be equipped for power drive, if so desired. The feed motion for the table is taken from the spindle and transmitted to the gear-box by a silent chain. The gear-box is oil-tight, and there are three available rates of feed for each spindle speed. The spindle and many other shafts in the machine are made of tool steel, which is hardened and ground. The arbor is supported with the usual type of overhanging arm, and will accommodate cutters eight inches long. Weight of machine is 2200 pounds.



No. 1 Plain Milling Machine built by Dow Mfg. Co.

SLOAN & CHACE CARTRIDGE VENT DRILLING MACHINE

For use in drilling two vent holes through the cap cavity of a cartridge butt, the Sloan & Chace Mfg. Co., Ltd., 6th Ave and North 13th St., Newark, N. J., has recently brought out the machine shown in the accompanying illustration. The cartridges to be drilled are thrown into an oscillating hopper which automatically selects and drops one cartridge at a time into the feed-tube. This tube is provided with a mechanism which drops one cartridge each time the chuck turret comes to rest with an open chuck in place under the feed-tube. This chuck turret carries the cartridge successively under two drills



Cartridge Vent Drilling Machine built by Sloan & Chace Mfg. Co.

and then under a two-pin gage which moves intermittently with the drills; and if through the breaking of a drill or for any other cause, the two holes have not been properly drilled, the gage mechanism releases a clutch and stops the machine. After passing the gage, the chuck is automatically opened and the drilled cartridge drops through an opening in the bench into the receptacle placed to catch it. The chuck remains open until another blank drops from the feed-tube, and then automatically closes while moving toward the drills.

The drill spindles are made of steel which is hardened and ground, and they run in steel bushings which are also hardened and ground to size. The speed of the spindles is 11,220 revolutions per minute. It has been mentioned that the gage is connected with a friction clutch which automatically stops the machine if a cartridge has not been drilled through. The gage points are mounted in a disk which is adjustably held by a screw cap, and the gage points are set while the disk is free by inserting them into the first cartridge which is drilled; the gage is then locked in that position by tightening the screw cap. New gage points may be mounted on the machine by removing the holding cap and inserting a new disk, the points being re-set by the method which has just been described. The clutch is of the expanding friction-ring type, and is adjustable. The principal dimensions are as follows: height, 22 inches; length, 22 inches; width, 18 inches, and weight of machine with feed hopper and countershaft 178 pounds. The machine has a capacity for drilling 1100 cartridges per hour

PAWLING & HARNISCHFEGER DRILL PRESS

To meet the requirements of the heaviest classes of drilling, the Pawling & Harnischfeger Co., Milwaukee, Wis., has recently placed on the market an upright drill press which is illustrated and described herewith. The drive is transmitted through positive jaw clutches and hardened steel sliding gears

which provide nine changes of spindle speed. All bearings in the speed mechanism are furnished with Hess-Bright annular ball bearings of ample size, which insure positive alignment, durability and high efficiency. Any of the nine available spindle speeds may be instantly obtained. All speed and change gears are housed in a single gear-box and are controlled by three levers which govern the entire range of speed and feed changes, the changes of feed being obtained by a single lever. All the gears in the speed and feed trains are made of special steel which is heat-treated.

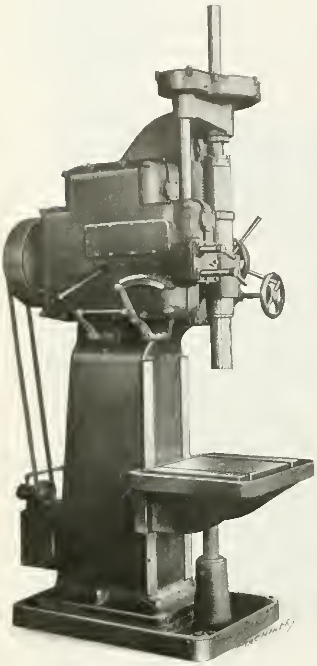


Fig. 1. Pawling & Harnischfeger Heavy-duty Upright Drill

The spindle is made from a high-carbon steel forging and is supported by bronze bushed radial bearings and a ball thrust bearing. The end of the spindle is slotted for driving boring and facing attachments, and is bored No. 6 Morse taper. An automatic depth stop is provided for disengaging the feed at a predetermined point. The spindle sleeve is of large size and is equipped with bronze bearings for the spindle. The feed rack is made of steel and set into the sleeve in such a way that ample support is provided for the end thrust. The feed pinion is cut solid on the shaft, and the worm and worm-wheel which drive this shaft are made of hardened steel and of a special grade of semi-steel, respectively, with the teeth accurately cut to insure long life and smooth operation. Capstan bars are provided on the worm-wheel hub to permit of a quick return of the counterweighted spindle. Six changes of feed are available for each of the nine spindle speeds.

The table is of the box type and provided with two T-slots of standard size; it is raised and lowered by a telescopic screw which is constructed in a way that makes it unnecessary to provide clearance below the floor level. A $2\frac{1}{2}$-inch hole is bored in the table to provide outboard support for boring-bars which may be used on this drill press; and a lubricant pump is furnished as part of the regular equipment of the machine. It has been stated that the drill is driven by positive clutches, and the shifter lever is located within easy reach of the operator. Either straight or right-angle drive may be furnished to suit the requirements of the shop in which the machine is to be used. All such parts as gears, worms, etc., are carefully covered with guards to provide for the safety of the operator.

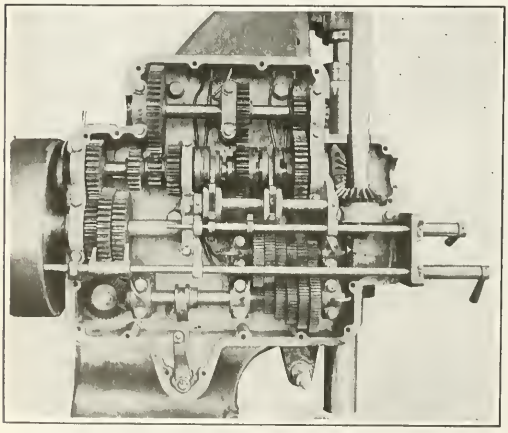


Fig. 2. Arrangement of Gearing in Speed and Feed Box

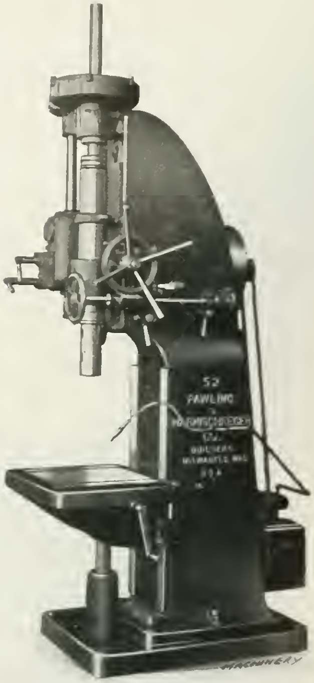


Fig. 3. Opposite Side of Machine shown in Fig. 1

The principal dimensions of the machine are as follows: capacity for drilling holes in steel, up to $2\frac{1}{2}$ inches in diameter; distance from center of spindle to face of column, 12 inches; maximum distance from end of spindle to table, 32 inches; spindle travel, 16 inches; diameter of spindle sleeve, $5\frac{1}{2}$ inches; bore of spindle, No. 6 Morse taper; size of table, 19 by 23 inches; vertical adjustment of table, 20 inches; available feeds, 0.007, 0.010, 0.016, 0.028, 0.042, and 0.064 inch per revolution; available spindle speeds, 41, 54, 72, 95, 124, 167, 227, 300 and 400 revolutions per minute; floor space occupied by the machine, 4 feet by 3 feet, 6 inches; and weight, 4900 pounds.

NEW MACHINERY AND TOOLS NOTES

Friction Surface Facing: Royal Equipment Co., Bridgeport, Conn. A friction facing material known as "Raybestos" which is adapted for use on friction clutches, hoisting drums, brake rings, and similar forms of mechanism.

Flexible Steel Belt Lacing: Manufacturers Belt Hook Co., Chicago, Ill. A flexible steel belt lacing with a ball bearing joint, which is noiseless in operation and easily attached. The chief claim made for the lacing is that it makes very strong belt joints.

Horizontal Hydraulic Press: Metalwood Mfg. Co., Detroit, Mich. A press designed to meet the requirements of shops which have use for a press capable of developing high pressure, but where speed of operation and a high rate of output are not essential.

Adjustable Sizing Tap: Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich. An adjustable sizing tap which is made in various sizes and styles of thread. This tap is of the same form as the tap of the combination threading die and tap which was described in the March number of MACHINERY.

Portable Pneumatic Drill: Ingersoll-Rand Co., 11 Broadway, New York City. A compound geared type of pneumatic drill which is suitable for use in flue rolling, drilling, reaming and tapping. The reversible feature of the drill makes it applicable for use in running on flexible staybolt sleeves or for setting locomotive valves.

Heavy-duty Lathe: W. & B. Douglas, Middletown, Conn. A single-purpose machine designed for turning and boring shells, and for similar classes of general manufacturing work. All

parts of the machine are heavily built to stand up under severe conditions of service. Three changes of speed and four variations of feed are available.

Straightening Machine: Brightman Mfg. Co., Columbus, Ohio. A machine for straightening round bars ranging in size from 1 to 2¼ inches in diameter. The machine is known as a ten-roll straightener, and in addition to straightening the bars it imparts a high finish. The capacity is for straightening from 20 to 40 feet of bars per minute.

Universal Controller: Allen-Bradley Co., Milwaukee, Wis. A line of controllers for use on rope-operated hoists where the service is intermittent. The controller is said to be universal in its application because it can be used with either direct- or alternating-current motors. The construction is such that the controller can be installed in practically any convenient position.

Scrap Baling Machine: Standard Pressed Steel Co. of Ohio, Cleveland, Ohio. A baling press for compressing iron and steel scrap, which has a capacity for handling material up to No. 10 gage; and scrap up to No. 6 gage may be handled if it is soft and pliable. The press is of simple construction and the charging box in which the material is deposited is 42 inches long by 16 inches wide by 22 inches deep.

Engine Lathe: Davenport Locomotive Co., Davenport, Iowa. A single back-geared heavy-duty lathe adapted for shell work and general lines of manufacture. The design follows established practice in the construction of machines of this type. The noteworthy features are an exceptionally heavy construction combined with simplicity of design, so that unskilled labor may quickly be taught to run the lathe.

Vacuum Pump: Ingersoll-Rand Co., 11 Broadway, New York City. A horizontal, center-crank vacuum pump intended for use in connection with condensers and for other service where it is necessary to maintain a high vacuum. The pump has been developed from this company's straight-line air compressor and is intended for either steam or belt drive. The capacity is from 292 to 2295 cubic feet per minute.

Crane and Hoist Controller: Cutler-Hammer Mfg. Co., Milwaukee, Wis. A reversible type controller designed for overhead mounting with rope operation. This controller is intended for use indoors and for duty in regulating intermittent speed, such service being found on cranes and hoists. It is made in two standard types, one of which gives 50 per cent speed reduction and the other 90 per cent reduction.

Cylinder Boring-bar: E. J. Rooksby & Co., Philadelphia, Pa. A portable locomotive-cylinder boring-bar intended for use in reboring cylinders and valve chamber bushings. The tool can be used with one or both cylinder heads removed, being provided with crosshead blocks which are bolted to the cylinder with the cylinder head studs. The boring-bar revolves in sleeves which are supported and centered by set-screws in the crossheads.

Hydraulic Arbor Press: Lourie Mfg. Co., Springfield, Ill. A hydraulic press on which the movement of the ram is unusually rapid, eight strokes of the pump handle serving to raise the ram 6 inches. When heavy pressure is reached, the large piston of the pump differential is automatically disengaged, heavy pressures up to 30 tons being produced by the small piston which moves the ram at a rate of 1 inch for seven strokes of the pump handle.

Vertical Air Compressor: Lyons Atlas Co., Indianapolis, Ind. A portable self-contained two-stage vertical air compressor driven by an internal combustion engine. This compressor is built in capacities for delivering from 35 to 150 cubic feet of air per minute at a maximum pressure of 200 pounds per square inch. Reference has been made to the fact that the compressor is portable, but it may also be removed from the truck and employed for stationary service.

Multiple-spindle Drilling Machine: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. A multiple-spindle drilling machine equipped with what is known as a "center feed," with which the feed pressure is applied at the center of the head in the middle of the drill layout, so that any tendency of the head to spring away from the guides is eliminated. Other features of this machine are essentially the same as those of the well-known multiple drill presses manufactured by this company.

Electric Shop Tractor: Mercury Mfg. Co., Chicago, Ill. A tractor for use in pulling about factory trucks on which the product is loaded for transfer from one department to another. The provision of an independent power unit enables the tractor to be constantly in use, while the trucks may be loaded at the convenience of the different departments. The tractor is driven by an electric storage battery which supplies power to a Westinghouse electric motor from which it is transmitted direct to the rear axle through a worm-gear.

Worm Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine represents the further development of a machine of the same type which was developed about fifteen years ago for use in the factory of the Newton Machine Tool Works. In its present form it embodies a number of improved features of design and is offered to the trade for the first time. The work consists of hollow cylinders which have previously been turned to the proper outside diameter; they are mounted on a mandrel which is supported at one end by a collet in the machine spindle.

Manufacturing Lathe: Robert H. Snider & Co., 1524 Chestnut St., Philadelphia, Pa. An 18-inch lathe adapted for general manufacturing work, and particularly for use in factories engaged in the manufacture of shrapnel and high-explosive shells. As the lathe is intended for manufacturing work, only eight spindle speeds are provided, four of which are secured by a selective sliding-gear headstock, the other four being obtained by the use of a two-speed countershaft. The general design follows that of standard heavy manufacturing lathes with the parts liberally proportioned to withstand the test of severe service.

Turret Head: Charles Eisler, 43 Dodd St., Bloomfield, N. J. A turret head for use on lathes in shops where the amount of screw machine work is not sufficient to warrant the installation of a standard screw machine. The turret is of extremely simple design and can be put in the working position as quickly as an ordinary lathe center or chuck. The head does not rotate, as is usually the case with lathe turrets, but swings to reach the various settings of the tools, which are three in number. It is claimed by the maker of this head that more than 85 per cent of the work requiring the use of a turret machine can be handled satisfactorily with a series of three tools.

* * *

HELP WANTED ADVERTISEMENTS EXTRAORDINARY

The accompanying reproduction of a portion of an advertising page clipped from the *Bridgeport Evening Post*, indicates how extraordinary is the demand for labor in the Connecticut city now styled by some the "American Essen." It is very seldom that display advertisements are published like these calling for all grades of labor. The need there for machinists, toolmakers, and milling machine and punch press operators is unprecedented. One large concern has been carrying on a systematic canvass for the skilled labor required to operate its enormous plant to full capacity, but it still lacks thousands of the number wanted. The growth of Bridgeport during the past year is unparalleled in its history, and the demand for houses, tenements and boarding places is far in excess of the supply.


Store For Rent
For Sale
WANTED
WANTED
FOR SALE
WANTED
Wanted
BULLARD'S
WANTED
WANTED
WANTED
BOYS and GIRLS WANTED
BOYS
GIRLS WANTED
The Bryant Electric Co.

Help Wanted'

* * *

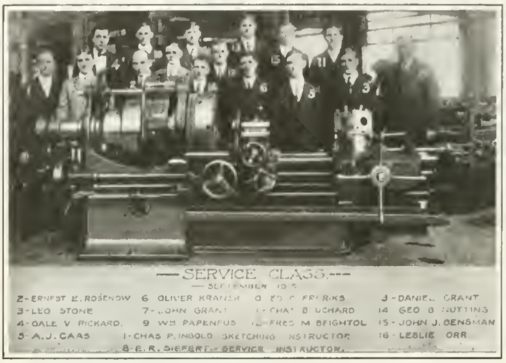
In the practice of interchangeable manufacturing, quick-action machine vises play a prominent part, especially in the production of firearms, typewriters and similar products. The vises provided with false jaws, stops, locating pins, and other means for holding the work in a fixed position are quickly operated and cheaply maintained. In preparing for interchangeable manufacture, it is not necessary to invest large sums in elaborate fixtures, but instead quick-action machine vises may be fitted with jaws suitable for holding all the parts within their range requiring milling operations. In use, the fixtures are washed free from chips by a flood of soda water so that no trouble is experienced by chips getting under the parts and throwing them out of line. The quick-action vise may be used for a great number of operations, the false jaws are quickly changed, and in themselves represent comparatively small toolmaking cost.

SERVICE COURSE, GISHOLT MACHINE CO.

The Gisholt Machine Co., Madison, Wis., has instituted a service course for the purpose of giving those men who wish to take advantage of the opportunities a chance to progress, and to supply its customers with men who are thoroughly familiar with the construction of the Gisholt turret lathe and proficient in handling it. Following is a statement of the qualifications required and what the service course consists of:

Qualifications

1. To be able to handle all sizes of machines, a man should be at least five feet six inches in height, although men under this height who have all the other qualifications could probably be placed. He should be about twenty years of age, to have had time for proper schooling and the three years practical experience mentioned below. He should not be over thirty-five years of age when starting the course. Otherwise, there will not be time for him to acquire the experience necessary for holding the responsible position which ought to result later, from his taking the service course.



Service Class, Gisholt Machine Co.

2. A man should have had three years or more practical experience in operating machine tools. This is necessary if he is to grasp in the one-year course all the information which he must have in order to do the service work in the field after he leaves us.

3. In order to receive promotion through the several branches of the course, a man must constantly demonstrate that he is capable, diligent and dependable.

The Service Course

The service course consists of:

1. Not more than 1000 hours in general manufacturing departments.

2. Not more than 900 hours in the building of turret lathes. This consists of all the scraping and lining up of beds, slides, bearings, etc., assembling of headstocks, feed-boxes, turret and toolpost carriage slides complete, aprons for both turret slide and toolpost carriage slide, rapid traverse, etc.

3. Not more than 900 hours operating in the turret lathe department.

4. Not more than 200 hours in the service department at which time instructions will be given regarding the handling of the work in the field. Catalogues, data for reference, etc., will be given out at this time.

The length of the course is at a maximum approximately one year.

Disposition of Service Course Men

We intend that each man shall have the chance to acquire such a knowledge of our product that we will be proud to recommend him to our customers at any time.

When the course is completed, we will secure for each man a position on the pay-roll of one of our customers in which he will receive at least the same hourly rate as paid him by us during the course.

The nature of the position will be governed by the qualifications of the man for whom it is secured. It may be one of operating, repairing, tool setting or foremanship.

When the man leaves for his new position in our customer's plant, we will pay his railroad fare from Madison to the city in which that plant is located. In special cases where we agree to do so when a man starts the course, we will also refund the railroad fare which he paid to reach Madison.

Basis of Service Course

1. The man will receive during the entire course the hourly rate of wages which is agreed upon at the beginning. He must agree to this and must also agree that he will accept, at not less than the same rate, the position to be secured for him by the Gisholt Machine Co.

2. That during unsettled business conditions, the service course men will be kept on the pay-roll up to such time as it is necessary for the company to reduce its force to a minimum. This minimum would consist of only those who had been what we call our regular men.

3. In the interests of all concerned, the company reserves the right to make such changes in the above plan as may seem expedient.

* * *

DURABILITY OF HIGH-SPEED DRILLS

The question regarding the amount of work that a high-speed drill one-inch diameter will do between grindings when running at a speed of 400 revolutions per minute and with a feed of three inches per minute in forty-point carbon steel, was submitted to George E. Hallenbeck, superintendent of Baker Bros., Toledo, Ohio, who gave his opinion substantially as follows:

A one-inch drill running at 400 R. P. M. with a feed of three inches per minute would have a peripheral speed of approximately 105 feet, and the feed per revolution would be 0.0075 inch. At this speed and feed a drill provided with a copious supply of cooling lubricant, drilling material not exceeding two inches thick, should, on an average, drill from 300 to 500 inches between grindings. The depth of the hole drilled has a very marked influence on the durability of the drill. The deeper the hole, the more often it will be necessary to grind the drill. The depth of the hole affects the grindings not in a direct but in a higher ratio. This is due to several factors, one of which is the failure of the lubricant to reach the drill point as freely as it should; another is that hot chips lie against the drill and heat the entire body, preventing it from carrying away the heat from the point. The chips also clog and score the lands of the drill in deep holes and cause a considerable increase in heating. These are probably the most important factors. Another factor which enters into the question of the time between grindings is the manner in which the drill is ground, the clearance angle given the drill and the lipping of the drill. We have found that a clearance angle about two degrees greater than that ordinarily given by the drill makers will cause the drill to cut freer and materially increase the depth that can be drilled between grindings.

Whether the steel is clear open-hearth or Bessemer and whether it is forged or rolled stock also affects the durability of the drill. Probably the most important item of all is the manganese content. Steels that are high in manganese have a tendency to wear away the cutting edge of a drill rapidly, and if they are carelessly handled in the rolling or forging, segregated manganese and chilling are likely to occur. Segregated manganese in steel will ruin a drill the moment it strikes it and the chilling imposes considerable work on the drill. Altogether there are so many factors influencing the durability of drills that it seems practically impossible to lay down any definite rule to apply generally.

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NO N. M. T. B. A. SPRING CONVENTION

The executive committee of the National Machine Tool Builders Association has decided, in view of the great stress of business, not to hold the usual spring convention, with regular program, this year.

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A man who was sent by an independent set of employers to investigate the Lawrence strike told me that he found much more intelligence among the labor leaders than among the employers concerned, and that they had a far clearer comprehension of the problems involved. His mission in the investigation was to report to those who engaged him as to the best method of combating the I. W. W. They got the answer that nothing permanent could be done until the employers learned more about the industrial problems with which they had to deal.—*H. L. Gantt, in Industrial Leadership.*

FOREIGN TRADE POLICIES

SOME OF THE EFFECTS OF THE WAR ON TRADE AND POSSIBLE FUTURE DEVELOPMENTS

IN his annual report, President Meyer of the Association of German Iron and Steel Manufactures said that Germany's ability to carry on the war is due to the development of the nation's resources by her enormous foreign trade. Reginald McKenna, chancellor of the exchequer, said last month that one of the chief factors in Great Britain's power of endurance is her commercial interests; that if her trade is destroyed her life as well as her ability to help her allies and her dominions is destroyed. Frank A. Vanderlip, president of the National City Bank of New York, said that expansion of foreign trade is absolutely necessary if the United States is to maintain its credit at the end of the war; that as long as the war continues gold will flow into the country, but just as soon as the war is over every nation will attack the nation's gold reserve by every method known to trade and commerce, and that if this attack is successful the entire United States credit will have to be adjuated, for the reduction in credit will be many times greater than the loss in gold. While this attack can be resisted by the investment in short-term foreign loans, the only effective means of resistance is the development of foreign trade.

Many bankers think that this attack was begun last month when so large a quantity of German securities was sold in New York, for as soon as the ocean is again free to German vessels the large bank balance that Germany has in New York may be drawn out in gold. To retard as far as possible the growth of the American gold reserves, England has stopped buying wheat in the United States, though it recently purchased $86,000,000 worth of the cereal in Australia, Argentina, and Rumania.

That the entire world is seeking American goods is shown by the inquiries and orders sent here daily. A representative of an American machinery firm recently refused an order, amounting to nearly $1,250,000, from a Russian dealer because the dealer wanted to withhold payment until one year after the end of the war; a leading Russian banker was willing to guarantee the payment of both the principal and the interest. It is doubtful if the manufacturers of any nation, even Germany, will extend to the purchaser the extremely long credits that were so great a factor in the building up of the German foreign trade. The *Practical Engineer*, of London, says:

> The matter of credit must be looked at from the national point of view, with the interests of bankers and engineers as subordinate. It is all very well to talk of the commercial success of the Germans, but it is a success that has more than anything else caused Russia to detest Germany. The first effect of the German system is that the producer becomes the dependent and servant of the banker. The second effect is to make the purchaser the debt-ridden slave of the banker. The banker becomes supreme. The buyer and the seller are under his hoof for money due, and it follows that they are equally under his hoof in conducting their business and making all their future plans and contracts.
>
> The British engineers must take the initiative, jointly, in forming a financial or trade organization, say in Russia, which will supply information, advise as to opening of credit, and take part of the risk. The British banks should cooperate to a limited extent and only on condition that the Russian banks join. The organization would not be an independent bank, but a cooperative effort to secure the legitimate interests of the British seller and the Russian buyer. The approval, and perhaps the financial assistance, of the British and Russian governments would be necessary, and both governments should be officially represented in the direction of the organization. The buyer would be given clearly to understand that he was not only buying a machine but that he was also borrowing money for which he would have to pay interest. The real price of the machine (that is, the cash-on-delivery price) should be stated and the cost of the loan should be given separately. In that way British capital would be advanced to Russia and mutual trade promoted.

Many of the South American countries attribute their late financial troubles to these long-term credits, together with the speculation they encourage, as the stringency was due to the failure of the dealers to meet the demands of the German banks when the war began.

Russian manufacturers are now preparing to modernize their shops in anticipation of the great manufacturing era that they expect will follow the declaration of peace. Benton Hopkins has already gone there as the representative of two Ohio firms that are to erect twenty-seven large automobile factories in different parts of the country. Over fifty vessels are now en route to Russia with American goods; one recent order placed in this country was for 2,000,000 scythes. The British Board of Trade *Journal* says: "Ural mining works may have to close down for lack of machinery. Not only is it impossible to obtain machinery for new enterprises but spare parts cannot be got for machinery now in use. It is doubted if allied and neutral powers can produce the machinery Germany formerly supplied Russia. All firms desirous of obtaining a share of this business should send salesmen having a good technical knowledge and also a knowledge of the Russian language to the Ural mining region at once." During the past month American and British companies secured 252 deposits of gold and platinum in this region for $15,000,000.

Italy has been a steady buyer in the American iron and steel markets since the war closed the German markets to her. In 1913, Germany sold $1,000,000 more pig iron to Italy than either England or the United States. France, China, Japan, Brazil, Java, Cuba, and Chile have recently made large purchases of American railway supplies. Chile has given the contract for the erection and equipping of several of her railway shops to a New York firm. A Chicago firm of contractors is building the public health works for the government in Uruguay. Other American contractors are building the new port works in Asuncion. Americans have been granted railway and wharfage rights in Nicaragua. Norway has placed orders with most of the shipyards on the Great Lakes and with some on the Atlantic. British Guiana is desirous of obtaining an American engineer to construct its sea defence works, especially one who has had experience with similar work along the Mississippi.

In order to bring their countries into closer relationship with the United States, the leading business men of the South and Central American countries have formed chambers of commerce. Besides, each country has selected a commission of nine men, of which its minister of finance is the chairman, to represent it in the International High Commission, of which Secretary of the Treasury McAdoo is the chairman. This commission will meet in Buenos Aires, Argentina, on April 3, to study and arrange for the application of uniform laws that will assist trade and commerce among the American republics.

When the Interstate Commerce Commission was investigating the cause of the freight embargo of the railways entering New York, several persons said that it was caused by the British and French governments. They stated that any ship that loads without permission is at once requisitioned by the governments. Some cars have been standing in the yards for months because the vessels that were to have taken their freight were commandeered. The vessels of some of the larger lines are now used exclusively for the transportation of war supplies. But a strong American merchant marine is being developed. During the past month, the Gaston, Williams & Wigmore Co. has been formed. It starts with a fleet of fourteen vessels and has contracted for four more. The W. R. Grace Co. acquired the property of the Pacific Mail Steamship Co. with its fleet of steamers and has since purchased a number of others, and is now operating a fleet on the Pacific and the Atlantic. Besides many smaller companies have been formed. In addition every shipyard is working to its fullest capacity. There are now under contract about [illegible] ships of which fifty-nine are for the United States government and the rest for the merchant marine; many of these, though, are for foreign countries. The American Marine Insurance Co. was also formed to compete with the foreign companies that for nearly a quarter of a century have controlled this field. But this increase of the merchant marine has not been confined to

the United States. Norway and Sweden have so filled their shipyards with orders that it is expected that the war will have ended before all the vessels contracted for will be built. France is lending money to its citizens to buy vessels with. Italy has contracts for twenty-three ships with shipyards on the Great Lakes. Portugal has requisitioned the German vessels interned in its harbor so that they may be used for the transportation of British supplies; Italy and Brazil, it is said, are about to do the same. Japan's shipyards are busier than ever and the only limit to their output is their inability to secure steel as rapidly as desired.

It is quite probable that the International High Commission will accept the following plan for the establishment of rapid and regular maritime communication between the ports of North and South America:

1. By the organization of a large company, subscription to which may be made by the public, the balance of the stock, if any, to be taken by the government of the United States and the governments of those Latin-American republics interested, in a proportion to be agreed upon.

2. The company to be incorporated under the New York laws, but the steamers to be registered in the different countries in proportion to the capital subscribed, and to fly the flag of said country.

3. For the purposes of customs laws the steamers to be considered as of the nationality of the port, except the coastwise trade in those countries where that trade is reserved for nationals.

4. The vessels to fulfill certain conditions, *e. g.*, minimum tonnage of 5000 tons and a minimum speed of sixteen miles per hour.

5. The board of directors shall be composed of representatives appointed by the respective countries in proportion to the capital subscribed.

6. The payment of the capital subscribed may be made in cash, or by transfer of vessels belonging to the government subscribing, provided said vessels are suitable.

In order that American trade to neutral countries may be inconvenienced as little as possible, Lord Robert Cecil, England's minister of war trade, has established in Washington, under the direction of the British embassy, a bureau that will inform all shippers exactly what goods may be shipped with safety. He says: "We want to give the fairest play to American merchants, who are entitled to all the legitimate trade with neutrals that they can get. We are now working on a specific list for their guidance that will enable them to know what they can do; in other words, we shall throw a better light on the whole contraband question."

Dr. Paul Ritter, minister from Switzerland, says that only certain goods can be shipped to that country, and these must be consigned to the Société Suisse de Surveilance Economique, in Berne; a list of the articles that may be exported may be seen in the various Swiss consulates.

But contrary to the general impression, Great Britain's trade has not been stopped. During 1915, its total export trade was only 20 per cent less than its trade in 1913, which was its greatest year, while in cotton and some lines of iron and steel manufactures its exports to South America were far greater than in 1914, during a part of which the country was not at war. The government is now planning to obtain the lion's share of the world's trade when it is at peace again. The British Association of Chambers of Commerce has asked the government for preferential trading relations between all British countries; for reciprocal trading relations between the British Empire and allied countries; for favorable treatment of neutral countries; for restriction, by tariff and otherwise, on all trade relations with enemy countries. Sir Edward Grey, the foreign secretary, said, after telling of the present movement to expand the foreign trade of the United States: "We must do the same thing quickly. We should have a system of banks throughout South America, Russia, and the other allied countries." Referring to the mining industry, the prime minister of Australia recently said:

> When war broke out nearly all the base-metal trade of Australia was in the hands of a great German combine, which manipulated the markets to suit itself. This trade represented at least £15,000,000 yearly, excluding the value of the gold and silver in the base metals. The policy of the government to encourage Australian industries has resulted in largely extending the facilities for treating the ores of zinc, lead, and copper in Australia. All copper goods required in Australia will soon be made there. After the war, the Australian metal industries will look only to Great Britain and her allies for markets, the aim being to have Australian goods take the place of German.

New South Wales has decided that in the purchase of all supplies for the government, a ten per cent preference will be extended to local, British, and Empire manufacturers as against those of other nations. Canada is planning to develop its resources and to manufacture all articles possible so as to become largely self-sustaining. A government commission is investigating conditions in other countries and a government laboratory is to be erected for the encouragement of its manufacturers. In addition, Canadian bankers last month made a tour through the West Indies to study conditions in order that Canadian banking facilities in that region might be improved. Although not heralding the fact with the blowing of trumpets, Japan has been supplying a good deal of the markets formerly supplied by Germany, especially on the Pacific; it has a most decided advantage there because of its control of the shipping on that ocean. In the meantime Germany has not been thinking only of war. Dr. Reichert, director of the export department, recently said:

> With regard to the commercial policy after the war, the association is clear on the following points: The protective system of Germany, inaugurated by Bismarck, must be maintained. Germany must lay down the conditions upon which her goods are to be exported to the principal foreign markets. She must see that her products are placed upon an equal footing with those of other countries in foreign markets. Where necessary, German customs duties must be raised so as to render the country independent of foreign goods.

In line with its policy of conserving its resources, Germany is now organizing the cattle trade. The organization will have its headquarters in Berlin and will have a board of directors and an advisory committee of twelve members in which the agricultural interests, the chambers of commerce, and the large cities will be represented.

In addition to the loans to England, France, and Russia, the United States has lent $79,000,000 to Argentina, a loan of $15,000,000 having been made in March. Besides, $75,000,000 has just been lent to Canada, while negotiations are being made for additional loans to England, France, and Russia. The Canadian loan is for a period of five, ten, and fifteen years; the Argentina loan last made is for one year.

The Mexican government is now trying to reorganize the financial affairs of the country. It has decided to handle the finances itself and not let this be done by banking and capitalist groups, as has been the custom. It will limit the amount of currency in circulation, both paper and cash, to the present resources of the treasury, which are: $5,000,000 cash; the accumulated bullion in the treasury; $5,000,000 placed at the disposal of the government by the Hennequin regulating commission of Yucatan; the entire taxes for rental and exploitation of mineral lands and forests; the entire mining taxes; and loans that may be obtained on the government property, with a limit of $10,000,000. D. E. J.

* * *

EXPORT BUYERS' LEAGUE

The Export Buyers' League is being organized by Mr. Pels, purchasing agent for the Warner Sugar Refining Co. and the Miranda Sugar Co. of Cuba, and F. M. Moore, buyer for Alexander & Baldwin, Ltd., representing Hawaiian Island sugar interests. Membership in the Export Buyers' League will also include membership in the Purchasing Agents' Association of New York City, a branch of the National Association of Purchasing Agents. The league will include in its membership only those who purchase for export and will not include anyone who personally solicits domestic orders. Further information can be obtained from E. B. Hendricks, secretary of the Purchasing Agents' Association of New York, 129 Lafayette St., New York City.

* * *

A German silver containing about 60 per cent of copper, 14 per cent of nickel, 24 per cent of zinc and from 1 to 2 per cent of tungsten is known as "platinoid" and is used for electrical resistances.

CUSTOMS INFORMATION

DECISIONS ON IMPORTATIONS OF AGRICULTURAL IMPLEMENTS, STEEL BLOOMS AND STRIPS, ETC.

BY JULES CHOPAK, JR.*

The United States Court of Customs Appeals at Washington made a final and important decision to domestic interests, holding that many machined implements must pay 20 per cent duty when imported, notwithstanding alleged free-of-duty claims. The test case involved lawn rakes. Many other articles of the case, however, such as lawn mowers, turf cutting machines, pruning, garden, border and lawn shears and hedge clippers, are affected so as to be excluded from the free-of-duty class. The articles were assessed with duty at 20 per cent, as manufactures of metal. They were claimed free of duty under paragraph 391 which reads:

> Agricultural implements: Plows, tooth and disk harrows, headers, harvesters, reapers, agricultural drills and planters, mowers, horserakes, cultivators, thrashing machines, cotton gins, machinery for use in the manufacture of sugar, wagons and carts, and all other agricultural implements of any kind and description, whether specifically mentioned herein or not, whether in whole or in parts, including repair parts.

As first read, this paragraph would appear to be very broad and take in all kinds of machinery used on vegetation. The Court determined what might be agricultural implements and what were such articles, as follows:

> While, therefore, "agriculture" in its broad application may extend into and include elements of horticulture, viticulture, arboriculture, and other allied industries and pursuits, in its primary significance it extends to and embraces only those parts of all such as pertain to human and incidental animal subsistence—the substantial requirements of life (food) and possibly man's comfort (raiment), and not the merely pleasurable pursuits; the necessities and not the essentially pleasurable or ornamental.

The Court thereupon defined an "agricultural" implement to be one which "serves some purpose in the production of food from the soil or in the raising of domestic animals thereon," following two of its previous decisions. This decision has been religiously followed by the Board of General Appraisers, in consequence of which the many articles aforesaid and all others not coming within the scope of the limited definition of "agricultural implements" must pay 20 per cent duty.

Steel Blooms and Strips

Steel blooms were assessed with duty at 8 per cent under paragraph 110 as Bessemer bar steel. Steel strips were charged 15 per cent under paragraph 110, as steel made by the crucible process and finished by rolling. The importers protested in each case to the Board of General Appraisers, which has just decided the matter. The blooms were claimed free of duty (paragraph 613) as "steel blooms * * * if made Bessemer * * * process, not containing alloys." The Board sustained this claim, saying:

> The evidence in the case conclusively shows that these so-called blooms have been made by the Bessemer process and that they do not contain any of the alloys mentioned in said paragraph 613; that steel bars are made from blooms by either hammering or rolling; that while the particular articles here under consideration were probably in the form of square blooms before they were hammered partially into the shape of bars as imported, they were nevertheless still commercially known and dealt in as blooms, not having been hammered sufficiently to transform them into bars; that these blooms differ from bars in that the former have not the regular and uniform surface dimensions throughout their entire lengths which must always be present in the latter before they are known and recognized throughout the trade and commerce of this country as bars; that this difference in the condition of the two classes of articles is the determining factor by which blooms and bars are distinguished by such trade; and that the commercial understanding as to what constitutes a bloom in no way differs from the common and ordinary meaning thereof. This term is defined by Webster as a large bar of steel formed directly from an ingot.
>
> Inasmuch, therefore, as it is conclusively shown that the articles represent blooms and not bars, free entry therefor is specifically and *eo nomine* provided for in paragraph 613, and we so hold.

The steel strips were proved to be regarded as such in the trade, although they measured over five inches in width and varied in length from 6 to 100 feet. They were made by the Bessemer or the Siemens-Martin open-hearth process, and finished by rolling. The Siemens-Martin strips were tempered and polished, while none contained alloys like tungsten. They were not made by the crucible, electric, or cementation processes but were finished by the process known as "strawing"—coloring by heat. A lower claim of 8 per cent was made by the importers, under paragraph 110, as steel "plates," but this claim was decided as invalid because, obviously, such goods are not plates. An alternative lower claim, which was made, at 12 per cent (paragraph 105) as "strips of iron or steel, not specially provided for," was sustained by the Board.

Card Clothing Grinding Machines

The Board of General Appraisers also decided that Dronsfield patent traverse wheel grinders adapted for grinding card clothing were dutiable at 15 per cent, under paragraph 165, as "machine tools," rather than at 20 per cent, as manufactures of metal not specially provided for.

In the March number of MACHINERY, page 624, the customs definition of "machine tools" was given. The government has appealed, however, to the Court of Customs Appeals for a reversal of this decision. The result of the appeal will not be known for several months.

Parts of Sprocket Chains

The Board also decided a protest on made-up sprocket chain, chain in knocked-down condition, and various chain repair parts, classified as sprocket chains at 25 per cent ad valorem under paragraph 126, tariff act of 1913, claimed dutiable as manufactures of metal at 20 per cent under paragraph 167. The protest was sustained as to all items except a transmission chain and inner and outer links for chains, as to which items it was overruled.

The following are some protests now before the Board of General Appraisers, in which testimony may be introduced upholding the government's assessments of higher duties. Any person who can qualify and wishes to testify may do so to enable the Board to reach a correct conclusion.

> *Protest:* Sheep shears. *Assessed:* 30 per cent under paragraph 128 as shears. *Claim:* Free under paragraph 391 as agricultural implements.

If the Customs Court's definition quoted above is strictly followed these sheep shears cannot be admitted free of duty as agricultural implements, since they serve no purpose in the production of food from the soil or in the raising of domestic animals thereon. Shears for cutting wool from sheep are not usually articles in the category of agricultural implements.

> *Protest:* Tubes invoiced as hollow steel bars. *Assessed:* 20 per cent under paragraph 127 as steel tubes. *Claim:* 8 per cent or 15 per cent as steel bars under paragraph 110.

Are these articles tubes or are they bars? The burden of the proof is on the importers to show that they are bars or else the tubes duty will stand. Hollow bars are not the usual bars imported. If the common understanding of bars is solid metal in recognized dimensions—shown by dictionaries or textbooks—then the importer's only hope to succeed is by showing that all wholesale dealers in this country have recognized such articles as "bars," since before October, 1913, when this tariff became law, or since then, only if it is a new article.

> *Protest:* Pedals for bicycles. *Assessed:* 25 per cent under paragraph 120 as finished parts of bicycles. *Claim:* 20 per cent under paragraph 167 as manufactures of metal.

The Board of General Appraisers has already decided that lamps, for instance, are not parts of bicycles, but only "accessories." It is on this theory that the claim is made that pedals are not parts. The impossibility of the claim is at once apparent.

> *Protest:* Centrifugal machines—machinery used in sugar making and for other purposes. *Assessed:* 20 per cent under paragraph 187 as manufactures of metal. *Claim:* Free under paragraph 391 as machinery for use in the manufacture of sugar.

The reason for the government's assessment in this case is that, conceding that the machines are used in the manufacture of sugar, they may be otherwise used. Paragraph 391

* Customs Lawyer, 29 Broadway, New York City.

does not exempt from duty machinery used for sugar making which is susceptible of other uses. Those uses have been shown to the Treasury Department which ordered this assessment. In its instructions to customs collectors, the Treasury Department said:

It appears that many of the machines can be or are used for purposes other than sugar making, such as in dye works, certain chemical processes, laundry extractors, cream separators, etc., only about 10 per cent of those imported being installed in sugar-making plants. When installed in sugar-making plants it appears that it is your practice to pass the merchandise as free of duty as 'machinery for use in the manufacture of sugar' although identical with machinery installed for other purposes which is assessed for duty at 20 per cent.

The department is of the opinion that the general or chief use of the machinery should govern, and when the machinery, even though installed in a sugar-making plant, is identical with machinery used chiefly for purposes other than the manufacture of sugar, as in the case of the centrifugal machines in question, it should not be permitted free entry, but, if in chief value of metal, should be assessed with duty at 20 per cent.

The rule is not uniform that goods actually used for the tariff mentioned purpose are not classifiable as such. Sometimes the actual use settles the matter, notwithstanding the susceptibility to different use. On the other hand, we remember a court decision wherein it was held that circular disks which were actually used as ends for spools were held dutiable as circular saw plates because of their identity as such.

Protest: Points or needles of diamond or sapphire used for phonographs. *Assessed:* 25 per cent under paragraph 374 as parts of phonographs. *Claim:* 10 per cent under paragraph 161 as jewels for use in watches, meters, etc.; or 20 per cent under paragraph 357 as precious or semi-precious stones.

The 25 per cent assessment here cannot be upheld, because these points, as imported, are not parts of phonographs. They have to be further manipulated and really identified with phonographs before this rate can be taken. However, the 10 per cent claim as jewels can be disregarded for the proof would never be that their use is as such. The points are dutiable at 20 per cent—not under paragraph 357 as precious stones—under paragraph 81 as manufactured mineral substances. This view has been judicially declared both by the Board and Customs Court. The Board recently held that flat pieces of real sapphire, polished and sharpened on two sides, used in cutting tools such as chisels, etc., classified as a manufacture of semi-precious stones at 45 per cent ad valorem under paragraph 98, tariff act of 1913, were dutiable as a mineral substance, manufactured, at 20 per cent under paragraph 81. The Court of Customs Appeals has previously so decided on pieces of sapphire used as "bearings for electrical or other delicate measuring instruments," in the case of U. S. vs. General Electric Co., 4 Ct. Cust. Appls., 287.

Protest: Aluminum foil, 21 inches by 9 inches by 0.0005 inch thick. *Assessed:* 20 per cent under paragraph 167 as manufactures of aluminum. *Claim:* 3½ cents pound under paragraph 143 as aluminum sheets.

The point here is if the above dimensions are of aluminum in "sheets." If not, the charged duty is correct. If so, the lower duty should be fixed. The government claims that 0.0005 inch is too thin for a sheet. There should be no difficulty in upholding this claim if it became necessary for the government to do so. Aluminum in "plates, bars, sheets, strips, and rods" is admitted at 3½ cents per pound duty. Judging sheets from the accompanying words, they must be of a more substantial character than the present dimensions show the goods to be. When the duty on this merchandise was considered by the Treasury Department, its conclusion was governed somewhat by previous decisions of the Board of General Appraisers holding that zinc foil and a foil in chief value of copper, both commercially known as "foils," were dutiable as here classified and not as "sheets." So also was gold foil distinguished from gold leaf. The department adds, in speaking of the thickness of aluminum sheets:

For the purpose of such classification (as sheets) you will consider aluminum in the form of either sheets or strips not more than 0.0015 of an inch and not less than 0.0003 of an inch in thickness, as foil.

THE PROGRESS OF WIRELESS TELEPHONY

An interesting account of the progress made in wireless telephony—generally known among scientists and investigators as "radio" telephony—was given in a lecture before the American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y., by Ernst F. Alexanderson of the General Electric Co., Schenectady, N. Y., at the society's meeting March 4. Mr. Alexanderson has been the chief investigator and the designer of the most important apparatus used in connection with this work at the General Electric Co.

One of the main difficulties in wireless telephony is to cause a current of, say, 50 or 100 kilowatts, to operate or respond to the vibrations caused by the human voice in a telephone transmitter with a current of a fraction of a watt. This problem, however, has been solved by means of a special device or regulator interposed between the transmitter and the aerial antennae. For successful radio telephony, currents of from 50 to 500 kilowatts are required in order to overcome static conditions in the atmosphere. The experiments recently undertaken by other investigators, which proved successful in transmitting messages from Washington to Paris and the Hawaiian Islands, were undertaken with much less power, but under perfect static conditions. In commercial practice, however, the apparatus must provide ample power margin even for comparatively unfavorable static conditions. A high frequency current is required, and a large generator has been built having a frequency of 50,000 cycles per second. Wireless messages are being transmitted daily between Schenectady and New York with a small generator of the same type, designed for 100,000 cycles per second. It appears that there are no limitations to the possibilities of wireless telephony, as practically all of the problems have been solved, and it is only a question of whether the commercial world is willing to pay the price that this service will cost, because the apparatus will be costly, and the transmission of messages of this kind cannot be done cheaply.

It is not expected that radio telephony will ever compete with ordinary telephone service for private subscribers. It would be too expensive and, probably, generally unsuitable for that service; but there are three distinct services for which it would be especially suitable. One is for long distance telephone service over water where it would be impossible or impracticable to use wires as conductors. The second is for long distances over land, where the use of radio telephony may be cheaper than the erection and maintenance of long telephone lines subject to derangement by storms and snow. It is possible that arrangements can be made so that a radio telephone system might be used between two cities like New York and Chicago, and when subscribers to the regular telephone service in either of these cities desire to speak to subscribers to the regular system in the other city, the radio system could be coupled into the regular net system, so that the message could be transmitted from the subscriber to the central in one city by wires; from this central to a central in the other city by radio telephony; and from this central to the subscriber by wires. The third valuable use for wireless telephony would be in the case of a central office or agency that wanted to send out messages to a great number of branch offices all over the country. In that case the sending apparatus, which is the most costly part, would be installed at headquarters, while all the branch offices would have receivers only. In this way orders or messages could be given from headquarters at any time, and without the need of private wires to all the branches. Of course the branch offices would not be able to reply if they had receivers only, but in many cases that would be unnecessary.

The general conclusions to be drawn from Mr. Alexanderson's address were that wireless telephony is no longer an experiment, but has entered upon its commercial development; that its future application depends mainly upon whether the commercial world considers the service worth the price; and that there are a number of distinct services for which it is vastly superior to ordinary telephone service.

ARTHUR J. BALDWIN

Arthur J. Baldwin, recently elected president of the Hill Publishing Co., New York City, is a well-known lawyer of pronounced business ability, for many years the intimate friend and advisor of the late John A. Hill, and therefore familiar with his ideals and policies. Mr. Baldwin is admirably qualified to carry upward and onward the great enterprise committed to his charge, and his administration starts with the good wishes of all friends of the Hill organization, among whom are included its competitors. Mr. Baldwin is an official in five other business corporations, and has an extensive legal practice; but we are informed that he will devote his entire time and energy to the business of the Hill Publishing Co.

PERSONALS

F. L. Cone of the Windsor Machine Co., Windsor, Vt., has resigned his position as superintendent.

William Arend has been appointed general superintendent of the Cisco Machine Tool Co., Cincinnati, Ohio, succeeding George Spinner.

E. P. Worden, formerly with the Fred M. Prescott Steam Pump Works, Milwaukee, Wis., has been appointed chief engineer of the Henry R. Worthington plant, Harrison, N. J.

F. D. Walden, formerly of the Heald Machine Co., Worcester, Mass., has taken a position with the Davis Machine Tool Co., Inc., Rochester, N. Y., as manager in charge of operations.

Peter Plantinga, formerly with the Heald Machine Co., Worcester, Mass., has taken charge of the mechanical engineering department of the Davis Machine Tool Co., Inc., Rochester, N. Y.

Dewitt Tappan, for eleven years with the Watervliet Arsenal, Watervliet, N. Y., has resigned the position of planning room foreman to enter the employ of the Veeder Mfg. Co., Hartford, Conn., as assistant superintendent.

J. E. Lawton, for the last nine years inspector and chief inspector of the Panama Canal, has resigned to take a position as consulting engineer and sales manager for Ward & Co., manufacturers' agents, Washington, D. C.

Dr. F. W. Cunningham has resigned his connection with the research and development work of the Newark plant of the General Electric Co. to join the engineering research staff of the Powdered Coal Engineering & Equipment Co. of Chicago.

Arthur Churchill, in charge of the small tools department of Charles Churchill & Co., Ltd., London, England, has been elected managing director succeeding his brother, the late Charles Henry Churchill, whose death occurred February 8.

L. E. Jordan, treasurer and general manager of the Vulcan Process Co. Inc., Minneapolis, Minn., has disposed of his interests in the company and has been succeeded in office by Clifford N. Lockwood, who will fill the position of treasurer and general manager.

P. P. Bourne, formerly chief engineer of the Blake & Knowles Steam Pump Works, East Cambridge, Mass., is again associated with the International Steam Pump Co. in connection with special engineering work, and is located at the main office, 115 Broadway, New York City.

Herbert J. McCauley has been appointed district sales manager for Julius Blum & Co., New York City, in the western New York and Pennsylvania territory. A warehouse at 308-314 Terrace, Buffalo, N. Y., has been opened, carrying a full stock of strip and bar steel, tubing and other products handled by the company.

Thomas F. Williams, formerly chief mechanical engineer of the Aeromarine Plant & Motor Co., Avondale, N. J., has taken the position of chief consultant of the board of engineering research, mechanical applications, of the Powdered Coal Engineering & Equipment Co., of Chicago, and will direct the research work of the company in the carburization of comminuted fuel and the application of automatic mechanical regulation devices.

W. S. Chase, for thirteen years head of the sales department of the National-Acme Mfg. Co., Cleveland, Ohio, has resigned to devote himself to personal affairs. He will spend much of his time at his ranch in Meridian, Idaho. Mr. Chase's connection with the National-Acme Mfg. Co. dates from a time soon after the company was incorporated, and those who have worked with him are united in a high appreciation of the importance of his services in building up the business.

Benton Hopkins, representing Samuel Austin & Son Co., Cleveland, Ohio, engineers and builders, and the American Engineering Co., Alliance, Ohio, has sailed for Russia to open the way for the construction of a chain of automobile plants. The plant immediately under consideration is the first one of a group of twenty-seven large self-contained plants which will be erected in Russia as part of a great movement for placing Russia on the map industrially. The first plant will be used for the manufacture of automobiles and motor trucks.

CHARLES CHURCHILL AND CHARLES HENRY CHURCHILL

Expressions of the deepest regret for the death of Charles Churchill and his son Charles Henry Churchill of London, England, have come from many American machine tool builders, among whom the elder Mr. Churchill, especially, had a wide acquaintance extending over many years. Charles Churchill was well known as the founder of the machine tool importing firm of Charles Churchill & Co., Ltd., and as he had been in poor health for several years his death was not unexpected. His health necessitated his withdrawal from active business about a year ago, when his son, Charles Henry, succeeded him as managing director. The elder Mr. Churchill's death occurred on February 15, only seven days after that of his son.

Mr. Churchill was born in Hamden, Conn., 1837, and received his education in the schools of that town. His first business experience was gained with his father who was at that time engaged in the manufacture of augers. Subsequently Mr. Churchill and his father were sent to England by Thompson, Langdon & Co. of New York to superintend the erection of some wire-coating machinery which had been exported by that firm. The interest taken in this equipment impressed Charles Churchill deeply and this fact, together with the knowledge of the British machine trade gained by his work in England, led to the establishment of the machinery importing firm of Charles Churchill & Co. in 1865. This firm was the first to engage actively in the business of importing American machine tools for sale in Great Britain. Those who knew the elder Mr. Churchill and are familiar with the rapid progress made by his firm to the position of importance which it now occupies, will readily understand the peculiar qualifications of the man for the business which he selected as his life's work. He was both aggressive and progressive, and possessed of a genial disposition which enabled him to make new friends easily and hold the esteem of old acquaintances. These were powerful factors in gaining customers for the firm during the early years of its existence, and the importance of their effect upon the growth of Mr. Churchill's business was second only to the reputation for absolute integrity which was built up by years of honest trading. Although Mr. Churchill had long been a resident in Great Britain, he remained an American citizen to the last and was often heard to express himself as being extremely proud of the fact. Mr. Churchill is survived by two sons, one of whom, Arthur, is at present in charge of the small tools department of the firm.

Charles Churchill

Charles Henry Churchill was born in London in 1864 and received his education in the schools of that city. At an early age he entered his father's business and about a year ago succeeded him as managing director of the firm of Charles Churchill & Co.

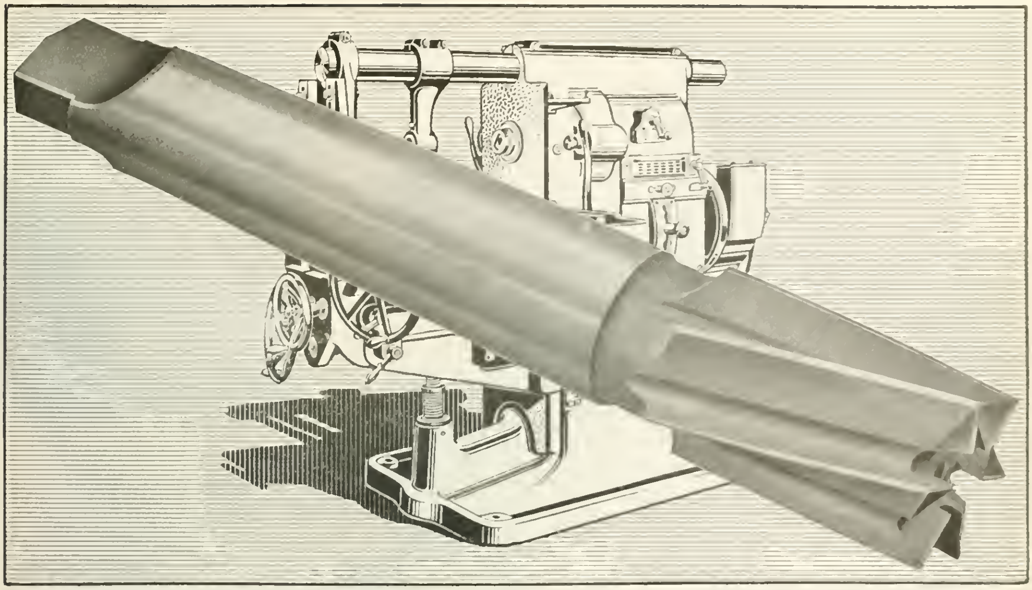
OBITUARIES

Melville H. Barker, general manager of the American Tool & Machine Co., Boston, Mass., died at his home in Dorchester, Mass., March 12, aged seventy years, following a brief illness of pneumonia. Mr. Barker was a charter member of the National Metal Trades Association.

Eugene E. Garvin, vice-president of the Garvin Machine Co., New York City, which was founded by his father, the late Hugh R. Garvin, died at his home in Englewood, N. J., March 20, aged fifty-eight years. Mr Garvin was born in Hartford, Conn., and has been connected with the Garvin Machine Co. during his entire business career, for the last twelve years as vice-president.

Edward T. Betts, vice-president and treasurer [illegible] Machine Co., Wilmington, Del., builder of boring [illegible] and other machine tools, died at his home in Wilmington, February 28, aged sixty years. Mr. Betts was [illegible] nent citizens of Wilmington. He was a [illegible] of the Wilmington Savings Fund Society, and a director of the Wilmington Trust Co. He is survived by a widow, a [illegible] and a son, Edward T. Betts, Jr.

William H. Dayton, master mechanic of the Excelsior Needle Co., Torrington, Conn., died suddenly of heart failure March 6, following a brief illness. He was born in Torrington, then



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known as Wolcottville, in 1840. His father was Arvid Dayton, a builder of melodeons and organs, from whom no doubt he inherited his mechanical genius. Mr. Dayton was first employed in his father's shop but joined the newly organized Excelsior Needle Co. in 1866, remaining in its employ until his death. His many inventions concerned the machinery used in the products of the company—sewing machine and knitting machine needles, bicycle spokes, nipples and pedals. He was also the inventor of the swaging machine which bears his name and has been sold for many years by the company. While he had not been in vigorous health for some time, he was actively engaged in his usual duties and was constantly devising new methods and machinery for manufacturing. Mr. Dayton served the borough of Torrington as a burgess and later as wàrden from its organization in 1888 for twenty-four years. He is survived by a son, James M. Dayton, and three grandchildren.

FRANKLIN ALTER

Franklin Alter, president of the American Tool Works Co., Cincinnati, Ohio, died at his home in Cincinnati, February 23, aged eighty-four years. For many years Mr. Alter has been a conspicuous figure in the machine tool industry of Cincinnati. He was born in Carlisle, Pa., and his boyhood was spent at Hagerstown, Md. At the age of nineteen, he went to Pittsburg with the intention of going to New Orleans by steamer down the Ohio and Mississippi rivers, but on stopping a few days at Cincinnati waiting for the steamer to load he decided to locate there. His first position was with a wholesale hardware dealer, and he finally became sole owner of the concern. Expansion of his business brought him in contact with the machine tool industry, and in 1900 he purchased a controlling interest in the Davis & Eagan Co., which was reorganized into the American Tool Works Co. The company has grown to be one of the largest machine tool building concerns in the country, and is now erecting a new plant which will afford about 238,000 square feet of floor space. It is a matter of regret to those associated with him that Mr. Alter did not live to see the completion of the work in which he took so much pride and interest. He is survived by a widow, three daughters and two sons; of the latter Robert and L. W. S. are, respectively, secretary and foreign trade manager, and production engineer of the American Tool Works Co. Mr. Alter's death will not affect the general policy of the company, and its business will be continued on the same lines as heretofore.

Franklin Alter

COMING EVENTS

April 11-14.—Spring meeting of the American Society of Mechanical Engineers at New Orleans, La. Headquarters, Hotel Grunewald. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

April 13-14.—Conference on engineering cooperation to discuss cooperation among engineering organizations, methods, aims, legislation, employment, exchange of ideas, etc. Monadnock Block, Chicago, Ill., headquarters. C. E. Drayer, secretary, Cleveland Engineering Society, Cleveland, Ohio.

April 27-28.—Annual meeting of the National Metal Trades Association in New York City. Hotel Astor, headquarters. H. D. Sayre, secretary, Peoples Gas Bldg., Chicago, Ill.

May 16-17.—Annual meeting of the National Association of Manufacturers at the Waldorf-Astoria Hotel, New York City. George S. Boudinot, secretary, 30 Church St., New York City.

June 12-16.—Midsummer cruise of the Society of Automobile Engineers on the Steamship "Noronic," leaving Detroit June 12 and returning June 16. Reservations can be made by application to W. H. Conant, treasurer, 601 Kerr Bldg., Detroit, Mich.

June 14-16.—Annual meeting of the Master Car Builders Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 14-21.—Annual meeting of the Railway Supply Manufacturers Association at Atlantic City, N. J., in connection with the A. R. M. M. and M. C. B. Associations. J. D. Conway, secretary and treasurer, 2136 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual meeting of the American Railway Master Mechanics Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 27-July 1.—Annual meeting of the American Society for Testing Materials at Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

August 15.—Annual meeting of the International Railroad Master Blacksmiths Association, Chicago, Ill. A. L. Woodworth, secretary and treasurer, C. H. & D. Ry., Lima, Ohio.

September 11-16.—Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Beloit College, Beloit, Wis. Catalogue 1915-1916 with announcements for 1916-1917.

Columbia University, New York City. Announcement of Division of Chemistry for 1916-1917.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of the College of Engineering, 1916-1917.

Yale University, New Haven, Conn. General catalogue 1915-1916, containing calendar, outline of curriculum, etc.

American Museum of Safety, 14-18 W. 24th St., New York City. Special bulletin on the award of the Travelers Insurance Co.'s medal for 1915 to the Hudson & Manhattan Railroad Co., Wilbur C. Fisk, president, for achievement in accident prevention among its personnel and for promoting safety for the traveling public. The booklet contains a historical article on the Hudson Tunnel Railroad Co., showing the plan of the Hudson & Manhattan Railroad tunnel system and describing safety devices in cars, shops and power stations.

American Museum of Safety, 14-18 W. 24th St., New York City. Special bulletin on the award of the Louis Livingston Seamen medal for 1915 to the Diamond Match Co., William Armstrong Fairburn, president, for progress and achievement in the promotion of hygiene and the mitigation of occupational disease. This booklet contains an article on the welfare activities of the Diamond Match Co. and illustrates the tennis courts, gymnasium, lunch and rest rooms, library, emergency room and other features provided for the recreation and comfort of its employes.

Franklin Institute, Philadelphia, Pa. The city of Philadelphia, acting on the recommendation of the Franklin Institute, has awarded the John Scott legacy medal and premium to Clement F. Street of New York City, for the Street locomotive stoker. The increase in size of locomotives during recent years has imposed labor on firemen beyond the endurance of most men, and locomotive stokers have come to be regarded as necessities for the largest and most powerful locomotives. The Street mechanical locomotive stoker has been designed for keeping the fire in direct relation to all conditions of operation and for securing the maximum output. Over six hundred of these stokers are in use.

NEW BOOKS AND PAMPHLETS

The Testing of Hydrometers. 16 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 16.

United States Standard Tables for Petroleum Oils. 64 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 57.

Microstructural Changes Accompanying the Annealing of Cast Bronze. By Henry S. Rawdon. 17 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 60.

Railroad Track Scales, Specifications and Capacity Rating. 28 pages, 8 by 10½ inches. Issued by the Bureau of Standards, Department of Commerce, Washington, D. C.

These specifications issued in mimeograph form for railroad track scales, give complete data for calculating the sizes of members of scales of the straight lever and pipe lever types.

Colorado Industrial Plan. By John D. Rockefeller, Jr., 726 Broadway, New York City. 94 pages, 4 by 6¾ inches.

This booklet contains a complete copy of the plan of employes' representation—or "industrial constitution"—and the agreement between the Colorado Fuel & Iron Co. and its employes adopted at the coal and iron mines of the company.

Spring Engineering. By Egbert R. Morrison. 75 pages, 6 by 9 inches. Illustrated. Published by Egbert R. Morrison, Sharon, Pa. Price, $4.

This work treats of the fundamental principles of spring design, elliptic or leaf springs, spiral springs, heavy helical springs, grouped helical springs, conical helical springs, wire springs, elliptical and rectangular sections, and includes mathematical tables. The author is well known to MACHINERY's readers as a contributor, and the articles in part are reprints of chapters contributed by him to MACHINERY.

Dams and Weirs. By W. G. Bligh. 206 pages, 5½ by 8½ inches. 122 illustrations. Published by the American Technical Society, Chicago, Ill. Price, $1.50.

This is an analytical and practical treatise on gravity dams and weirs, arch and buttress dams, submerged weirs, and barrages. It deals with the various subjects treated from a theoretical point of view mainly, which, in dam construction, is highly important, as calculations are absolutely necessary to safe design. In addition there is, however, much information of direct practical application.

Statistics of Railways in the United States, Twenty-seventh Annual Report. 785 pages, 9 by 12 inches. Published by the Interstate Commerce Commission, Washington, D. C.

This is the twenty-seventh annual report of railway statistics. The contents comprise statements of receiverships, mileage, classification of railways, equipment, railway employes, capitalization and railway property; selected statements and assignments; income and profit and loss statements; taxes; investments in road and equipment; and abstracts of reports rendered by steam railway companies in three classes.

Mechanical World Electrical Pocketbook for 1916. 240 pages, 4 by 6 inches and diary and memoranda for 1916 additional. 130 illustrations. Published by Emmott & Co., Ltd., Manchester, England, and Norman Remington Co., Baltimore, Md. Price, $0.30.

This compilation of electrical data is published yearly and is well known to electrical engineers, electricians, etc., in Great Britain and America. It treats of a great variety of electrical matters and includes many tables. Anyone needing a small treatise on electricity of a strictly practical nature will make no mistake in purchasing one of these year books.

Practical Perspective. By Frank Richards and Fred H. Colvin. 58 pages, 4½ by 6⅞ inches. 64 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $0.50.

This little treatise on making isometric mechanical drawings has just been issued in the fourth revised edition. It treats of the principles of isometric perspective and is illustrated with many examples. The use of isometric paper, which is also sold by the publishers, is described. This paper makes the construction of isometric sketches without preliminary layouts very simple, and the art can be quickly mastered by anyone at all handy with the pencil.

Concrete and Reinforced Concrete. By W. L. Webb and W. H. Gibson. 240 pages, 4½ by 7 inches. 118 illustrations. Published by the American Technical Society, Chicago, Ill. Price, $1.50.

This treatise is intended for the use of the engineer or contractor and also for those seeking general information upon the subject. The authors have endeavored to present the subject in as simple and concise a manner as possible. The book covers the composition and treatment of concrete, and describes the mixing and laying of concrete for different purposes, including T-beams, footings, piles, retaining walls, culverts, girder bridges, building blocks, fence posts, walks and curbs, and flat-slab construction. The general theory of flexure in reinforced concrete, and the practical calculation and design of beams and slabs are dealt with. The book is neatly bound in flexible leather.

House Wiring. By Thomas W. Poppe. 125 pages, 4 by 6 inches. 95 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $0.50.

This little treatise describes and illustrates methods of installing electric light wiring, bell wiring and burglar alarm wiring, and is intended for the instruction of electricians, helpers and apprentices. The instructions given are in conformity with the rules of the National Board of Fire Underwriters. The chapter heads are as follows: Showing the Plans and Layout of the Electrical Work; Flexible Metallic Wiring Systems; Installing Rigid Conduit;

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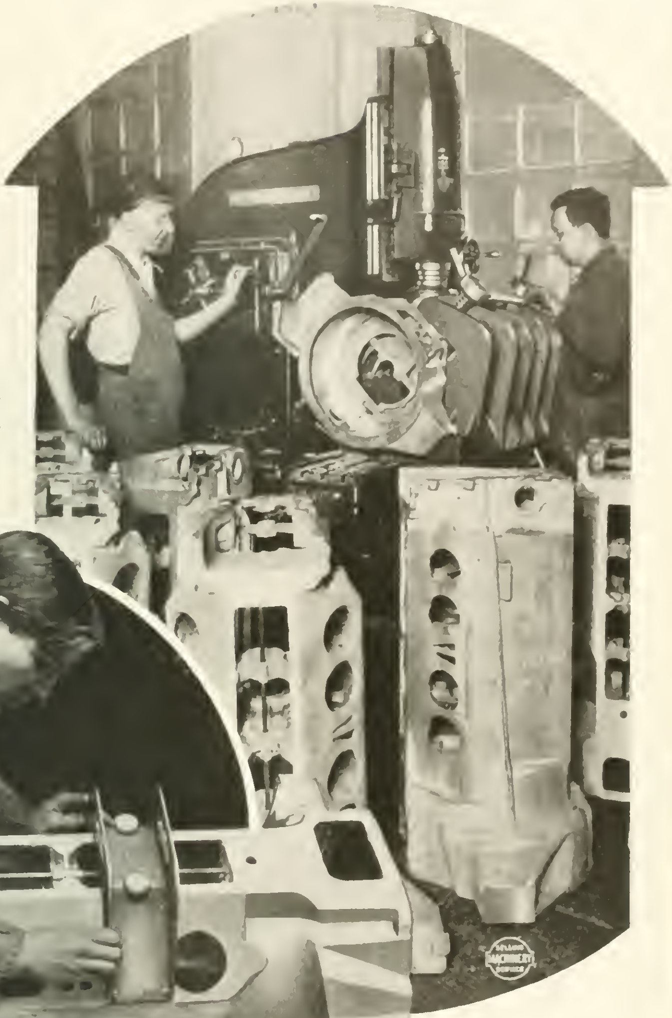

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Magnetic and Other Properties of Iron-Silicon Alloys, Melted in Vacuo. By Trygve D. Yensen. 67 pages, 6 by 9 inches. 40 illustrations. Issued by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 83. Price, 35 cents.

The bulletin describes the methods employed in producing a number of iron-silicon alloys, which the author has subjected to mechanical and electrical tests. The tests show that silicon increases the mechanical strength of iron in almost direct proportion to the amount added, until the maximum strength is reached with a silicon content of about 4.5 per cent. The elastic limit of this alloy is 94,000 pounds per square inch, and the ultimate strength 105,000 pounds. The magnetic properties of the vacuum alloys are remarkable. The maximum permeability is above 50,000 and the hysteresis loss is only one-eighth to one-third of that for commercial silicon steel.

Lathe Design Construction and Operation. By Oscar E. Perrigo. 469 pages, 6 by 9 inches. 341 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $2.50.

This is a revised and enlarged edition of a book originally published in 1907. The aim of the author has been to present in as comprehensive a manner as possible the history and development of the lathe and to describe its practical use on various classes of work. In the revised and enlarged edition of this work a chapter has been added dealing with lathe installation and management, milling, drilling and grinding attachments, and their use, methods for turning tapers and spherical surfaces, and various odd jobs that may be performed in a lathe. The book deals completely with the history of the lathe; classification of lathes; lathe design, covering all the various details required; lathe attachments; rapid change gear mechanisms; tests performed on lathes; lathe tools and the operation of engine lathes, turret lathes, and special lathes.

Elevators. By John H. Jallings. 217 pages, 5½ by 8½ inches. 172 illustrations. Published by the American Technical Society, Chicago, Ill.

This is a practical treatise on the development and design of hand, belt, steam, hydraulic and electric elevators. The author has for twenty years been superintendent and chief constructor with a well-known elevator company, and writes, therefore, with the force of authority behind him. The work is divided into three main sections, the first of which deals with hand- and belt-power elevators the second, with steam and hydraulic elevators, and the third, with electric elevators. As a general descriptive treatise covering the whole field of elevators, the book is to be recommended to anyone who requires a complete review of the subject. The theoretical principles are not dealt with in great detail, the work, apparently, not having been intended to be a designer's handbook, but rather a detailed history of the mechanical and electrical developments of various types of elevators.

Oxy-acetylene Welding and Cutting—Electric, Forge and Thermit Welding. By Harold P. Manly. 215 pages, 4¼ by 6½ inches. 56 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, bound in cloth, $1; bound in leather, $1.50.

The work deals with metals and alloys; heat-treatment; welding materials; acetylene generators; welding instruments; oxy-acetylene welding practice; electric welding; hand forging and welding; soldering, brazing and thermit welding; and the oxygen process for removal of carbon. The author's object was to cover the several processes of welding and other processes which are so closely related as to make them practically a part of the whole subject of jointing metal to metal with the aid of heat. For this reason, annealing, tempering, hardening, heat-treatment and the restoration of steel have been included. The book is condensed, much more information being contained than might be inferred from a casual examination of the small volume.

Industrial Leadership. By H. L. Gantt. 128 pages, 5 by 7½ inches. Published by Yale University Press, New Haven, Conn. Price, $1.

This book, by one of the best known of the exponents and organizers of scientific management plans, contains a series of lectures delivered by the author in the Page Lecture Series, 1915, before the Senior Class of the Sheffield Scientific School at Yale University. It contains an exposition of the fundamental principles of scientific management, divided into five chapters—Industrial Leadership, Training Workmen, Principles of Task Work, Results of Task Work, and Production and Sales. The freedom from dogmatic doctrine and the ability to see far beyond the narrow limits of mere systems, which characterize all of the author's writings and public utterances, are in evidence in this book, and it can be well recommended to all those who wish to obtain a sound conception of the fundamental principles upon which scientifically planned management must be based in order to be successful. The book is full of veritable gems of thought relating to the broader aspects of industrial work.

Indexing and Filing. By E. R. Hudders. 292 pages, 6 by 9 inches. Numerous illustrations. Published by the Ronald Press Co., New York City. Price, $3.

This book has been written with a view to formulating rules covering the indexing and filing of records, such as are ordinarily used in commercial organizations. The scope of the work can best be indicated by giving the headings of the twenty-nine chapters of which it consists. These chapters deal, respectively, with Terminology and Definitions; Indexes; Rules for Writing Indexes; Rules for Filing Index Cards; Filing of Papers; Direct Alphabetic Filing; Alphabetic-Numeric Filing; Numerical Filing; Geographic Filing; Subject Filing. Lost Papers; Transferring; Central Filing Department; Classing and Grouping of Records; Notation, Information and Data Files, Catalogue and Pamphlet Filing, Purchase Records; Sales Records; Credit Records; Filing of Sales Invoices; Filing of Purchase Invoices; Check and Voucher Filing, Filing of Electrotypes and Cuts; Filing Equipment; Filing in Lawyer's Offices; Architectural Filing; and Files of an Accountant.

Starting, Lighting and Ignition Systems. By Victor W. Pagé. 509 pages, 5¼ by 7½ inches. 295 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $1.50.

This book contains descriptions of the various forms of electrical ignition systems used in internal combustion engines and includes chapters on the starting and lighting systems of automobiles. In addition to the chapters dealing specifically with the ignition, starting and lighting systems, the book contains a simply written treatise on elementary electricity. The chapters dealing with ignition methods are headed Battery and Coil Ignition Methods, and Magneto Ignition Systems. The electric starter is dealt with in two chapters, one on elementary principles, and one describing typical lighting and starting systems. A special chapter is devoted to starting system faults and their location, and in addition, there is a chapter on miscellaneous electrical devices used in connection with automobiles. The book should prove of value to owners of automobiles and repair men, as well as to designers and others who are interested in the different devices employed in connection with starting, lighting and ignition systems.

Metric System in Export Trade. By Samuel W. Stratton. 80 pages, 6 by 9 inches. Illustrated. Published by the U. S. Government, Washington, D. C., as Senate Document No. 241.

This is a report to the International High Commission relative to the use of the metric system in the export trade by the director of the Bureau of Standards. Its circulation among manufacturers at this time when so many are laying plans for developing foreign trade should be generally helpful. It answers the specific questions: What proportion of manufacturers have adopted the metric system in preparing goods for export? Has experience warranted an expansion of this policy? What are the chief objections to such action? Are certain lines less adaptable than others? What will be the effect upon the scale and tool trades of any systematic movement in this direction? Ought we to recommend the compulsory instruction in our schools in the metric system, or might it be limited to high schools? Practical suggestions and data on the metric system follow. Examples of American products made to conform to the requirements of metric measure countries are also included.

NEW CATALOGUES AND CIRCULARS

Van Emon Elevator Co., 46-54 Natoma St., San Francisco, Cal. List of second-hand machine tools for sale.

Economy Engineering Co., Willoughby, Ohio. Circular of electric hoists made in capacities from 1000 to 10,000 pounds.

Phoenix Mfg. Co., Eau Claire, Wis. Catalogue and price list of Phoenix and Conradson turret attachments for engine lathes.

Enterprise Machinery Co., 32-34 S. Clinton St., Chicago, Ill. Circular of "Emco" No. 1 bench drill, speeded from 1500 to 5000 R. P. M.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Loose-leaf catalogue containing bulletins, with prices and dimensions, of electric controlling apparatus.

Wright Mfg. Co., Lisbon, Ohio. Catalogue 7 covering the line of chain hoists, steel trolleys and hand cranes manufactured by this company.

Skinner Chuck Co., New Britain, Conn. Circular illustrating independent lathe chucks with solid reversible jaws, giving dimensions, prices, etc.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Booklet of direct- and alternating-current electric fans.

Chicago Pneumatic Tool Co., Chicago, Ill. Bulletin E-38 descriptive of the Duntley universal electric hammer drill and the work for which it is adapted.

Link-Belt Co., Chicago, Ill. Catalogue 213 illustrating Link-Belt elevators, conveyors and machinery for handling, preparing and storing gravel, stone, sand, etc.

Union Switch & Signal Co., Swissvale, Pa. Booklet describing the forging and foundry departments and machine shop of this company and listing the forgings manufactured.

Tirrill Gas Machine Lighting Co., 103 Park Ave., New York City. Booklet on Tirrill equalizing gas machines, high efficiency gas burners and gas appliances for all purposes.

Allis-Chalmers Mfg. Co., Milwaukee, Wis. Leaflet containing a summary of a test on the Allis-Chalmers 10-inch single-stage centrifugal pump, which gave an efficiency of 85 per cent.

Schum Bros., Metropolitan Bldg., New York City. Circular advertising Schum automatic nut locks, the locking capacity of which has been increased from a quarter to a tenth turn of the nut.

J. M. Rogers Works, Inc., Gloucester City, N. J. Circular on the use and care of Rogers measuring appliances, illustrating limit gages, control gages, plug gages, snap gages and gages in sets.

Excelsior Tool & Machine Co., E. St. Louis, Ill. Circular descriptive of the Excelsior automatic grinding and polishing machine, which is a special machine with grinding capacity of 60 by 60 inches.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 48705 illustrating and describing direct-current motors and controllers for flat-bed and small rotary printing presses.

Joseph Dixon Crucible Co., Jersey City, N. J. Pamphlet containing suggestions on the proper care of belts, information on belt dressings, with directions for applying, and rules for calculating speed of pulleys.

Spaulding Print Paper Co., 44 Federal St., Boston, Mass. General catalogue, 224 pages, 6 by 9 inches, listing the company's line of drafting-room supplies, drawing materials, blueprint outfits, mathematical and engineering instruments.

Kingsford Foundry & Machine Works, Oswego, N. Y. Bulletin 17 of a compound Lancashire boiler and setting which provides for practically perfect combustion of fuel and enables bituminous coal to be burned without making black smoke.

Cowan Truck Co., 8 Water St., Holyoke, Mass. Catalogue describing Cowan transveyors and illustrating them in use in various plants. These transveyors are made in three types to handle loads of 3500, 5000 and 3000 pounds, respectively.

Davis Machine Tool Co., Inc., 307-313 St. Paul St., Rochester, N. Y., is issuing a table of fractional inch equivalents in decimals and millimeters, mounted on metal and reinforced with strawboard to withstand hard usage in shops, drafting-rooms, etc.

Marvin & Casler Co., Canastota, N. Y. Catalogue E illustrating the Casler offset boring head in operation on the turret lathe, drilling machine and milling machine. Specifications and prices are given for the various styles of boring heads and boring bars.

Blanchard Machine Co., 64 State St., Cambridge, Mass. Catalogue descriptive of Blanchard high-power vertical surface grinders equipped with magnetic chucks. The various details of these grinders are well illustrated, making the construction very clear.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 8 describes the method of aligning the suspended type heading slide of the National heavy-pattern forging machine. Halftone and cross-sectional views make the description very clear.

General Electric Co., Schenectady, N. Y. Bulletin 46023 describing the G. E. arc circuit volt meter, which is a special instrument designed for testing direct-current series arc circuits. The approximate dimensions and the connections, together with prices, are included.

New Departure Mfg. Co., Bristol, Conn. Sheets 59 FE to 62 FE for looseleaf catalogue, treating of ball bearings in carver cotton seed huller; ball bearing installation in conveyor rolls; utility of ball bearings in electric hammer; and ball bearings in the pneumatic drill.

International Oxygen Co., 115 Broadway, New York City. Catalogue 3 containing a detailed description of I. O. C. bipolar oxygen and hydrogen generators. It is claimed that the chief characteristics of these generators are safety, reliability, and economy in operation.

Kennicott Co., Chicago Heights, Ill. Circular describing the Kennicott cycloid weir meter, which is particularly adapted for measuring relatively large quantities of water or for use wherever a limited amount of head room is available for the installation of an accurate meter.

Pajaro Mfg. Co., 1251 Brown's Ave., Erie, Pa. Circular of small magnifying mirror for toolmakers and machinists. The mirror is useful in cutting internal threads, setting forming tools and in many other operations requiring sharp eyesight and good light in situations difficult to illuminate.

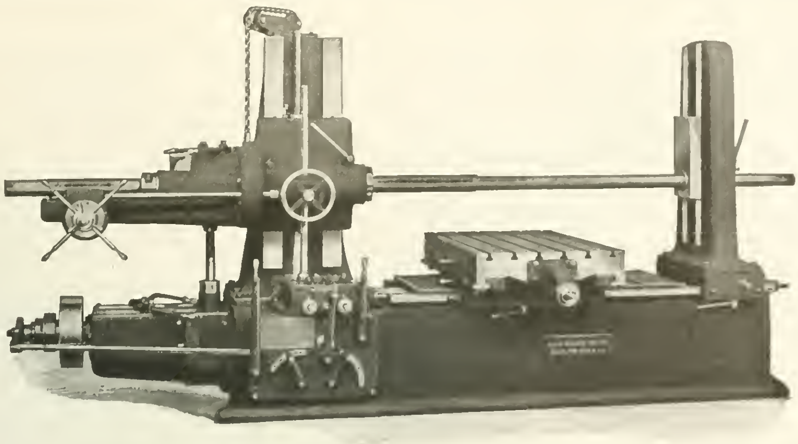
Chisholm-Moore Mfg. Co., Cleveland, Ohio. Catalogue 24 containing 95 pages, 6 by 9 inches, on Cyclone chain hoists, trolleys, hand power traveling cranes, ammunition trolley hoists, malleable iron castings and shell tongs. The chain blocks, trolleys and traveling cranes of this line range from ¼ ton to 40 tons capacity.

Bacharach Industrial Instrument Co., Pittsburg, Pa. Leaflet descriptive of a new pocket CO_2 indicator for quickly and accurately determining the amount of CO_2 in flue and furnace gases. The instrument is made in a portable form so that it can be conveniently carried around and is always ready for use. A test takes about 2½ minutes.

C. & C. Electric & Mfg. Co., Garwood, N. J. Bulletin 101 descriptive of Type SL direct-current motors, built in all standard sizes from ½ horsepower up to 150 horsepower, for every variety of application. The bulletin describes the operating characteristics of these motors, and gives suggestions on the selection of the proper motor for varying conditions.

R. Martens & Co., Inc., 24 State St., New York City. Booklet on Russia and the vast opportunities for American trade there. Russia has a population of 180,000,000, and the potential market possibilities following the close of the war of this great population are enormous. The booklet contains much valuable information for manufacturers and others interested in foreign trade.

James Clark, Jr., Electric Co., Louisville, Ky. Catalogue 26 showing the line of "Willey" electric driven tools, dynamos and motors, which includes motor-driven hand drills, portable drills, portable



Do you keep a record of the performance of every tool in your shop; how much work it does; how good work it does; how long it takes to "break in" a new man on the machine; how much it stands idle for repairs, and how much the repairs cost? If you do, you are just the kind of a customer we want for the

"PRECISION"

BORING, DRILLING AND MILLING MACHINE

THE

ORIGINAL "LUCAS TYPE"

Power feeds in every direction. QUICK POWER RETURN to every feed. THE SAME LEVER FOR ALL.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

grinders, bench grinders, floor grinders, wet and dry grinders, buffers, hacksaws, sensitive drills, notching presses, winding machines, locomotive turntable motors and direct-connected motors and dynamos.

Emmert Mfg. Co., Waynesboro, Pa. Catalogue of the Emmert vertical or horizontal T-square, which comprises a combination of the usual type of T-square, scales, triangles and protractor. By the use of this instrument, much time can be saved in drafting work. The catalogue also describes Emmert drawing boards, which are so designed that they can be adjusted to any angle and slid toward or away from the draftsman.

Colonial Steel Co., 213 W. Lake St., Chicago, Ill., is publishing a stock list every two months, which lists all the standard sizes of the regular grades of Colonial steels carried in stock in the Chicago office, as well as grades that are not carried in stock. The booklets contain tables of information relating to tool steel and other interesting data. A complete list of the products made by this company is given on the inside back cover.

Rodman Chemical Co., E. Pittsburg, Pa. Booklet entitled "Casehardening," intended as a guide in the various operations of casehardening, and calling attention to an improved casehardening material—"Carbo" casehardening compound. The contents of the booklet are: heat-treatment of steel; casehardening; quality of steel; carbonizing material; apparatus; carbonizing operations; "Carbo" casehardening compound; condensed instructions.

Mark Mfg. Co., Chicago, Ill. Catalogue 12 on black and galvanized wrought pipe, line and drive pipe, well casing, irrigation casing, boiler tubes, electric wire conduit, cold-drawn steel unions, wrought nipples, drive well points, well strainers, pump — Artesian and tubular — well cylinders, tubular well valves and tools, pump leathers, pipe cutters, pipe vises, pipe threading dies and diestocks. The catalogue contains complete price lists of the product.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Treatise on "Nonpareil" corkboard insulation, used for cold storage warehouses, ice plants, dairies, creameries, refrigerators, etc. This piece of advertising literature contains 151 pages, 6 by 9 inches, and numerous illustrations. The valuable data on heat insulation makes the work of general interest to engineers, especially those who have anything to do with the conservation of heat or the exclusion of heat from rooms, etc.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Booklet giving compositions and physical properties of titanium aluminum and other standard bronze alloys. The alloys are distinguished by numbers, and photomicrographs of 20 and 200 diameters illustrate the structure of each. The book also contains a description of the methods used in making various tests, as well as tables of resistance and relative conductivity of various metals and alloys, physical constants, bearing pressures for various classes of bearings, etc.

A. S. Cameron Steam Pump Works, 11 Broadway, New York City. Bulletin 154 treating of Cameron centrifugal pumps. Sectional views illustrate both the single- and double-suction, open impeller types, and the booklet gives tables of capacities, speeds and horsepowers. Bulletin 110, covering the Cameron line of duplex pumps, which includes both piston and plunger types with single and compound steam cylinders for general service, boiler feeding, tank service, water works, hydraulic elevators, automatic pumps and receivers, brewery, quarry and mining work.

De Vilbiss Mfg. Co., Toledo, Ohio. Booklet H of the "Aeron" System of applying varnishes, enamels, first coats, lacquers and practically every kind of finishing material on wood and metal products with compressed air. The apparatus eliminates the hand brush from the finishing room. The company exhibited, at the Second Annual Industrial Safety Exposition of Ohio at Cleveland, in January, its exhausting equipment which insures complete removal of all fumes and vapors from the finishing room, thereby making for better sanitary and safer working conditions.

Garden City Fan Co., 1532 McCormick Bldg., Chicago, Ill. General catalogue 160 containing 143 pages, 6 by 9 inches, devoted to this company's line, which includes fans, blowers, heating and ventilating apparatus and air washers. The book contains tables of air pressure, temperature of steam at different pounds steam gage pressure, indoor temperatures under varying outdoor conditions, constants for heat transmission of miscellaneous materials with rules for applying, area and circumference of circles, allowable velocities of air through heaters, properties of air, and other useful information.

Greaves-Klusman Tool Co., Cincinnati, Ohio. Catalogue entitled "G-K Betterments" of engine lathes, heavy quick-change type and geared-head, single-lever control type. The company builds a complete line from 16 inches to 30 inches swing, and the 16-inch and 18-inch lathes are built with three styles of headstock as follows: four-step cone single back-gear, three-step cone friction double back-gear and geared-head, single-pulley drive. The 20-, 22-, 24- and 30-inch lathes are built in two styles as follows: three-step cone friction double back-gear and geared-head single-pulley drive. All sizes are built with quick change mechanism.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Catalogue DS 846 giving a complete list of the necessories used in pole-line construction, together with prices and dimensions. Catalogue IP 54, describing type CW slip-ring, induction motors for constant and varying-speed continuous-duty service. This motor is built in capacities from ½ to 650 horsepower, two and three phase, 25 and 60 cycles, 220, 440, 550, and 2200 volts. Leaflet 3763 of the Westinghouse 532-B railway motor; leaflet 3818 of Westinghouse type C push-button control stations for use with automatic motor starters and controllers of alternating and direct current; leaflet 3823 of commutating-pole rotary converters.

TRADE NOTES

Hess Steel Corporation, Bridgeton, N. J. has been absorbed by the Hess Steel Corporation, Baltimore, Md.

Continental Motor Mfg. Co., Detroit, Mich., has changed its corporate name to Continental Motors Co. No change has been made in the organization.

Hultberg-Johnson Tool Co., Inc., Jamestown, N. Y., was recently incorporated for the manufacture of tools, machinery and devices, with a capital of $25,000.

Advance Grease & Chemical Co., Jackson, Mich., has changed its name to Advance Grease Co. The company manufactures drilling and cutting compounds, lubricating greases and soap products.

Electric Controller & Mfg. Co., Cleveland, Ohio, announces that the net selling price of all E. C. & M. apparatus has been increased ten per cent because of the increased cost of manufacturing.

Hyatt Roller Bearing Co., Newark, N. J., announces that owing to advances in the cost of raw materials used in the manufacture of Hyatt flexible roller bearings, it has been necessary to raise its prices.

Cleveland Twist Drill Co., Cleveland, Ohio, states that the publication in another technical journal of the notice of a fire in its plant was greatly exaggerated. It did have a fire, but only a small outhouse or shed was partially burned.

Lober Art Brass & Specialty Co., 124-130 11th St., Toledo, Ohio, has recently moved into its new building, which has a floor space of 6000 square feet. The company makes a specialty of steel spinnings and is giving regular employment to twenty-four metal spinners. A stamping and plating department has been added to the plant.

American Machine Co., Newark, Del., builder of improved Rider & Ericsson hot air pumping engines and the Denny tag machine, has sold its entire capital stock, factory and equipment to the Titan Motor Car Co. The business will be continued as a department in connection with the production of the Titan steam motor cars, under the original name.

Stow Mfg. Co., Binghamton, N. Y., manufacturer of the Stow flexible shaft, has made arrangements with the American Express Co. by which customers in foreign countries may place orders with the American Express Co. for transmission. These orders will be transmitted directly by the express company and no buying commission will be charged.

Electro Dynamic Co., Bayonne, N. J., maker of interpole motors, has placed a contract with the John W. Ferguson Co. for the erection of an addition to the plant approximating 100 feet square. The building will be one story high with mezzanine galleries and will be built on the regular mill construction lines with brick walls and a felt and slag roof.

Ward-Leonard Electric Co., Mount Vernon, N. Y., originator of the electrical control system bearing its name, has let a contract for a two-story factory to be located at the corner of Pearl and South Sts., Mount Vernon, to John W. Ferguson Co. of New York. The building, measuring 83 by 153 feet, will follow regular mill construction lines, and will be covered by a slag and felt roof.

Allied Machinery Co. of America, 120 Broadway, New York City, has been purchased by the American International Corporation, which proposes to extend and develop the business. The Allied Machinery Co. was capitalized at $200,000 and was formed about four years ago by interests connected with the National City Bank of New York City, for the purpose of promoting the sale of American machine tools and machinery abroad.

Cowan Truck Co., 8 Water St., Holyoke, Mass., builder of transveyors, has acquired a site having a frontage of 265 feet and a depth of 222 feet. A contract has been let for the erection of a two-story building 100 feet wide by 200 feet deep, affording about 40,000 square feet floor space. The building will be of concrete and brick with foundations designed to support three additional stories. The Cowan shop transveyor was awarded a gold medal at the Panama-Pacific International Exposition.

Curtiss Aeroplane & Motor Corporation, 65 Churchill St., Buffalo, N. Y., incorporated in January, has taken over the assets and property, and assumed the debts and liabilities of the Curtiss Motor Co. The business formerly conducted by the Curtiss Motor Co. will be conducted by the Curtiss Aeroplane & Motor Corporation. The corporation has a branch office and plant at Hammondsport, N. Y., and the subsidiary company—the Curtiss Aeroplane Co.—also has offices at Hammondsport, N. Y., and Buffalo.

Landis Tool Co., Waynesboro, Pa., which has sold its grinding machines direct in the West, has severed its connection with the W. H. Foster Co. and has now made arrangements to handle its sales direct in the eastern territory also. A. G. Nevin will represent the company in New York state and eastern New Jersey; M. G. Dunbar in the New England states, and T. M. Scherer in western New Jersey, Pennsylvania, Maryland and Delaware. An office will be opened by the company at 50 Church St., New York City.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, builder of lathes and milling machines, has broken ground for a new plant located on Madison Road not far from Oakley, a suburb of Cincinnati. The new plant will afford 600,000 square feet of floor space and will be on a plot of land covering thirty-eight acres. A separate office building will be erected. The present intention of the company is to build lathes exclusively in the new plant and utilize the plant on Eastern Ave. for the manufacture of milling machines.

J. N. Lapointe Co., New London, Conn., manufacturer of broaching machines and broaches, will resume work, which was stopped in February, on a new three-story building 50 by 140 feet, as soon as the weather conditions permit. The construction will be of stone, brick and concrete. The new office will be located in this building. The company has started the construction of one additional story on the two-story building completed last year, converting it into a three-story building. The structure will be extended 27 feet in length.

Harrison Safety Boiler Works, 17th St. and Allegheny Ave., Philadelphia, Pa., was awarded the gold medal at the Panama-Pacific Exposition for its exhibit of the combined open feed water heater and hot water meter, known as the "Cochrane" metering heater. This apparatus is designed to heat boiler feed water by means of exhaust steam from engines, pumps, etc., and simultaneously to meter the water and record the rate of flow and to integrate the total flow in any elapsed period. This enables the engineer or plant owner to determine how many pounds of steam are being evaporated per pound of fuel burned under the boilers and hence to compare the different fuels, methods of firing, etc.

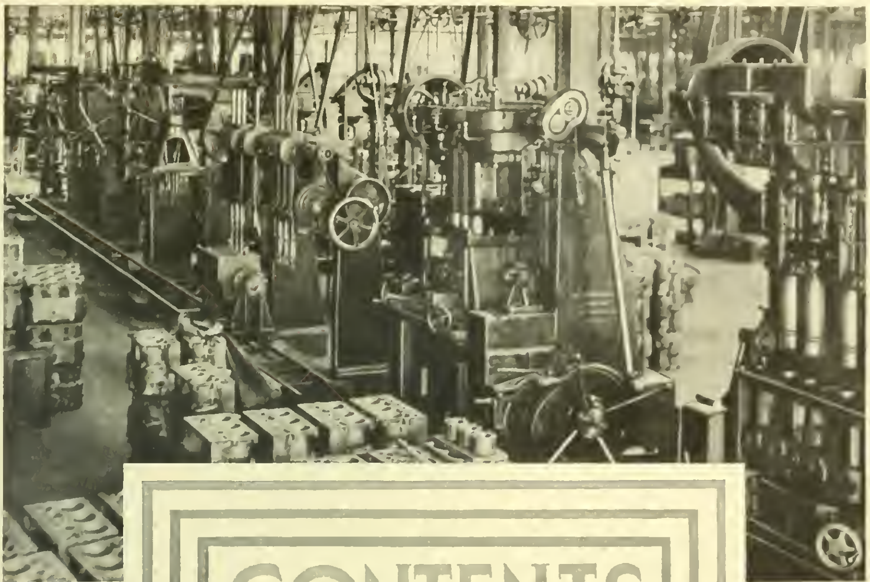
American Foundry Equipment Co., Cleveland, Ohio, manufacturer of the Wadsworth direct-pressure system sandblast apparatus, and the Sand Mixing Machine Co. of New York City, manufacturer of the "Auto" sand cutting machine, have combined interests and moved into a new and up-to-date factory at 1111 Power Ave., Cleveland. H. L. Wadsworth, inventor and designer of the "Wadsworth" sandblast apparatus, is factory manager in charge of all departments. Charles L. Benham, an old employe of the Sand Mixing Machine Co., will be in charge of affairs as factory superintendent. The executive offices of both concerns will be maintained at 52 Vanderbilt Ave., New York City, in charge of V. E. Minich, vice-president and general manager.

Wagner Electric Mfg. Co., St. Louis, Mo., has begun the construction of two new buildings on Plymouth Ave. Building No. 1 is 140 by 90 feet with an open bay 50 feet wide spanned by a traveling crane, with galleries 20 feet wide on each side. This building will be devoted to punch press operations. The framework will be of structural steel, with an all metal roof having a longitudinal skylight down the center. Building No. 2 will be 90 by 106 feet, and will be devoted to various operations involving the production of small parts, including small punch press work. This building is of reinforced concrete construction and fireproof throughout. The reinforced floors of concrete in building No. 2 will be built under the "Acme" system of the Condron Co.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., maker of drop-forgings, has placed with John W. Ferguson Co. a contract for several additions to its Buffalo plant. The drop-hammer shop addition will be the largest, consisting of four bays giving additional space of 64 by 310 feet. The construction will be similar to that of the main building—a structural steel frame with exterior walls of brick, steel sash and a gypsum slab roof, using the "Metropolitan" system. There will be no floor. The stock and finishing building will have its floor space increased by five bays, 82 by 80 feet, and the construction of this addition will be similar to that of the hammer shop. The roof, however, will be of the sawtooth type; a maple floor will be laid.

Hoover Steel Ball Co., Ann Arbor, Mich., will double its entire plant this year; the new buildings will afford approximately 42,000 square feet additional floor space, making a total of about 84,000 square feet of manufacturing floor space in the entire plant. The machinery and equipment have been ordered for the new buildings, and it is expected that the entire addition will be in operation by October 1. Business has been increasing so rapidly during the past eighteen months that the company has orders booked ahead for a year or more. With the new equipment installed the production will be from 25,000,000 to 30,000,000 balls a day, and 350 tons of steel will be used in the manufacture of balls monthly. All the new buildings will be of fireproof construction, as they are being built of concrete and brick.

Davis-Bournonville Co., New York City, manufacturer of oxy-acetylene and oxy-hydrogen welding and cutting apparatus, announces several changes and additions in its selling organization. W. R. Noxon succeeds W. S. Schoenthaler as manager of the Chicago office. Mr. Schoenthaler goes to the company's general offices in Jersey City. H. H. Armstrong was recently appointed district sales manager of the Pittsburg district. The Pittsburg sales office and demonstrating plant has been removed to 316 Penn Ave. A demonstrating plant and commercial welding department has been established at 147 W. Austin Ave., Chicago, in charge of F. J. Maeurer. Mr. Maeurer was formerly superintendent of the welding department at the Jersey City shops, and he was succeeded by H. Ulmer as superintendent of the Jersey City welding department. John B. Redd formerly with the Pacific Gas & Electric Co. and superintendent of the Collective Gas Exhibit at the Panama-Pacific Exposition, and George S. Pearson, recently with the American Stove Co. and superintendent of that company's exhibit at the Panama-Pacific Exposition, have joined the Davis-Bournonville sales organization. The company is now erecting a building at the Jersey City plant, which will give 40,000 square feet additional space and will provide for approximately doubling its production of apparatus.



CONTENTS

MAY 1916

VOL. 22 NO. 9

THE INDUSTRIAL PRESS, Publishers

140-148 Lafayette Street, New York

Seeing the Market Whole—4

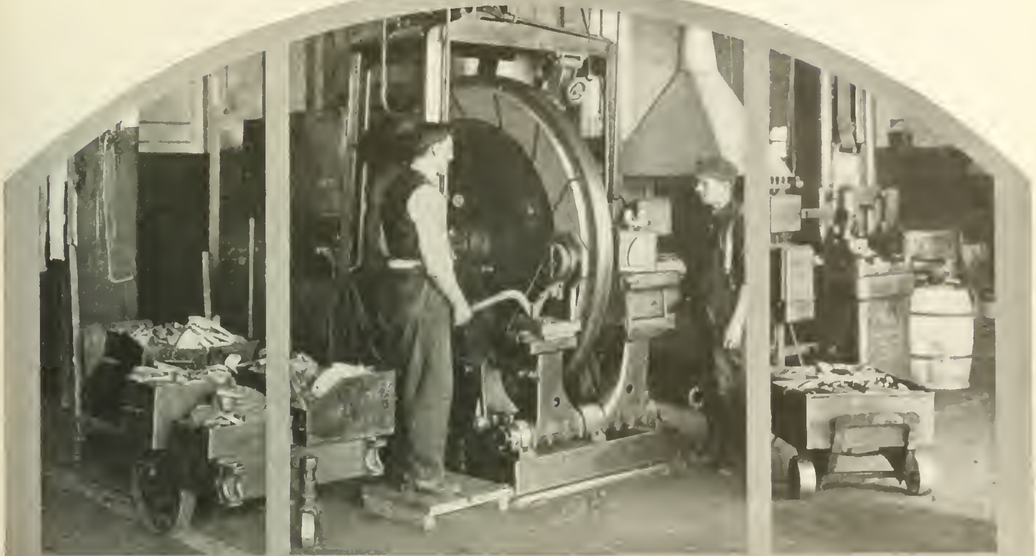
We have been looking over the mechanical world with the sales manager, noting that (1) the modern market for shop equipment is universal, and is rapidly increasing in volume and extent; (2) that customers are found in industries of almost every description; (3) that the buyers are not office men, but practical shop men who *originate* the orders and specify makes and brands as well as sizes wanted.

Fortunate the sales manager who has the gift to visualize this boundless field, its unlimited possibilities, its manifold, increasing opportunities, its definite objectives. If he sees it all, his advertising plans will show it, his copy will demonstrate it. If he finds inspiration in so vast a market, there will be intelligence, method, conviction, force, and possibly power, in his advertising. His copy is read not only in America, but in Europe, Asia, Japan, China, India, Australia, New Zealand, Africa, South America. It is read wherever the wheels of industry revolve. It is read for *business*.

American metal-working tools admittedly lead the world, and descriptions of them are eagerly read and studied by engineers everywhere. How anxious the sales manager should be to see that these intelligent, interested, responsible men are fully and accurately informed about the tools which it is his mission to market.

The sales manager who sees with his mind's eye the engineering world of readers will endeavor earnestly to make every advertisement convey some definite data, idea or suggestion. To do less than this is to trifle with serious business and real opportunities. Ask any foreign dealer representing American tools for his opinion of the value of good copy in reaching the foreign engineer, interesting him, arousing his curiosity.

The modern advertising method developed by MACHINERY, which shows the machine demonstrating high efficiency under actual shop conditions, makes a lasting impression on an engineer no matter where he is. He sees the tool doing the work and reads the authentic figures of production. He, too, wants results, and his competitors want them. Once he knows the best he is not likely to be satisfied with anything less. Advertising copy carefully planned to definitely and specifically inform the engineering reader, and persistently carried on month after month and year after year, builds a granite foundation under a business. In time this is called Good Will, and sometimes it is the most valuable asset that a business retains.



Some Electrical Manufacturing Operations

by Chester L. Lucas

THOSE who have seen a General Electric Co.'s fan, must have noticed the ingeniously formed wire fan guard with which it is equipped. A fan motor with the guard in place is shown in Fig. 1, and Fig. 2 shows the guard alone. It is the purpose of this article to describe the making of this guard and also to show a few of the interesting operations incident to the making of other electrical apparatus.

A study of the guard in Fig. 2 will show that it is made up of a central monogram cup, eight arms, a front rim and a rear rim. As two arms are made from one piece of wire, the entire guard is made from the monogram and six lengths of wire. In the case of smaller sizes of guards, where there are but six arms, only five pieces of wire are necessary. The group of halftone illustrations Figs. 3 to 9 show the different steps the arms and rims pass through from the first operation to the assembling of the finished piece

The brass wire is first cut to lengths which are long enough to make two complete arms, including all the bends. Then, as shown in Fig. 3, the wire is centrally located in the bending fixture and held from creeping during the bending operations by the clamp at the center. A gage at the right assists in locating the wire. At each end of the fixture are two fulcrum pins around which the bends are made with the aid of a hand key having a central hole to engage the fulcrum pin and a projecting stud that is spaced far enough from the hole to reach over the wire and control the bending when the key is turned. The lower of the fulcrum pins may be slid below the surface of the fixture so as to be out of the way while the upper bends are being made. One turn of the key completes each upper bend and a half turn forms each end bend This fixture swivels on its base and the

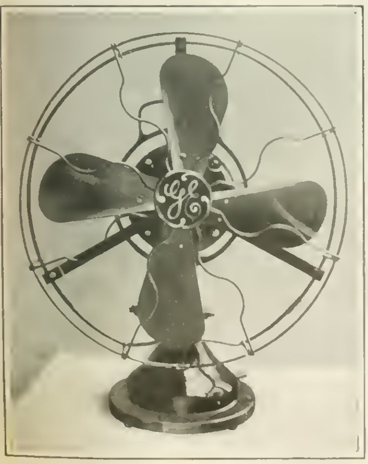


Fig. 1. General Electric Fan Motor

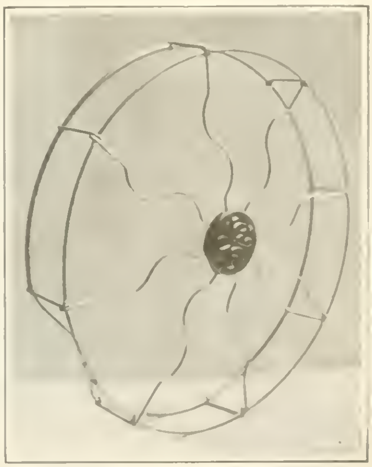


Fig. 2. Wire Fan Guard

Fig. 3. Bending Fixture for Preliminary bending of Wire Fan Guard

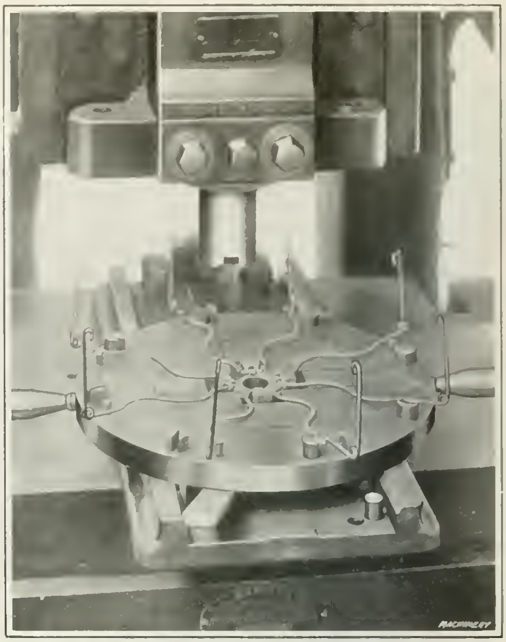


Fig. 4. Punch and Die for assembling Wire Arms and Center Plate

bending is rapidly handled at the rate of one hundred wires per hour.

The second and third steps are bending operations and are performed in the dies illustrated in Figs. 5 and 6. In Fig. 5 the die and punch are built up from rolls and formed sections having central grooves to receive the wire and form it without marring. Gages on the ends of the die and on the front side of punch and die support the ends of the wire and insure that the bending is done at right angles to the end sections.

The die shown in Fig. 6 performs the final operation on the double-arm wire, and makes the angular bend that leaves it ready for assembling. The wire is located from the bends previously made. The operating slide of the die has a recess that matches the stationary form in front of it, and as the slide advances, the bend is made. The slide is advanced by the tapered punch that descends behind it and moves it forward. Spring pressure brings it back for the next stroke.

The assembling of the guard is started by the die shown in Fig. 4, whose function it is to close the lugs in the center plate over the four double arm wires. To facilitate placing the work in position, the die is mounted on a slide on the bed plate. The center plate is first located and then the four wires are placed in position, the outer ends of the arms being supported by guides around the edge of the work-holder. One stroke of the punch turns the twelve lugs over and closes them on the arm wires. The lever at the front ejects the work.

The rim wires are cut off and formed by rolling, and the ends of each rim are joined by a short piece of brass tube crimped in place. Before the ends of the front rim wire can be joined, the wire must be run through the arm loops by hand. After joining the ends of the front rim wire, the loops are pressed down onto it by the tools shown in Fig. 7. This operation accomplishes a twofold purpose—improving the general appearance of the guard and locking the arms into their correct positions so that they cannot shift. This set of tools is the most complicated of those required for making the guard. After the guard has been placed in the die, with the eight arms properly located, handle A is thrown hard to the left. This moves the ring to which it is attached, and the movement causes the eight sliding blocks B to travel outward, reaching

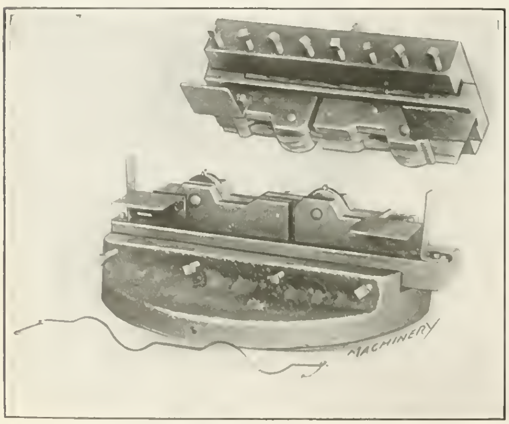


Fig. 5. Punch and Die for shaping Wire Arms

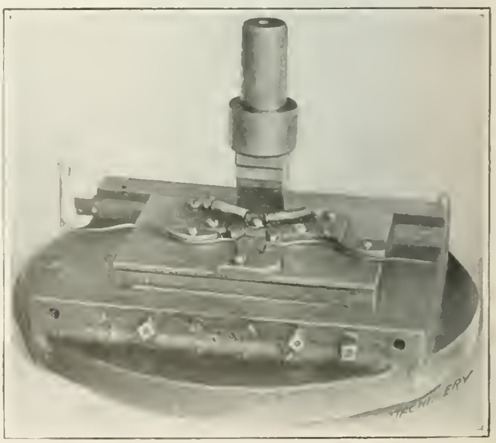


Fig. 6. Final Bending Operation on Wire Arms

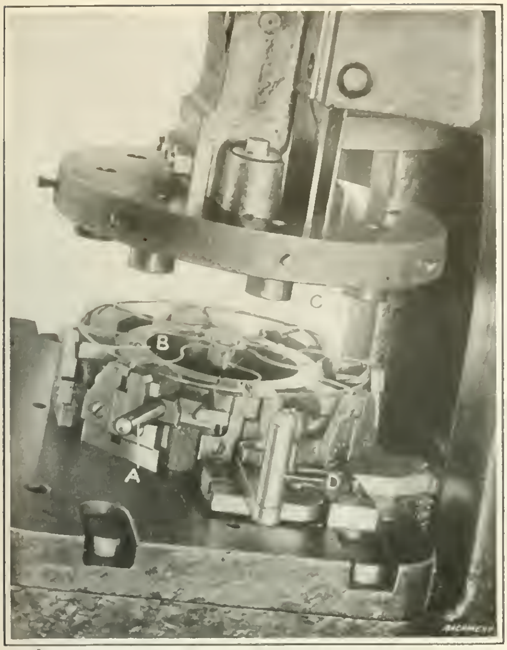


Fig. 7. Inclined Press for assembling Front Rim Wire and Arms

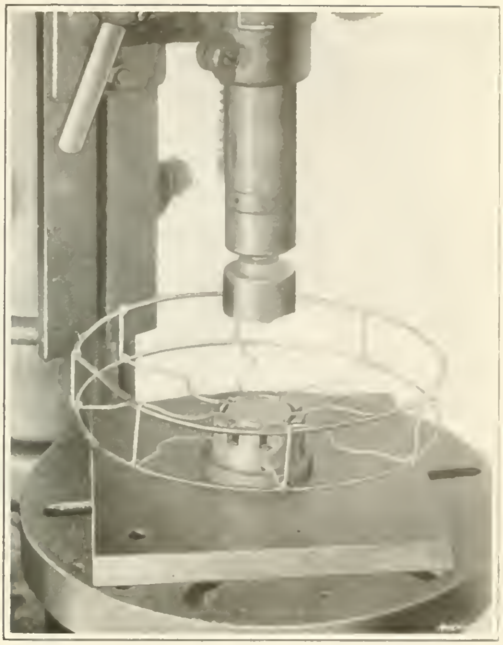


Fig. 8. Tool for applying Monogram to Center of Guard

under the arm loops. In this position, the press is tripped and the eight studs *C* on the punch flatten down the loops and depress them into the rim wire. To facilitate loading, the die is pivoted at the left-hand side and may be swung out from under the punches. Latch *D* holds it in the operating position.

The rear rim wire, after having been joined by a short piece of tubing, is dropped into the end bends of the arms and the loops are closed over the rim wire in the die shown in Fig. 9. The die has eight angular posts to back up the arm wires and in each of these posts is a steel insert grooved to receive the wire. In the central casting of the die there are eight plungers, operated by the central punch. The working ends of these plungers are formed to fit the ends of the arm wires and curl them around the rear rim wire when the punch is struck by the "pusher" on the ram. Spring fingers hold the guard in place for this operation and the plungers are withdrawn by springs.

The depression in the bottom of the inner or rear rim wire is made to clear the base of the fan motor. This is a simple operation and is performed with a pair of bending dies in a horn press. The final operation, that of applying the monogram to the center of the fan guard, is accomplished in a drilling machine as shown in Fig. 8. Eight slots in the monogram rim permit it to be placed over the wires from the front, and after dropping in the thin backing plate the edges of the monogram are spun over by a tool in the drilling machine. After lacquering, the guard is mounted on the motor as in Fig. 1.

Semi-automatic Spinning Lathe

The semi-automatic spinning machine used for spinning the lighting arrester cones is of more than ordinary interest. This machine is a Pryibil spinning lathe of the gap pattern, and is tooled as shown in Figs. 11 and 14. The lighting arrester cones are made of aluminum 0.037 inch thick and are shaped about as shown in Fig. 14, being approximately 10 inches in

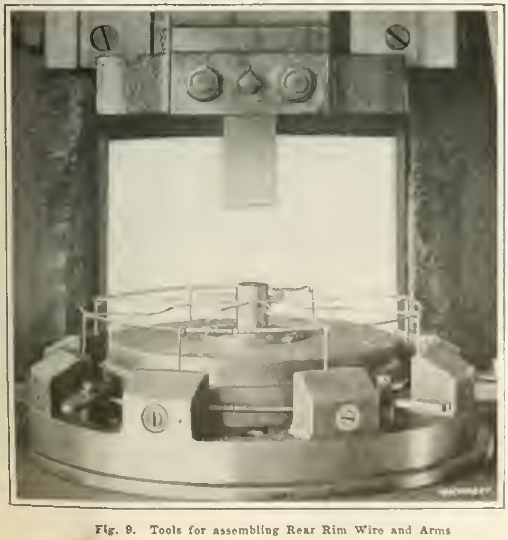


Fig. 9. Tools for assembling Rear Rim Wire and Arms

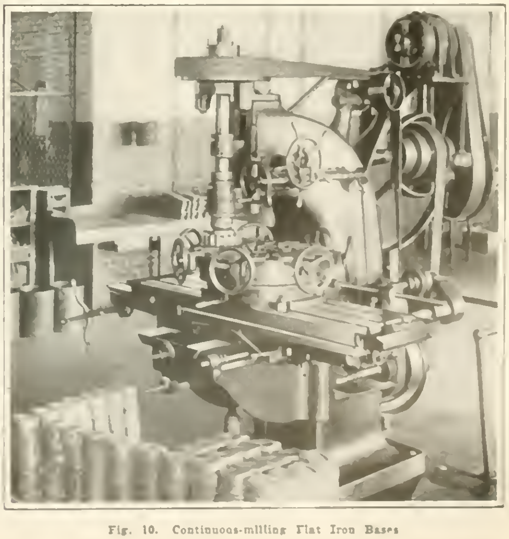


Fig. 10. Continuous-milling Flat Iron Bases

diameter and 7 inches from base to peak. The reflectors are spun rather than drawn because the spinning operation subjects the metal to a tension that is highly desirable for the use to which they are put. There is a female spinning form on the headstock of the lathe, and a blank-holder operated from the tailstock holds the work while it is spun inward to fill the form.

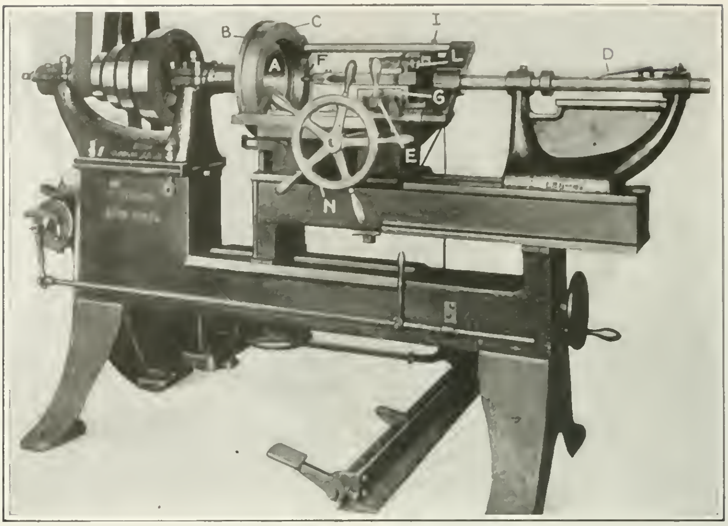


Fig. 11. Semi-automatic Metal Spinning Machine

Fig. 14 shows a diagrammatical view of the mechanism by which the spinning is done, and from this it will be seen that the spinning form shown at A is located directly on the spindle of the machine, which travels at approximately 1000 R. P. M. The blank is placed in the blank-holder B, and pressed against the form by means of the tail-

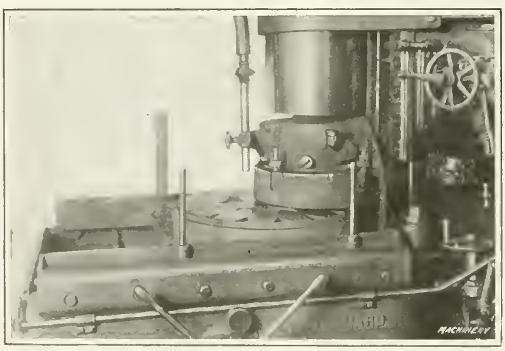


Fig. 12. Surface Grinding Flat Iron Bases

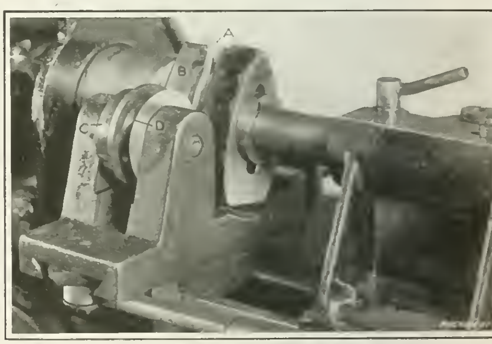


Fig. 13. Trimming Flanges from Flat Iron Clamp Covers

block C that is held by two bars that run back to the tailstock. The friction between the tail-block and the form is overcome by means of a ball bearing located on the tailstock holder. A clamping lever D on the tailstock locks the work.

The spinning mechanism itself is controlled by the movement of arm E that carries the spinning tool F located on a sliding carriage G. By means of an electric motor at the pivot of this arm indicated at H in Fig. 14, a worm-wheel I is turned continuously. On the same shaft with this worm-wheel is a pinion J that meshes with a rack which is part of a bar K attached to carriage G on which the spinning tool is located. The pinion and bar K may be caused to operate at will by clutch L and the rack consequently advances carriage G and hence the spinning tool F. A spring M is provided which tends to pull carriage G back toward the pivot of arm E. By means of the foot-treadle shown in Fig. 11, the operator can engage the clutch and cause carriage G to be pushed inward by means of the rack and pinion motion previously explained, and when the foot pressure is released, the clutch is thrown out and the spring pulls the carriage back ready for another stroke. Arm E, with the carriage and tool, is caused to swing toward the spinning chuck when the tool is advanced by wheel N that reciprocates the regulation carriage. Upon the carriage is a plate with a slot O inclined at an angle of approximately 45 degrees. Pin P which projects beneath arm E engages slot O. When the carriage is moved toward the chuck, the pressure of the side of the inclined slot upon stud P tends to swing the arm inward on pivot H toward the chuck. Thus, with the action of the rack and pinion pulling carriage G and the spinning tool F *toward* the operator, there is combined the motion of the carriage

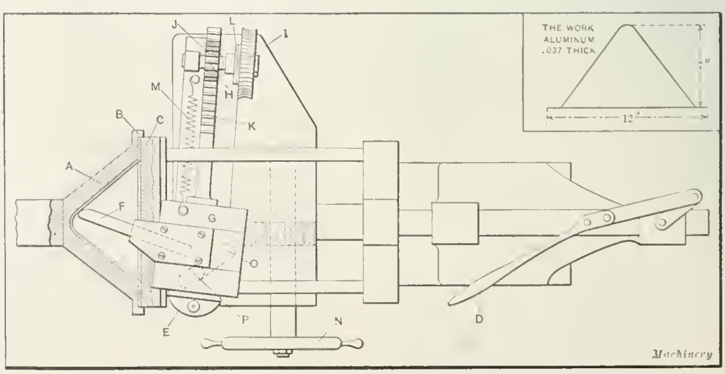


Fig. 14. Diagram illustrating Operation of Metal Spinning Machine

that causes the arm to swing *inward* toward the chuck, and thus tool *F* is made to follow approximately the line of the spinning form. It should be clear, however, that the operator, by moving the carriage faster or slower toward the chuck, can vary the angle of the path that tool *F* will describe.

After the blank has been placed in position, it is swabbed lightly with tallow, and the operator engages the clutch lever with his foot and causes tool *F* and carriage *G* to advance toward him. At the same time, he turns handwheel *N* and causes the arm to swing inward toward the chuck. It takes three passes of the spinning tool to complete the work satisfactorily. On the first pass he bears very lightly on the carriage handwheel so as to only spin the metal part way into the form. On the second pass, however, he advances the carriage more rapidly and causes the tool to carry the metal almost to the lines of the form. On the third pass he bears still harder on the carriage-operating handwheel and causes the tool *F* to crowd the metal into the form and completely form the shape.

The operator on this machine has become very adept in his work and produces six hundred of these lighting arrester cones in a ten-hour day, which is about five times the output that the best hand spinner could maintain.

Miscellaneous Flat Iron Machining Operations

In the manufacture of electric flat irons at the Pittsfield plant, there are several machining operations of special interest because of the thoroughness with which they are done, coupled with a high rate of production. The tops of flat iron bases are finished by milling on a Becker vertical milling machine as illustrated in Fig. 10. On the table of the machine is a continuously rotating fixture that holds fourteen castings. Each of the seven handwheels operates a wedge that enters between two castings and forces them forward against positive stops on the fixture. The milling is done by a large flat face mill that removes one-sixteenth inch of metal from the face of each casting. Although the fixture rotates continuously, it gives the operator time to remove and insert new castings without stopping the rotation of the table. This method of milling takes care of the facing of the top sides of these castings at the rate of two hundred per hour.

The facing of flat iron clamps is another operation that is done in an unusual manner. The leading illustration shows how this is done on a Conklin dry grinder. This machine is similar to a large disk grinder in principle, but employs solid blocks of emery for the abrasive. These blocks are closely fitted around a six-foot diameter disk and both sides of the disk are similarly fitted. The irons are held in magnetic chucks that are mounted on the work-tables. Levers are used for pressing the work against the grinding disk. The work-holding tables are automatically oscillated while the disk is in rotation. The amount of metal removed is just sufficient to clean up the casting, and two hundred finished pieces per hour is the production of each operator. One of the advantages of this machine is its high cutting capacity which is due to the large diameter of the disk.

Still another facing method that is used on flat iron castings is the operation of grinding on a Blanchard grinder. This is shown in Fig. 12, which represents the machine at work; the water guards have been removed for the sake of clearness. From ten to sixteen flat irons are placed upon the magnetic chuck and about one-thirty-second inch of metal is ground from the face of the castings, leaving the bottom perfectly smooth and true. One operator will face off eight hundred castings in ten hours. The wheel consumption is very low.

The sheet steel covers for flat iron clamps are made by drawing them up three-quarters inch deep in a heavy double-acting drawing press. After drawing, it is necessary to trim off the fin or excess metal around the edge. For this purpose the device shown in Fig. 13 has been made. A lathe has been utilized, upon the spindle of which is a special form of the same shape as the flat iron clamp over which the steel cover is to fit. The punching *A* is slipped over this form and held there by a similarly shaped block mounted on ball bearings on the tailstock. To the left of the form on the spindle is a hardened form *B* that acts as a guide for the shearing roll *C*, and through contact between form *B* and roll *C*, the cutting edge *D* of the roll is kept in the right relation to the left-hand face of the form over which the punching has been placed. Spring pressure at the rear of the cross-slide on which roll *C* is mounted insures the cutting being done properly. Lever *E* withdraws the cross-slide when the work is to be removed. With this device, the flanges of the punchings are quickly and cleanly trimmed.

* * *

FIXED CALIPER GAGES IN MANUFACTURING

The term "interchangeable manufacture" means that all parts are made alike within certain limits. The limits may vary, depending on the class of product and the accuracy required. The extension of the use of limit gages throughout the manufacturing field has produced some wonderful economies, but there is still much that can be done to standardize and improve manufacturing operations. A misconception exists as to the practical limitation of interchangeable manufacturing. It is not necessarily limited to parts made in large quantities, but may be profitably extended to include parts made in small numbers when all dimensions have been fixed.

Many manufacturers believe that limit gages are costly appliances, that they are short-lived and require extraordinary care. It is true that first-class measuring appliances are high priced, but it is not true that the maintenance of modern limit gages is expensive. As a matter of fact, an adjustable limit gage may be maintained at very low cost, and if properly designed its use is not limited to one particular piece. When a part becomes obsolete, the limit gages used in a shop for testing and inspecting may be readjusted for other parts, and so on indefinitely.

The fixed caliper system of gages was introduced in the United States by John Richards when he inaugurated his system in the plant of the present John M. Rogers Works, Gloucester City, N. J., in 1865. This gage system is built around the standard snap and standard plug gage, and the limit snap and limit plug gage. These are divided into three classes as follows: working gages for shop use, inspection gages for final checking, and control gages for testing and controlling all other gages.

Limit gages include two classes, termed tolerance gages and allowance gages. Tolerance gages provide for reasonable error in workmanship, while allowance gages take care of the necessary difference in the sizes of two pieces which have to go together to obtain the quality of fit wanted.

Allowance gages are again divided into four distinct classes, with reference to four distinct types of fits, *viz.*, running, push, driving and force fits. A running fit is that provided for a shaft which must turn easily in its bearing, the necessary allowance for which is dependent on the class of machine. A push fit is employed for parts that may be joined by hand but are not free to rotate. A driving fit is used for parts that must be driven into position with hand hammers or sledges, depending on the size and fit. Force fits are those that are assembled by hydraulic or mechanical presses. Force fits include shrink fits which are made with the same or slightly smaller allowance for assembling by heating the external part and shrinking it into place.

Allowances are nearly always made on the shaft, as it is far easier to vary the size of the shaft than the diameter of the hole. Therefore a standard diameter hole is the starting point in laying out a gaging system. The standard-hole system requires but one set of reamers and one set of internal cylindrical gages, in addition to the set of external limit gages for each kind of fit; whereas, should the standard-shaft system be used, each change of diameter would require a different set of internal cylindrical gages and reamers for the hole. —*Adapted from bulletin published by the John M. Rogers Works.*

* * *

During the year June, 1914 to June, 1915, about 600,000 automobiles were built in the United States, as compared with 445,000 during the preceding year. It is believed that the total production for 1916 will be about 900,000.

LATHE CHUCKS—2*

A REVIEW OF FACEPLATE AND COLLET WORK-HOLDERS

BY JOSEPH HORNER†

CHUCKS which do not resemble the faceplate in primitive outline constitute a very large class. Roughly speaking, they hold small diameters rather than large, and pieces long in proportion to their diameter. The old bell-chuck, Fig. 30, may be taken as typical of the principle, though it is clumsy and awkward to use, and the same result is secured in other ways more efficiently. The standard form of bell-chuck, shown with eight screws in the illustration, is still largely used in Europe. At times the screws are guarded by thickening the metal considerably and sinking the heads into the wall. This chuck is most useful when it is made especially to suit some piece of work that is awkward to hold in any other way. Fig. 31 shows a special bell-chuck with a bushing at the back, and other instances might be illustrated of long work outside the normal range of an ordinary jaw chuck being handled in a chuck of this type. The practice of using laterally adjustable screws for the purpose of tightening is also found in the special brass-finishers' "clambs," Fig. 32 and Fig. 34, to which suitable false jaws are screwed.

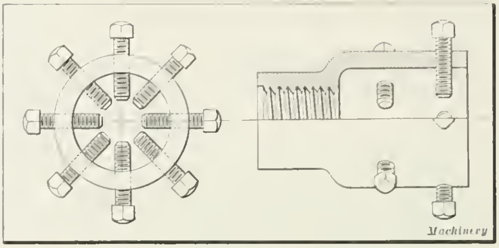


Fig. 30. Standard Design of Bell-chuck

Collet Type of Chuck

The most commonly used and convenient arrangement, however, for gripping pieces that are long in relation to their diameter is the collet type of chuck, employing jaws which are closed in by the action of a taper outside. There are two chief forms, one with loose "grips" or collet segments held by an annular collar, and the other of the spring type which opens of itself when released. A great many British turret lathes are provided with the first-named style, and require the use of a large wrench to tighten and loosen the cap which operates the grips. Sometimes a hand worm-gear drive is used instead, and the action can also be made automatic by means of gears from the headstock. In heavy lathes this becomes essential because of the amount of power required for tightening and releasing. The principle may be observed from Fig. 33, which shows the large collar nut fitting the spindle, the collar engaging with the grooves in the grips. The grips are comprised of a complete collet divided into three portions, so that when the nut is tightened the grips are forced inward and

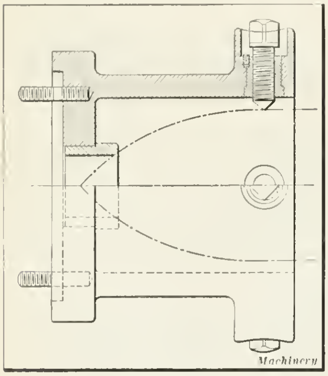


Fig. 31. Bell-chuck with Centering Bushing

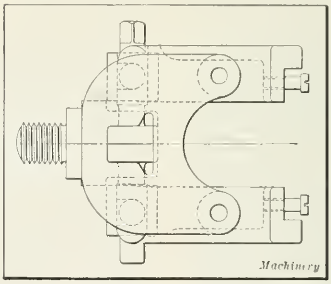


Fig. 32. Self-centering "Clamb"

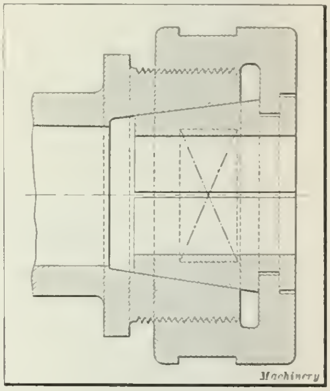


Fig. 33. Collet Chuck operated by Wrench

* The first installment of this article appeared in the March number.

† Address: 45 Sydney Bldgs., Bath, England.

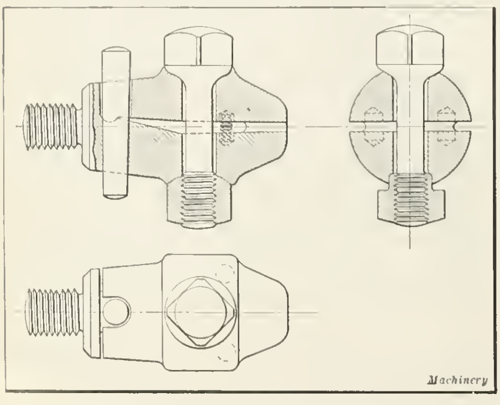


Fig. 34. Brass Finishers' "Clamb"

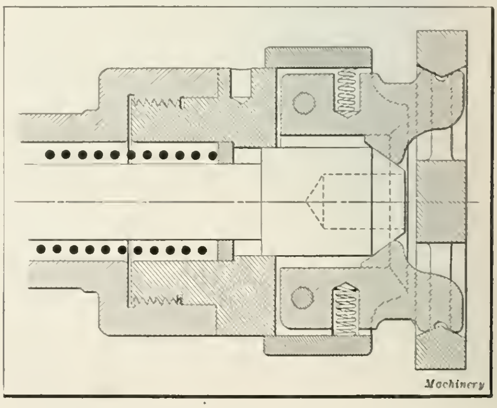


Fig. 35. Special Pivoted Jaws operated by Push-out Rod

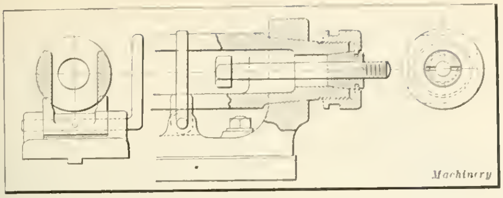


Fig. 36. An Open Spindle, affording Access to the Hand

closed around the bar. In some cases the bore is threaded to hold screwed pieces. Fig. 36 illustrates the "open spindle," having a space for the hand to reach in and push the bar forward, or to receive a head or other enlarged part of the work. The lever with stop blocks is thrown into action when the spindle has to be held immovably while the wrench is in use on the chuck nut. A set of grips with bores covering the desired range is furnished. When more rapid action is desired on a comparatively light chuck a sliding collar is arranged in place of the screwed

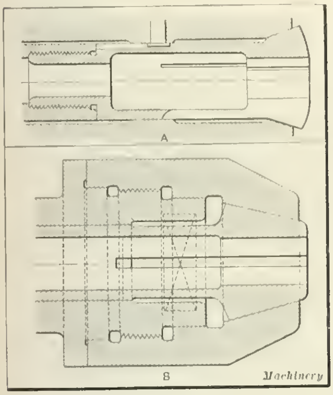


Fig. 37. Split-spring Type of Chuck

nut, and is slid by a lever forward or backward while the spindle is running.

The split chuck is the most popular device for gripping, of the class mentioned, and is fitted to bench lathes, various sizes of turret lathes, and to automatics. The precise mode of operation varies widely according to individual ideas, and in some degree to the size of the lathe. Thus in a watchmaker's or a bench lathe a movement by a handwheel is sufficient, so that the act of turning the wheel also rotates the tube and draws the chuck in by the action of the threaded tail as at *A*, Fig. 37. Tool-room lathes are also arranged to include a draw-in chuck, but in this case when the spindle nose is not bored specially, an adapter is required to act as a closer. Some turret lathes are preferably constructed with a plain bore spindle and an adapter nose screwed on, as shown at *B*, Fig. 37, which illustrates one of the "push-out" variety.

The methods of operation of the split chuck in turret lathes are so varied that it is out of the question to attempt to illustrate this section of the subject adequately. Generally speaking, however, they all depend on some modification of the Parkhurst method of action, comprising toggles opened by a

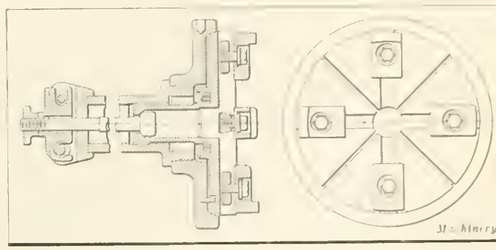


Fig. 41. Split Chuck of Faceplate Type

sliding collar, the toggles acting on the draw-in or push-out tube. The object of the sliding collar is to provide a mechanism that can be operated while the spindle is running, and the collar is slid longitudinally either by a hand-lever, or in automatics by a device operated by cams. Wire or bar-feed mechanisms also offer some complicated details, ranging from the simpler weight feed to the hand or power tube feed, and the more elaborated roller feeds.

The split chuck is capable of a wide range of capacities and capabilities when fitted with suitable liners, collets, or false jaws. These may hold unusual shapes, or sizes beyond the normal capacity of the lathe spindle. Larger hoods, for instance, supply the means of fitting an abnormal chuck, Fig. 38, to which are attached specially shaped liners. The capacity can be still further increased as in Fig. 42 by bringing the false jaws outside. The extreme in this direction is seen in the "stepped," "disk," or "wheel" chucks, Fig. 53, while a handy kind of modification, Fig. 41, combines the action of a split chuck with the jaws of a dog chuck, the jaws being adjustable for concentric or for irregular shapes.

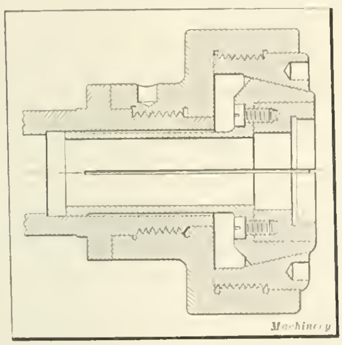


Fig. 38. Extra Capacity Hood and Collet with False Jaws

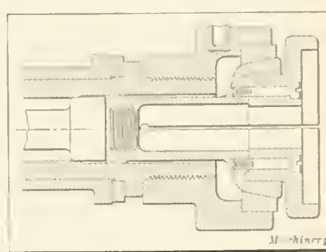


Fig. 42. Extra Large False Jaws in Collet

The inclusion of special fingers or jaws, as illustrated by the example Fig. 35, is another extensive method of providing for gripping special shapes by the outside or inside, the plunger of the chuck giving the required action for forcing the jaws against the piece. Simple studs or pegs furnish another means of holding work with openings, the studs entering the opening and being pressed laterally by the closing operation. The nose of a collet may be slotted to fit into openings in the work and act in a similar manner. It is not always necessary to exercise a gripping action on screwed objects, and the endwise movement of a plunger is often utilized (see Fig. 39) simply to lock work which has been screwed by hand into the adapter. An internally threaded piece is locked by a plunger, or push-out rod, entering it and forcing it outward to tighten the hold of the threads, as shown in the illustration Fig. 40.

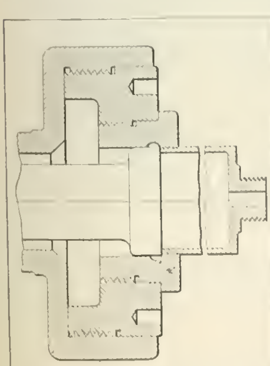


Fig. 39. Adapter Ring and Push-out Rod to hold Threaded Work

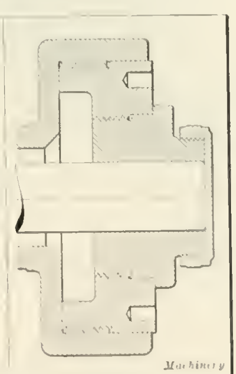


Fig. 40. Internally Threaded Work locked by Push-out Rod

Fig. 43. Reversible False Jaw with Stud

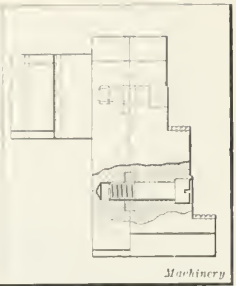


Fig. 44. Reversible Jaw with Dowel Washers

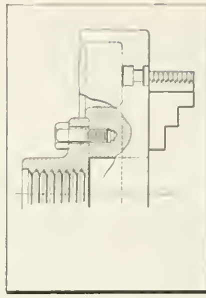


Fig. 45. Ordinary Way of fitting Chuck to Lathe Spindle with Adapter

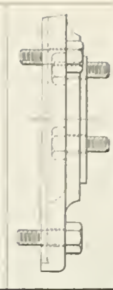


Fig. 46. Adapter to fit Small Chuck to Flanged Spindle

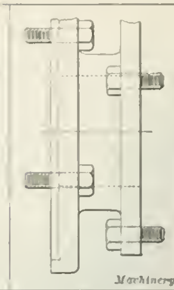


Fig. 47. Flanged Adapter for Flange Nose Spindle

Shapes of Chuck Jaws

Consider now some of the variations in form in which the regular chuck jaws occur. The three common shapes of standard jaws, Fig. 48, are well known, and serve for gripping work up to the largest capacity of the chuck by the outside and by the inside. The form without steps is used chiefly for rods and tubes, where its smooth back is safer. Blank jaws are simply rectangular in outline and are finished to shape according to the work to be held. A frequent practice is that of fitting a separate top or false jaw to a scroll toothed base, Fig. 49, so that it may be cut to outline, and when not wanted another top can be substituted in its place. Alternatively, a false top is screwed to the steps of an ordinary jaw, and cut to outline. The necessity for providing holding means for both inside and outside grips is solved in one of three ways: (1) a separate set of jaws is reserved for each function; (2) the same jaws are reversed in the chuck slots; and (3) separate tops or false jaws are fitted to non-reversible bases, and are turned end for end to reverse. The second practice is easy when the jaws can be run out at the ends (such as in Fig. 14 in the first installment of this article) and the steps are cut off suitably at the corners to adapt them for inside and outside contact. But if the screw and whole nut type of jaw is employed, this is not practical and the false jaw method must be adopted. The false jaw method shown in Fig. 43 is the Union Mfg. Co.'s device, held by a dowel and two screws. Fig. 44, which shows the Skinner chuck, is a variation of the above-mentioned practice, inasmuch as the thrust is received by washers entering half way in jaw and top. Another way is to dovetail the top into the base. Still another is to fit it over the ends of the base, screws being added in each instance. It is not practicable to reverse the jaw in a scroll chuck, because of the curvature of the teeth in the jaw. This can only be done in the special Sweetland jaw, which has lozenge-shaped teeth to fit the scroll either way. Otherwise a false jaw has to be fitted to it, one method being illustrated in Fig. 54—from Whiton practice—with dovetails and a screw. The screw is omitted in the light chucks, and the dovetail joint is sunk to a level below the chuck slot, so that the sides of the latter prevent lateral misplacement. In this case it is necessary to run the jaws out for reversing the tops.

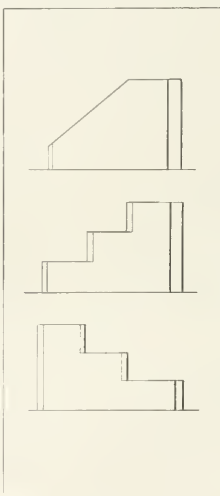


Fig. 48. Common Forms of Jaws

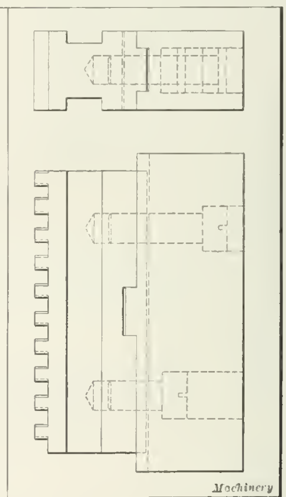


Fig. 49. Jaw with False Top

Jaws grooved or cut out to special forms to match parts of work are very common in the two-jaw or brass-finishers' variety of chuck. It is not necessary, easy or convenient to utilize three or four jaws for this service. The most that is done in three- or four-jaw chucks is to turn a recess on the inside or outside of the jaws to match the cross-section of the work, and to locate and grip it thereby. In the two jaws mentioned, much more is done and the cutting out may resemble a mold or a die, which is made to fit quite accurately the general outline of a small

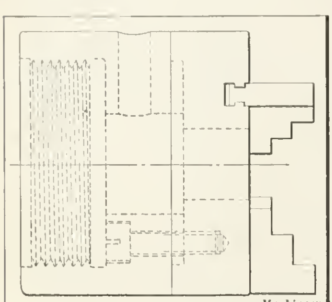


Fig. 50. Adapter for fitting Small Chuck to Large Spindle

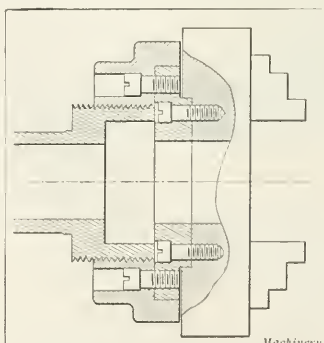


Fig. 51. Small Chuck fitted to Lathe Spindle with Special Adapter

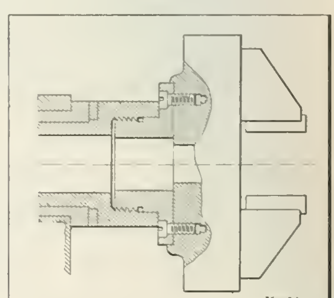


Fig. 52. Chuck with Adapter fitted to Inside of Spindle Nose

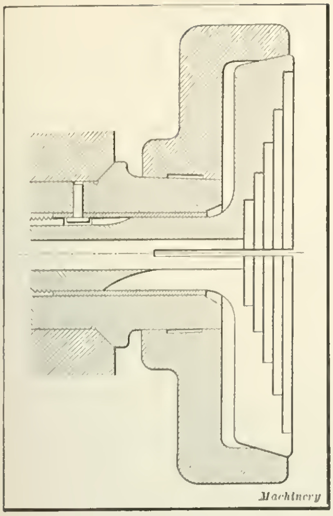


Fig. 53. Large "Wheel" Type of Chuck for holding Disks

casting, thereby holding it very securely. The recessing is done in loose slip jaws which are dovetailed to the real jaws. On the European continent, a chuck of novel design is quite extensively used. It is virtually a two-jaw chuck, but on each jaw is mounted a disk or turret, on the peripheries of which are cut suitable recesses to hold from five to seven different shaped pieces. To grip a different shaped piece, it is only necessary to revolve the disks till the corresponding recesses are opposite one another. This saves set-up time by comparison with the single-purpose slip jaws. Apart from these special two-jaw chucks the normal number of jaws on chucks is three or four (drill chucks excepted). Three jaws should give perfect results theoretically, but actually they do not afford the same power of grip that four do, neither do they get the same general average of the roundness of a slightly irregular piece. On the other hand, a universal chuck with four jaws may not give its full advantage if the work is slightly out of round, because two opposite jaws will do most or all of the work. This is not the case with an independent chuck, since the jaws are all set against the work separately and an equal pressure is insured. An uncommon style of chuck may be mentioned. It is of the regular three-jaw design except that an extra jaw is inserted diametrically opposite one of the other jaws. In this way it may be converted into a two-jaw chuck for work that is suitable. When this is in use, the two flanking jaws are of course unoccupied. More than four jaws are fitted to chucks chiefly when it is desired to get the truest average of a slightly irregular object, and to hold it with the greatest security. Some car-wheel chucks are so provided.

Attachment of Chucks

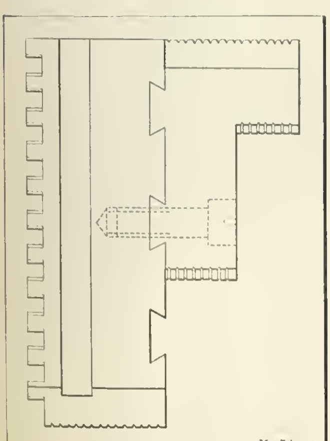


Fig. 54. Dovetailed Reversible Jaw

There is much variety in the methods of fitting chucks to lathe spindles, depending on the type and size. The standard method is to fit a back-plate or adapter threaded to match the spindle nose, and unite this to the chuck with screws or bolts. The recess in the back of the chuck, see Fig. 45, affords accurate centering. To avoid the undue overhang of a heavy chuck, the plate may be reversed, with its boss projecting into the chuck bore. On a large flange nose spindle, an adapter of the kind shown in Fig. 47 is often used, or if the chuck is small the adapter is modified as in Fig. 46. Fig. 50 represents a special adapter for mounting a small chuck on a large spindle, an occasional requirement when large hollow spindle lathes are used. Figs. 51 and 52 are alternative methods of mounting chucks with adapters, that shown in Fig. 52 being screwed inside the spindle nose, which ordinarily is employed for a split chuck.

Direct attachment of chucks, that is, without the intervention of an adapter, is done chiefly in the case of the common jaw chucks. Direct fitting is, of course, done in the case of the small chucks which are screwed over or into the spindle nose, but these are mostly of small capacity. A taper arbor is used for small rod chucks and drill chucks.

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DANGEROUS WAR BUSINESS

Many will make fortunes in the manufacture and sale of war munitions, and many will lose money as a result of undertaking to manufacture products with which they are unfamiliar or owing to conditions over which they have no control. The following extract from a circular letter that was recently sent to the creditors of a company reveals a situation that probably has many parallels:

We regret to be obliged to ask our creditors for a general extension of time for the payment of our accounts.

In explanation we would say that in September, 1915, we entered into a contract for machining 250,000 shrapnel shells to be done at the rate of 1000 to 1200 per day, beginning on the first day of November, 1915. We immediately changed our machines so as to enable us to do the work, but in this work we were at first delayed by the failure of the owners of the work to furnish correct gages and standards, and we were further delayed later by changes made in the specifications and by the failure of the inspectors of the work to arrive and make examinations of the work which had been done, until in the month of January, 1916, a new change was agreed upon in the specifications, not contemplated at the time of the making of the original contract, which necessitated the procurement of six grinding machines. Owing to the present conditions and congestion of orders in the machine making factories, it was found impossible to obtain deliveries of these machines until late in the summer; and owing to these conditions we made arrangements with the owners of the work to furnish us the necessary grinding machines which they have agreed to make and deliver.

Meanwhile with no income we have exhausted our resources and are at the present time shut down. We are assured by experts that we have a good contract and one which if carried to completion would not only pay all our indebtedness but leave a substantial profit for our stockholders. The quality of our product thus far has shown that we are able to do the work satisfactorily and below the figures we estimated when the contract was entered into. All that we need is the time to swing ourselves.

• • •

PECULIARITIES IN MACHINE DESIGN

A study of mechanisms used in machine tools and other machinery often perplexes the mechanical expert somewhat. He is at a loss to know why the designer has used a means for accomplishing a certain action when other simpler and better means were apparently available. The investigator might conclude that the designer was ignorant or foolishly preferred a complicated means rather than the simpler device.

This conclusion seldom would be borne out by fact; the real reason generally lies in the patent office. A design for performing a certain function has been patented and proved to be successful. Competitors have been obliged to get around the patent by resorting to the use of various clumsy and inefficient alternative mechanisms. Years after the patents have expired, the clumsy inefficient mechanisms may remain in use. The concerns interested have invested thousands of dollars in patterns, jigs, tools and fixtures, and rather than sacrifice this investment, they prefer to go on year after year making machines with inefficient features. This condition in machine design is somewhat similar to that with which humanity is afflicted due to the vestigial organ known as the vermiform appendix. Its original function is no longer apparent but it still remains to plague us.

UNUSUAL CYLINDRICAL GRINDING JOB

An unusual grinding job is the finishing of one edge of the steel adding machine part (shown about half size in Fig. 1) on the cylindrical grinder. Practically all work done on a cylindrical grinder is rotated through three hundred and sixty degrees, but this job rotates through only ninety degrees.

The work may be clearly seen in Fig. 2, in the simple holding fixture that goes on the centers of the machine. The corner of this piece is rough-milled before hardening. It

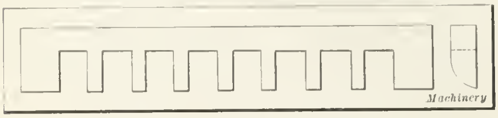

Fig. 1. Adding Machine Part

will be noticed that the surface to be finished is divided into ten sections; this provides a means for clamping the piece on the fixture by dogs that grip the sides of the slots. A bracket is clamped on the front face of the machine in the same way that the steadyrests are attached. This bracket carries a wheel which receives rotation from an overhead drum through the driving belt shown. From the right-hand face of the wheel, there extends a crankshaft that reaches down to the fixture mounted on the centers of the machine. The belt that transmits rotation to work held on centers for ordinary grinding is removed. When the shaft carrying the crank-plate is rotated, it is apparent that an oscillating motion will be given to the fixture on the centers. By lengthening or shortening the throw of the crank, any desired arc of traverse may be obtained. In operation, the machine is started and the work traversed by the wheel in the ordinary way; the fixture, meantime, instead

Fig. 2. Grinding Corner of Piece on Cylindrical Grinding Machine

of making a full revolution, simply makes a quarter revolution and returns. By this method the corner surface is ground true and to a better finish than could be obtained in any other way.

C.L.L.

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BRAZILIAN COMMERCIAL COMMISSION

Plans are being made in Brazil for the organization of a commercial commission which will visit the United States with the threefold purpose of: first, calling attention of capitalists in the United States to opportunities for investment in public utilities and manufacturing establishments in Brazil; second, increasing the exports from the United States to Brazil by showing what Brazil wants in machinery, textiles and other manufactured articles and by explaining Brazilian requirements in the matter of banking, exchange, customs regulations and transportation; and third, increasing the imports of Brazilian products into the United States.

CASEHARDENING AND CASEHARDENING COMPOUNDS

Casehardening is a carburizing process by which the carbon content of a thin shell or case of iron and low-carbon steel parts is increased so that when heated to a temperature of 1475 degrees F. (800 degrees C.) or higher they will harden when dipped in a cooling bath. Casehardening may be done in a variety of ways, the simplest and quickest being by the use of cyanide of potassium. The cyanide is heated in a pot to the hardening temperature of steel and the parts to be casehardened are immersed until thoroughly heated and are then dipped into a cold water bath as usual. Or the cyanide may be applied to the part to be hardened with tongs while the piece is heated to a low red temperature. After the cyanide has been applied all over, the work is reheated to the hardening temperature and dipped. But cyanide hardening is suitable only for work requiring a thin case— 0.002 inch or less. For a thick case, it is customary to pack the parts in a cast-iron box filled with granulated bone, burnt leather scraps or commercial compounds prepared for the purpose. The box is covered with a tight-fitting lid, sealed to exclude the air, and is heated in a furnace for several hours, depending on the size of the box and depth of case desired. When the required time has elapsed, the box is removed and the contents dumped into a bath. This practice, however, is not the best. Preferably, the box and contents should be allowed to cool down, after which the work is removed, reheated to the hardening temperature, and quenched on a "rising heat." Practice recommended is reheating to about 1650 degrees F., and quenching in warm oil or warm water. The temperature depends on the carbon content of the steel, however. Steel generally used for casehardening contains 0.25 per cent or less carbon and requires a temperature of 1650 degrees F. to toughen the core, which is the object of the first heat. If the carbon content is from 0.15 to 0.20 per cent higher, the reheating temperature should be from 75 to 100 degrees lower. The work should then be reheated to about 1425 degrees F. and quenched in cold water. Large pieces should be heated to a temperature of 25 to 50 degrees higher, but rarely more.

Besides the casehardening materials mentioned, a number of compounds have been placed on the market for which advantages are claimed in the way of cheapness, convenience in use, and depth of case with resulting toughness. It is important to remember, however, when using any casehardening compound that proper heat-treatment is necessary in order to secure satisfactory results. In the following list, are given the names of the commercial compounds for casehardening that have distinctive trade names.

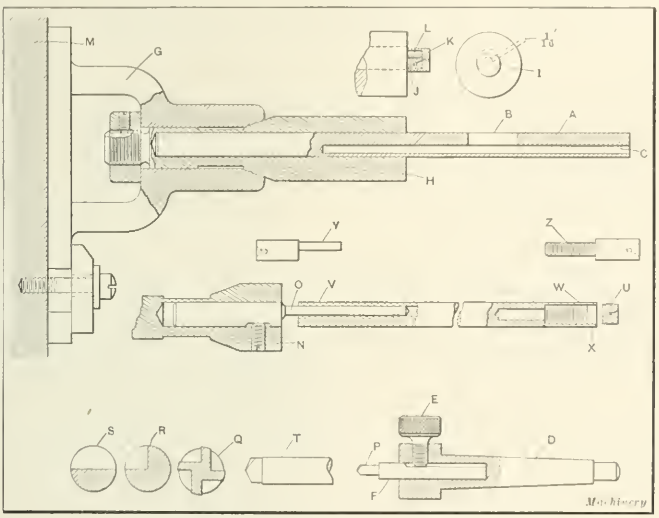
Name	Manufacturer
Achilles	E. F. Houghton & Co., Philadelphia, Pa.
Acme	European Color & Chemical Co., New York City.
Ajax	Montgomery Chemical Works, Inc., Baltimore, Md.
Atlas	European Color & Chemical Co., New York City.
Black Diamond	Rogers & Hubbard Co., Middletown, Conn.
Blaich	Alfred O. Blaich Co., Chicago, Ill.
Bohnite	Case Hardening Service Co., Cleveland, Ohio.
Bull Dog	Rodman Chemical Co., E. Pittsburg, Pa.
Carbo	Rodman Chemical Co., E. Pittsburg, Pa.
Case-Hardo	Thos. Buchanan Co., Cincinnati, Ohio.
Excelsior	European Color & Chemical Co., New York City.
Ferro Case	C. G. Buchanan Chemical Co., Cincinnati, Ohio.
German	European Color & Chemical Co., New York City.
Hardenite	Montgomery Chemical Works, Inc., Baltimore, Md.
Hi-Carbon	Bell & Gossett Co., Chicago, Ill.
Houghton	E. F. Houghton & Co., Philadelphia, Pa.
Hubbard	Rogers & Hubbard Co., Middletown, Conn.
Hydro Carbonated Bone-black	E. F. Houghton & Co., Philadelphia, Pa.
Ideal	Ideal Casehardening Compound Co., New York City
Kasenit	Kasenit Co., New York City.
Keystone	Rodman Chemical Co., E. Pittsburg, Pa.
Laffitte	Phillips-Laffitte Co., Philadelphia, Pa.
Monitor	European Color & Chemical Co., New York City.
Pearlite	E. F. Houghton & Co., Philadelphia, Pa.
Portland	Rogers & Hubbard Co., Middletown, Conn.
Pothard	Carl Nehls Alloys Co., Detroit, Mich.
Standard	Rogers & Hubbard Co., Middletown, Conn.
Sterlingworth	Sterlingworth Charcoal Co., Cambridge, Mass.
Tri B. Pack Comp.	C. G. Buchanan Chemical Co., Cincinnati, Ohio.
Vulcan	Montgomery Chemical Works, Inc., Baltimore, Md.
Woodside	Park Chemical Co., Detroit, Mich.

MACHINING RIFLING BARS ON THE BENCH LATHE*

BY A. H. CLEAVES†

It is the purpose of this article to describe the work of machining rifling bars on the bench lathe. The bars were made of steel and the work involved deep-hole drilling, and eccentric turning and grinding operations. It is not claimed that these bars could not have been machined in some better way, but it happened that the only equipment available at the time was three bench lathes, and the results obtained with these machines were very satisfactory. It is hoped that the following description may prove of value to readers of MACHINERY in suggesting ideas for handling bench lathe work where similar operations have to be performed. In the accompanying illustration the rifling bar is shown at *A*; the cutter is inserted in this bar at *B* and provision is made for adjusting the radial position of the cutter by means of a rod which has a tapered side that engages the bottom of the cutter. This rod is carried in the hole *C* in the rifling bar, which is 4⅞ inches deep by ⅛ inch in diameter. The finished size of the bar is 0.300 inch in diameter, and the hole *C* is 1/16 off center. It is the purpose to describe a fixture designed for drilling this eccentric hole, the work of drilling the hole, and the way in which the final turning and grinding operations were performed to bring the outside of the bar parallel with the hole and still maintain exactly the required eccentricity.

As previously stated, three bench lathes were available for use in machining the rifling bars *A*. Before starting work, these machines were carefully tested and it was found that the beds were comparatively straight, but that the tailstocks were approximately 1/64 inch out of alignment with the headstocks. The following expedient was adopted to correct this inaccuracy. Chucks *D* were made with tapered shanks to fit the tailstocks, and these chucks were provided with thumbscrews *E* to hold the tools. The chucks were next mounted in the tailstocks of the respective bench lathes on which they were to be used and marked in one position, and the holes were drilled and reamed to receive the sockets *F* by means of tools held in the headstock chuck. Brass sockets *F* were next made for each of the drills and reamers that were to be used in drilling the holes *C* in the rifling bars.



Tools used for drilling, turning and grinding Rifling Bar on Bench Lathe. Tools Q, R, S, and T are shown to an Enlarged Scale

The fixture for holding the bar while drilling the hole *C* is shown at *G* in the accompanying illustration; and in passing it may be mentioned that the same type of fixture may be used to advantage on the various classes of lathe, drill press and milling machine work. In the present case the fixture was also used for holding the chuck *H* in the proper position to drill the eccentric hole to receive the rifling bar *A*. The method of locating the chuck in the fixture preparatory to drilling the hole was as follows. The required eccentricity is 1/16 inch as indicated in the end view *I* of the chuck. To provide for obtaining this eccentricity, a projection *J*, 3/16 inch in diameter, was turned on the end of the chuck body while the latter was held on centers so that it was concentric with the lathe spindle. A cap or shell *K* was next made of such a size that the difference between the inside of the cap and the diameter of the projection *J* on the chuck was ⅛ inch; *i. e.*, twice the required eccentricity. After this cap had been made, a plug *L* was turned up to a diameter of exactly ⅛ inch and the cap *K* was then forced over the projection *J* and plug *L*, as shown in the illustration. The fixture *G* was next mounted on the faceplate *M* of the lathe and its position adjusted until the center of the cap *K* coincided with the center of the lathe spindle, as proved by indication on the center of the cap. The chuck *H* was then drilled and reamed to receive the rifling bars *A* which were held in place in the chuck by means of two setscrews that are not shown in the illustration. After the chuck *H* had been completed, the next step was to make a second chuck *N* without altering the setting of the fixture on the faceplate. After this chuck had been finished, an eccentric mandrel *O* was turned up and hardened, after which it was remounted in the chuck *N* and ground to insure accuracy.

The hole *C* was started with a short flat drill *P* which was followed by a twist drill that worked to a depth of 1 inch, after which a boring tool was used for machining the hole to a depth of ¾ inch. A four-lipped reamer *Q* was next employed to finish the hole to the depth reached by the first twist drill. The accuracy obtained with these preliminary operations was highly important because any error introduced up to this point would influence the accuracy of the entire job. In connection with the machining of deep holes of small diameter, it may be mentioned that the writer has never obtained satisfactory results with the so-called "cannon" drills of the form shown at *R* or half reamers of the form shown at *S*. The corners on tools of these types are too easily dulled and too much resistance is offered to the clearance of the chips from the holes. But the reamer *Q* gave very satisfactory results; the ends of the lips of this tool are not rounded and they are backed off on the top just enough to give a free cutting action. A tool of this type is easily "stoned" on the ends of the lips to keep it in good working condition. The writer is prepared to recommend this type of tool for use in reaming deep holes of small diameters. After the hole had been finished to a depth of 1 inch, special No. 31 twist drills 1¾, 2½ and 6 inches in length were used to complete the drilling of the holes to the required depth. These tools were used in conjunction with reamers of full length. If an exceptionally smooth finish had been required, a second reamer would have been used in connection with each drill and the lips of this second reamer would have been rounded.

The tool *T* is one of the most important of those used for drilling the holes. It will be seen that the body of this tool is slightly larger than the cutting point; this body fits closely into the reamed hole and is of sufficient length to re-

* For other articles on bench lathe work and allied subjects published in MACHINERY, see "The Bench Lathe and Its Uses," February, 1912; "Taper Turning on the Bench Lathe," October, 1910; "Accurate Gage Work on the Bench Lathe," May, 1910; and "Jig and Die Work on the Bench Lathe," November, 1909.

† Address: Princes Bay, N. Y.

align the other drills for a depth of 3 or 4 inches. Each of the No. 31 twist drills works to a depth of about 1 inch, and between successive operations of the twist drills the drill *T* was used to maintain the alignment of the hole by re-centering. From three-quarters to one hour was required for drilling hole *C* in each of the rifling bars, and the writer drilled and reamed over ninety of these holes without breaking or choking a drill. The accuracy was sufficient to allow a piece of drill rod 0.0015 inch under size to drop to the bottom of the hole through the force of gravity. Two reamers were broken in reaming the ninety holes referred to, and the cause of this was that the tools were inadvertently started to work under conditions of speed and pressure suitable for the drills, which were too severe for the reamers.

After completing the drilling of the holes in all of the rifling bars, the next step was to finish the outside of the bars to the required diameter; and in performing this operation, precautions had to be observed to insure having exactly the required eccentricity for the hole and also to have the hole parallel with the outside of the bar. For this purpose the chuck *N* was mounted in the fixture—with the position of the fixture on the lathe faceplate unchanged—and the mandrel *O* was mounted in the chuck so as to insure replacing in the same position, but in use, of course, it was placed in the lathe itself. The mandrel is of such a size that it is a wringing fit in the hole *C*, and in preparing to machine the outside of the rifling bars the first step was to mount one of the bars on the mandrel as shown in the illustration. It will be noted that the position of the rifling bar on the eccentric mandrel is reversed in the lathe, with the result that the axis of the bar is brought concentric with the axis of the lathe spindle. When the position of the work had been adjusted so that the outside of the bar ran approximately true, the bar was soldered to the mandrel, after which a centering button *U* was brought near the opposite end of the rifling bar *A* by means of the tail-center. This center was then "sweated" onto the end of the rifling bar. In securing the center in place, great care had to be taken to avoid deflecting the rifling bar, and after it had been soldered in place, the work had to be tested to see that such deflection had not occurred. This was easily determined by backing the tailstock away from the work and rotating the lathe spindle with the outer end of the work free. Under these conditions any disturbance in the alignment of the work can be readily detected.

The next step was to turn the outside of the rifling bar at *V* and *W* to a diameter of 5/16 inch to form bearings for steadyrests. After this had been done, the work was released from the center *U* and mandrel *O* by melting the solder; it was then mounted in a spring chuck and supported by a center at the opposite end, after which the entire outside of the bar was turned to a diameter of 5/16 inch. The next step was to drill and tap the hole *X*, and for this purpose special taps were employed. These were made with an enlarged section between the tap and the straight shank which entered the opening in the collet *D*. The tap was turned by a pin entering holes in the large central part of the tap, the work being held in a chuck and further secured by means of a dog. After finishing the machining of the tapped hole *X*, the plugs *Y* and *Z* were introduced into opposite ends of the rifling bar and carefully centered while the bar was supported in steadyrests on the bearings machined at *V* and *W*. It will, of course, be evident that plug *Y* was soldered to secure it in the desired position. The work was then set up on centers on the grinding machine and ground while soft to a diameter of 0.306 inch, after which it was hardened, straightened and finish-ground to the required diameter of 0.300 inch.

* * *

Holes in castings should be located at a certain minimum distance from the edge of the casting. A drilled bolt hole should be located at least one anu one-fourth diameter from the edge of the casting; a cored bolt hole, one and one-half diameter; a drilled rivet hole, one and three-fourths diameter; and a cored rivet hole, two diameters from the edge of the casting.

MORE LIGHT ON THE SELECTION OF A TRADE

BY E. H. FISH*

The choice of an occupation on the part of a boy is a question which has been given deep consideration. The choice depends usually very largely on circumstances. Most boys are thrown or jump into an industry with no consideration whatever as to the consequence. The result is that most of us are trying to rub off enough corners so that we can sit in a round hole without sore elbows. The people who are interesting themselves in vocational guidance are divided into two camps, *i. e.*, those expecting to apply some psychological test to pick out boys who will grow up to fit the proper niches in the hall of fame, and those hoping to present the attractions and objections to the various vocations in such light that boys, and girls too, will make an intelligent selection of their own accord.

I am a little inclined to look askance at any scheme whereby something short of actual work will give a boy a real insight into any industry. A boy may be told all about the machine industry and still be wildly anxious to take up electricity, not realizing in spite of all that may be said to him, that the greater part of electrical work is machine work. The pity is that so many start toward such a goal with every intention of making good, only to find in a few years that the best there is for them is a wireman's job and no promotion. To my mind the safest and most easily carried out plan, though probably the most expensive, is for the boy to be tried out on the job. Then he actually gets his hands on something even if it is nothing more than a live wire, that sets him to thinking; if he is where he can be gently backed into another job if he does not fit the first, there is always a hope that the right one will be found. Of course there are many boys who have such strong tastes that their niche in the world seems to have been prepared for them, but such boys do not enter into the problem we are discussing.

It was with a view to setting forth some of the fundamentals of the most practiced skilled trades that I worked out the accompanying chart, the trades cited thereon covering about 75 per cent of the skilled industries. I have omitted the women's trades, the textile industries and iron and steel manufacture, on the ground that so small a proportion of the workers in those industries need be skilled, that even if a few are very highly skilled, the industry as a whole should not come under that classification. The percentage which all the workers in each industry are of all workers in all of the skilled industries is shown in the second column. Too much reliance should not be placed on these figures, however, as they were taken from Table I of the 1910 Census, which does not appear to agree very faithfully with any of the other tables. I have then picked out the fundamental operations of each of the trades and grouped them under the heads of forging, molding, cutting, fastening, assembling, measuring, etc.

There is more of a resemblance in these fundamental operations than might be suspected at first thought. Out of all these trades the painter is the only man who has no bending to do, that is to his materials. He has to bend himself enough to make up. In fact the painter is practically in a class by himself, and his is the only one of the trades which includes very distinct processes. The molder and the painter are the only ones who have little or no use for a knowledge of the principles of cutting metal or wood, and the painter's method of assembling his wares, or of painting, is entirely his own. Almost the only place where the painter uses the methods of the other trades is in measuring for his layouts for interior decorating, and even there he is more apt to halve a space on a wall by doubling a string than by means of arithmetic. The printer is specially favored by a system of measurement which is chiefly a matter of mental arithmetic, his system of interchangeable type being a measuring system in itself. The blacksmith also has a freak process, that of welding under

* Supervisor of Education Department, Norton Co. and Norton Grinding Co., Worcester, Mass.

TABLE SHOWING PERCENTAGE OF SKILLED WORKERS EMPLOYED IN EACH TRADE AND THE CLASSES OF WORK THEY DO

Trade	Per Cent	Molding, Bending, Drawing and Forging, Malleable or Plastic Material	Cutting	Fastening and Assembling	Measuring
Blacksmith	4.0	Bending, Forming by Pressure and Blows, Welding	Hot and Cold Chiseling, Drilling, Filing, Punching, Shearing, Bolt Cutting	Bolting, Riveting, Welding	Crude—Limits about 0.1 Inch
Boilermaker	0.7	Bending, Riveting, Flanging, Staking and Scarfing	Cold Chiseling, Punching, Shearing, Drilling and Reaming	Bolting, Riveting	Crude—Limits about 0.1 Inch
Mason Stone Cutter Plasterer, etc.	4.7	Modeling Artificial Stone, Plaster Cornices, etc.	Brick and Stone Cutting	Cementing, Bricklaying, Stone Setting	Very Varied in Different Parts of Trade
Cabinet Maker	2.7	Bending Wood, Veneering Curved Forms	Chiseling, Turning, Planing (by hand or with revolving cutter), Sawing, Drilling	Gluing, Nailing, Screwing, Bolting, Joining	Fair—Limits, 0.01 Inch or Closer
Carpenter	30.3	Bending Wood (Usually Cold)	Same as Cabinet Maker but with a Larger Proportion of Hand Work	Same as Cabinet Maker	Framer's Limits—1 to 2 Inches
Printer	3.9	Embossing Press Work	Cutting Borders, Electros, Cutting and Scoring Paper, Cards, etc.	Type Setting, Stone Work, Make Ready.	A System of Interchangeable Units
Machinist	17.3	Bending, Drawing	Turning, Planing, Milling, Drilling, Grinding, Punching, Shearing (cold)	Bolting, Riveting, Thread Fitting	From 0.00025 to 0.002 Inch Limit
Molder	2.0	Shaping Dry and Green Sand, Loam, etc.	Practically None	Ramming Sand, Setting Cores, Chaplets, etc., Wedging Flasks	Usually Very Crude
Painter	5.7	Practically None	Practically None	Brush Work	Limit 0.1 Inch When Laying Out Decorative Work
Plumber and Steam Fitter	2.4	Bending Pipe, Wiping Joints, etc.	Cutting Threads, Pipe, etc.	Soldering, Screwing together of Parts	Very Crude
Sheet Metal Worker.	1.0	Forming, Bending, Cornice, Pipe, etc.	Shearing, Punching, Drilling, Filing, etc.	Bolting, Riveting, Soldering, Spot Welding, etc.	Fair—Limits 0.05 Inch or Closer
Patternmaker	0.4	Bending Wood—Occasionally	Same as Cabinet Maker, but on Soft Woods	Same as Cabinet Maker	Limits 0.01 Inch Plus Considerable Judgment as to Finish and Shrinkage

Machinery

the hammer, though he is not nearly so much in evidence in that work as he was once. Today his heat-treatment processes bid fair to bring him into prominence in a very different way from the men of our fathers' generation.

Other than these idiosyncracies, there is a remarkable unity of processes in the trades. The fundamental principles of molding and forging, cutting, fastening and measuring may be taught with almost entire assurance that they can be carried over from one trade to another. That is, a boy could be given quite varied work at any or all of these trades with the assurance that when, after a year or two of learning to work, he took up with any one of the trades, he would not feel the loss of time. For example, take a very favorite occupation, that of tinkering on an automobile. The boy who has had experience in bolting parts together, taking the necessary measurements for repairs, machining the necessary repair parts, making the patterns for them, bending irons to fit into place, and soldering up the leaks in the tanks, would find that he had been simply getting experience in the fundamentals of any one of the trades that he might take up, except possibly those of painting and printing.

If some serious attempt were made in our schools to teach boys these fundamental processes, not on a play scale but on a real working scale, they would come out vastly better able to make an intelligent choice of a future trade, and much more likely to take hold of it with some degree of intelligence, than the present-day manual training graduate does. The manual training men may be able to show that all the things that they teach have a place in their courses, but it should be realized that there is a tremendous gap between making a thing for the fun of it, and making it to meet the test of the market. The fundamental processes lose all relation to the industries unless they are carried out in a professional manner. The fact that boys of a very tender age can be taught to do work well is something that is already demonstrated. They cannot expect to be mature, and we would not wish them to lose their youth, but they are just at the stage of life when they can imitate good work as well as poor. The unfortunate thing is that in our schools the boys have too great an opportunity to imitate poor work.

* * *

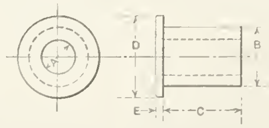
The Ford Motor Co. keeps a check on each department with regard to the number of accidents that occur, and the foreman's ability is judged, to a large extent, by the way in which he maintains a good record in this respect. It is held by the company that the foreman in whose department the work is constantly interrupted by accidents is not the best kind of foreman. The men in charge of departments are, therefore, requested to make sure that every man employed by them understands the work he has to do, and they are expected to be severe with men who are caught doing work in a careless or dangerous way.

JIG BUSHINGS*

STANDARDIZED JIG BUSHINGS AND BUTTONS USED BY GENERAL ELECTRIC CO.

BY R. F. POHLE†

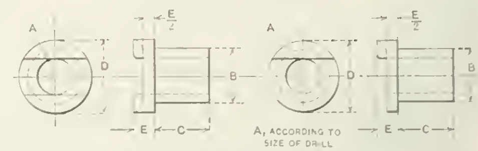
TABLE I. FLANGED BUSHINGS



Size of Drill used for A	B	C	D	E
No. 80 to No. 60	0.126	7/32 to 15/32	7/32	1/16
No. 59 to No. 30	0.251	13/32 to 29/32	3/8	1/16
No. 29 to No. 9	0.376	17/32 to 1 1/32	1/2	3/32
No. 8 to 5/16	0.501	21/32 to 1 13/32	11/16	1/8
21/64 to 7/16	0.626	23/32 to 1 15/32	7/8	1/8
29/64 to 9/16	0.8135	25/32 to 1 17/32	1 1/16	1/8
37/64 to 3/4	1.0015	27/32 to 1 27/32	1 1/4	1/8
49/64 to 7/8	1.1265	27/32 to 1 27/32	1 3/8	5/32
57/64 to 1	1.314	27/32 to 1 27/32	1 9/16	5/32
1 1/64 to 1 1/8	1.439	1 3/32 to 1 27/32	1 11/16	3/16
1 9/64 to 1 1/4	1.564	1 3/32 to 1 27/32	1 13/16	3/16
1 17/64 to 1 3/8	1.689	1 3/32 to 1 27/32	1 15/16	3/16
1 25/64 to 1 1/2	1.814	1 3/32 to 1 27/32	2 1/16	3/16
1 33/64 to 1 5/8	1.939	1 11/32 to 2 3/32	2 3/16	3/16
1 41/64 to 1 3/4	2.127	1 11/32 to 2 3/32	2 3/8	1/4
1 49/64 to 1 7/8	2.252	1 11/32 to 2 3/32	2 1/2	1/4
1 57/64 to 2	2.377	1 11/32 to 2 3/32	2 5/8	1/4
2 1/64 to 2 1/8	2.502	1 11/32 to 2 3/32	2 3/4	1/4

Machinery

TABLE II. MILLED SEAT BUSHINGS



B	C	D	E
0.376	17/32 to 1 1/32	1/2	1/8
0.501	21/32 to 1 13/32	11/16	5/32
0.626	23/32 to 1 15/32	7/8	3/16
0.8135	25/32 to 1 17/32	1 1/16	3/16
1.0015	27/32 to 1 27/32	1 1/4	3/16
1.1265	27/32 to 1 27/32	1 7/16	1/4
1.314	27/32 to 1 27/32	1 11/16	9/32
1.439	1 3/32 to 1 27/32	1 7/8	9/16
1.564	1 3/32 to 1 27/32	2	5/16
1.689	1 3/32 to 1 27/32	2 1/8	5/16
1.814	1 3/32 to 1 27/32	2 3/8	11/32
1.939	1 11/32 to 2 3/32	2 5/8	11/32
2.127	1 11/32 to 2 3/32	2 3/4	11/32
2.252	1 11/32 to 2 3/32	3	3/8
2.377	1 11/32 to 2 3/32	3 1/8	3/8
2.502	1 11/32 to 2 3/32	3 1/4	7/16

Machinery

WHEN accurate work is necessary, the bushings should support the cutting tool to within one diameter of the tool from the work. If a 5/16-inch drill is used, the end of the bushing should not be more than 5/16 inch from the work, and it may be carried to within 1/8 inch of the work. Bushings should never be brought up too close to the work with the object of carrying the chips up through the bushing. It is much better to provide other means in the jig for the removal of the chips.

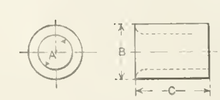
The headed or flanged bushing, Table I, is preferred by many tool designers as a lining bushing, whenever it is possible to utilize it. The flange prevents the bushing from being forced through the hole under the action of the cutting tool. If it is desired to have the head of the bushing flush with the surface of the jig, this can be accomplished by counterboring the jig sufficiently to lower the head below the surface. Headless bushings, Table III, should only be used when the wall of the jig is so thin that it will not allow of counterboring. A special type of flanged bushings is also used as seats for supporting rough work requiring a three-point bearing. In this case they are milled as shown in Table II.

Slip bushings, Table IV, are employed when several operations are to be performed through the same lining bushing. For example, when it is desired to drill and ream a hole and to finish a boss or spot around the hole while the work is still in the jig, a lining bushing is selected that will guide a counterbore 1/16 inch larger than the boss to be finished. A slip bushing is then made to guide the drill, the body of which is a sliding fit in the lining bushing. Another slip bushing is made for the reamer which is also a sliding fit in the lining bushing. The slip bushing walls may have any thickness, providing they are not too thin. Should the conditions require bushings with too thin walls, the counterboring operation in the jig must be abandoned and some different method of procedure adopted. It is generally necessary to lock slip bushings when they are used for reamers 1/2 inch in diameter or less; otherwise they are likely to rotate with the reamer.

The shape of the work frequently requires bushings of considerable length in order to carry the cutting tool close to the work. When the length exceeds four diameters of the tool to be guided, the bushing presents considerable friction surface. A length equal to two diameters of the cutting tool is sufficient for a bearing surface in the bushing. The remainder of the length of the hole in the bushing may be counterbored or relieved. The end that should be relieved is, of course, that which is furthest from the work into which the tool is to be guided.

Screw bushings, Tables V and VI, are generally avoided when accurate work is required. There must be a certain amount of clearance in the ordinary tapped hole, and a threaded bushing is likely to be out of true on that account. Sometimes, however, it happens that no other type of bushing can be used for the work in hand.

TABLE III. HEADLESS BUSHINGS



Size of Drill used for A	B	C
No. 80 to No. 60	0.126	7/32 to 15/32
No. 59 to No. 30	0.251	13/32 to 29/32
No. 29 to No. 9	0.376	17/32 to 1 1/32
No. 8 to 5/16	0.501	21/32 to 1 13/32
21/64 to 7/16	0.626	23/32 to 1 15/32
29/64 to 9/16	0.8135	25/32 to 1 17/32
37/64 to 3/4	1.0015	27/32 to 1 27/32
49/64 to 7/8	1.1265	27/32 to 1 27/32
57/64 to 1	1.314	27/32 to 1 27/32
1 1/64 to 1 1/8	1.439	1 3/32 to 1 27/32
1 9/64 to 1 1/4	1.564	1 3/32 to 1 27/32
1 17/64 to 1 3/8	1.689	1 3/32 to 1 27/32
1 25/64 to 1 1/2	1.814	1 3/32 to 1 27/32
1 33/64 to 1 5/8	1.939	1 11/32 to 2 3/32
1 41/64 to 1 3/4	2.127	1 11/32 to 2 3/32
1 49/64 to 1 7/8	2.252	1 11/32 to 2 3/32
1 57/64 to 2	2.377	1 11/32 to 2 3/32
2 1/64 to 2 1/8	2.502	1 11/32 to 2 3/32

Machinery

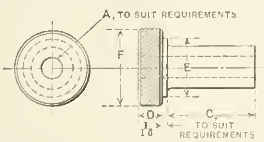
Jig Buttons

Pins or buttons used as seats or stops for castings, forgings, or other work having a rough exterior, where it is necessary to have a three-point bearing for both seating and stopping, are shown in Tables VII, VIII and IX. If the work must be supported against the action of cutting tools at more than three points, it is

* The tables of standards given in this article embody the practice of the General Electric Co., at Lynn, Mass. These standards have been developed for the company by R. F. Pohle, who is in charge of the tool designing department.

† Address: General Electric Co., Lynn, Mass.

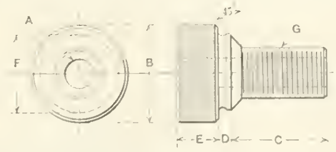
TABLE IV. SLIP BUSHINGS



B	D	E	F
0. 1285 to 0.196	3/16	3/8	1/2
0.199 to 0.3125	1/4	1/2	11/16
0.328 to 0.4375	5/16	11/16	7/8
0.453 to 0.5625	7/16	7/8	1 1/16
0.578 to 0.750	1/2	1	1 1/4
0.7656 to 0.875	1/2	1 1/8	1 3/8
0.8906 to 1.000	9/16	1 1/4	1 9/16
1.0156 to 1.125	5/8	1 3/8	1 11/16
1.1406 to 1.250	5/8	1 1/2	1 13/16
1.2656 to 1.375	11/16	1 5/8	1 15/16
1.3906 to 1.500	11/16	1 3/4	2 1/16
1.5156 to 1.625	3/4	1 13/16	2 3/16
1.6406 to 1.750	3/4	2	2 3/8
1.7656 to 1.875	3/4	2 1/4	2 1/2
1.8906 to 2.000	13/16	2 3/8	2 5/8
2.0156 to 2.125	13/16	2 3/8	2 3/4

Machinery

TABLE V. ALIGNING SCREW BUSHINGS



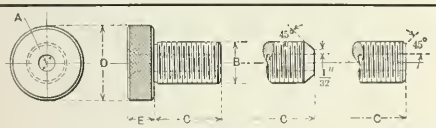
A and C, according to requirements

B	D	E	F	G Diameter and Number of Threads per Inch
7/8	1/8	5/16	11/16	1/2—13
7/8	1/8	5/16	11/16	9/16—12
1	5/32	5/16	7/8	5/8—11
1 1/4	3/16	5/16	1	3/4—10
1 3/8	3/16	3/8	1 1/8	7/8—14
1 1/2	3/16	7/16	1 1/4	1 —14
1 5/8	3/16	7/16	1 7/16	1 1/8—12
1 7/8	1/4	1/2	1 5/8	1 1/4—12
2	1/4	9/16	1 3/4	1 3/8—12
2 1/4	1/4	5/8	2	1 1/2—12
2 1/2	1/4	11/16	2 3/16	1 5/8—10
2 3/4	1/4	3/4	2 3/8	1 3/4— 8
3	1/4	3/4	2 1/2	1 7/8— 8
3 1/4	1/4	7/8	2 3/4	2 — 8

Machinery

necessary to make one of the points adjustable. The jig button shown in Table VII is used when the work has fairly large surfaces for seating. Jig edge buttons are used when the abutting surface is of comparatively thin section. The type shown in Table IX is used as a stop-pin for drop-forgings. It presents a line contact to the work at an angle equal to the draft of the forging dies. It is essential to know where the forging die for each piece is parted, before commencing to design tools for the forging, in order that the buttons may be located to the best advantage.

TABLE VI. SCREW BUSHINGS



B Diameter and Number of Threads per Inch	D	E	B Diameter and Number of Threads per Inch	D	E
1/2—13	7/8	5/16	1 1/4—12	1 5/8	9/16
9/16—12	7/8	5/16	1 3/8—12	1 3/4	5/8
5/8—11	1	3/8	1 1/2—12	1 7/8	5/8
3/4—10	1 1/8	7/16	1 5/8—10	2 1/8	11/16
7/8—14	1 1/4	1/2	1 3/4— 8	2 1/4	3/4
1 —14	1 3/8	1/2	1 7/8— 8	2 1/2	3/4
1 1/8—12	1 1/2	9/16	2 — 8	2 5/8	13/16

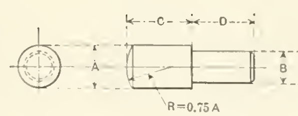
Machinery

A and C according to requirements.

* * *

It is well known that fires are often caused by the spontaneous combustion of rags soaked in oil. Fires have also been caused by chemical reactions that produced impure phosphoretted hydrogen or phosphine. That gasoline is a dangerous liquid to handle near open lights is well known, but the fact that it may be fired by static electricity sparks produced by its own flow under certain conditions is not generally known. Recent fires caused by the explosions of gasoline while being poured into motor car tanks indicate that there is an unsuspected danger in the act. When the liquid flows from a cock into the funnel, the funnel should be grounded if covered by a chamois filter. The Moline Automobile Co., East Moline, Ill., had two fires recently as a result of gasoline being fired by static electricity. The gasoline was pumped to a filling station through a long pipe line which leads through a duct beside an asbestos covered steam pipe. The gasoline became warm and static electricity accumulated in the pipe. When the tank on a motor car was being filled, an explosion occurred by the ignition of the gasoline fumes by a spark that jumped from the cock to the funnel.

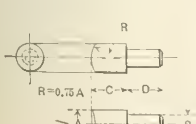
TABLE VII. JIG BUTTONS



A	B	C	D	A	B	C	D
1/4	0.1885	3/16 to 5/16	1/4	9/16	0.4385	3/8 to 7/8	9/16
5/16	0.1885	3/16 to 7/16	3/8	5/8	0.501	3/8 to 7/8	5/8
3/8	0.251	1/4 to 1/2	3/8	11/16	0.564	3/8 to 7/8	5/8
7/16	0.3135	1/4 to 5/8	7/16	3/4	0.6265	1/2 to 1	3/4
1/2	0.376	5/16 to 11/16	1/2	..	......	....	..

Machinery

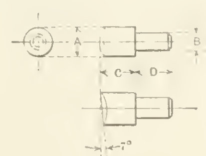
TABLE VIII. JIG EDGE BUTTONS



A	B	C	D
1/4	0.1885	3/16 to 5/16	1/4
5/16	0.1885	3/16 to 7/16	3/8
3/8	0.251	1/4 to 1/2	3/8
7/16	0.3135	1/4 to 5/8	7/16
1/2	0.376	5/16 to 3/4	1/2
9/16	0.4385	3/8 to 7/8	9/16
5/8	0.501	3/8 to 7/8	5/8
11/16	0.564	3/8 to 7/8	5/8
3/4	0.6265	1/2 to 1	3/4

Machinery

TABLE IX. JIG DRAFT BUTTONS



A	B	C	D
1/4	0.1885	3/16 to 5/16	1/4
5/16	0.1885	3/16 to 7/16	3/8
3/8	0 251	1/4 to 1/2	3/8
7/16	0.3135	1/4 to 5/8	7/16
1/2	0.376	5/16 to 11/16	1/2
9/16	0.4385	3/8 to 7/8	9/16
5/8	0.501	3/8 to 7/8	5/8
11/16	0.564	3/8 to 7/8	5/8
3/4	0.6265	1/2 to 1	3/4

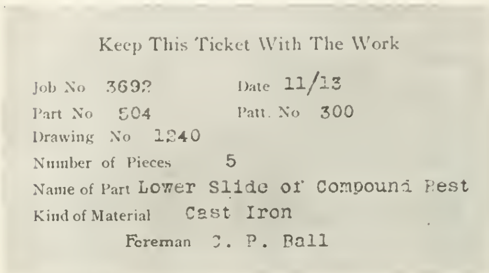
Machinery

TRAINING THE APPRENTICE

THE IMPORTANCE OF EMPHASIZING THE TIME ELEMENT IN SHOP WORK

BY T. H. ALVORD*

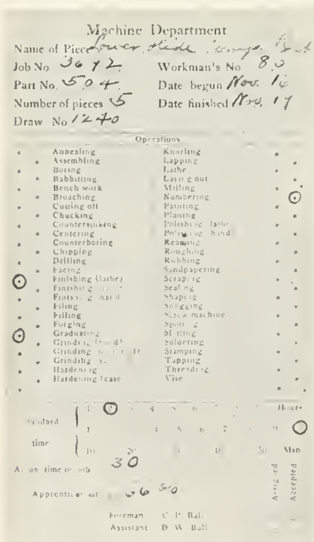
"You can teach a boy a trade, but you can't teach him the value of time." A few months ago this criticism of apprentice work was made by a manufacturer to James F. Johnson, superintendent of the State Trade School located in Bridgeport, Conn. No doubt the belief of scores of men was voiced in this comment, because it is true that a large percentage of labor, in whatever field, does not appreciate the inevitable relation between time and efficiency. Very few, either in the training school or in the shop, ever stop to think that a waste of only one minute by each member of a force of 5000 men, for example, means a total loss of over eighty hours. A habit of conserving time is probably one of the most difficult to form.


Keep This Ticket With The Work

Job No 3692 Date 11/13
Part No 504 Patt. No 300
Drawing No 1240
Number of Pieces 5
Name of Part Lower Slide of Compound Rest
Kind of Material Cast Iron
Foreman C. P. Ball

Fig. 1. Job Ticket that is filled out when Work is assigned to Student

Mr. Johnson realized the pertinency of the criticism, but did not acknowledge its truth. On the other hand, he set about evolving some sort of system which might be applied to trade school methods, and which would impress upon the boy the value of his minutes from the manufacturer's standpoint and the necessity of filling each one with definite, purposeful labor. The result was the development of a system, the basis of which Mr. Johnson calls the "apprentice rating card." When a job is assigned to a boy, a ticket (Fig. 1) is filled out and attached to a clip on his "tote box," and this ticket stays with the work until it is completed. As a certain drawing is usually called for, the boy goes to the listed rack and finds it, and with the tote box, ticket and blueprint, proceeds to the assignor of work, who gives him oral directions and such other explanations as are necessary for a thorough understanding of the task. In addition, he punches on another ticket (Fig. 2) the operations required on the particular piece of work and the approximate journeyman's time that it should take for completion, also punching on the back of the same ticket (Fig. 3) the time by the clock when the job was begun. The boy then places the ticket in the rack opposite his number, where it remains until the job is completed.


Machine Department
Name of Piece Lower Slide Comp. Rest
Job No 3692 Workman's No 80
Part No. 504 Date begun Nov. 16
Number of pieces 5 Date finished Nov. 17
Draw No 1240

Operations

Annealing	Knurling
Assembling	Lapping
Boring	Lathe
Babbitting	Laying out
Bench work	Milling
Broaching	Numbering
Cutting off	Painting
Chucking	Planing
Countersinking	Polishing lathe
Centering	Polishing hand
Counterboring	Reaming
Chipping	Roughing
Drilling	Rubbing
Facing	Sandpapering
Finishing (lathe)	Scraping
Finishing	Sealing
Finishing hand	Shaping
Filing	Slugging
Filling	Screw machine
Forging	Spotting
Graduating	Slotting
Grinding	Soldering
Grinding	Stamping
Grinding	Tapping
Hardening	Threading
Hardening (case)	Vise

Standard time — Hours — Min
Actual time on job 30
Apprentice's rat 66%
Assigned Accepted
Foreman C. P. Ball
Assistant D. W. Ball

Fig. 2. Operations to be performed and Approximate Journeyman's Time

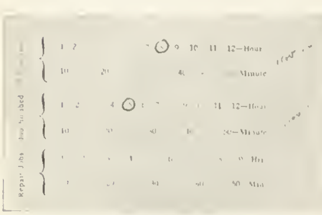
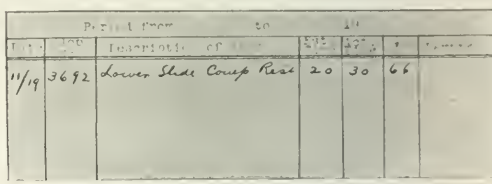


Fig. 3. Time and Date that Job was started and finished, from which Rating is calculated

After the work is finished, the boy takes it with the blueprint and his tickets to the assignor, by whom it is inspected and criticized. The time of completion is then punched on the back of the ticket, Fig. 3. The time when the work was begun subtracted from this gives the actual number of hours and minutes consumed in doing the piece of work. This figure is entered on the front of the card (Fig. 2). The next step is to obtain the apprentice's rating or percentage of efficiency, which is accomplished by dividing the approximate journeyman's time which the work should take, as suggested by the assignor, by the actual time consumed by the boy. This percentage the apprentice calculates and enters upon his ticket, which is then slipped into a box and goes to the superintendent for inspection.

Of the 4800 hours required in the Trade School course, about one-fourth are spent in related technical work. As a part of this special work, the boy enters in a book (Fig. 4) the details of each day's shop work, and then he figures out and plots his curve of efficiency for the week. In this way he has before him in graphic form a most readable account of all his work, an inspiration to himself and an aid to his parents or teachers


Period from to 19

		Description of				
11/19	3692	Lower Slide Comp Rest	20	30	66	

Fig. 4. Book in which Record of Shop Work is kept

Fig. 5 shows the efficiency curve of Machine Apprentice No 83 for the month of November. His percentage ranges from 50 to 72, giving an average of 61 per cent for the month, though the rating for the particular job described in the tickets shown herewith is 66 per cent. (Note circle.) This time system worked out by Mr. Johnson has proved to be highly satisfactory and has attracted considerable attention from public school and trade school men who have seen it in operation or to whom it has been explained. Its merit lies in the three principal results—all very practical and vital—which are obtained through its use: first, the apprentice learns how his time on a job compares with that of an experienced journeyman; second, the apprentice learns to conserve his time; third, the problem of discipline is practically eliminated.

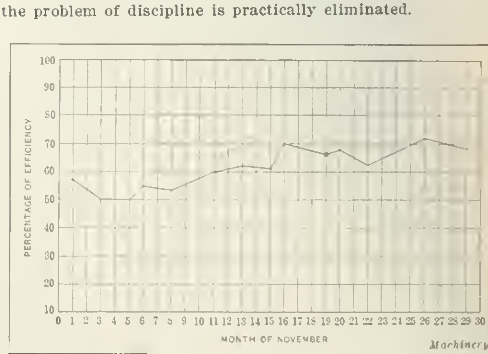


Fig. 5. Curve of Efficiency for the Week plotted from Data in Book (Fig. 4)

* Address: Commercial Department, Bridgeport High School Bridgeport, Conn.

The Military Rifle-2

by Douglas T. Hamilton *and* Staff

THE Spanish Mauser military rifle, which has formed the basis of this article, is of simple design, and nearly all of the parts are made solid or from one piece, instead of being riveted together as they are in some of the other military rifles. While this may increase the number of machining operations required, it makes a more rigid and a smoother working rifle. In the previous installment of this article, the machining operations on the barrel, receiver, bolt, etc., were outlined. In the following, the methods of manufacturing the magazine and trigger guard, rifle stock, and some of the smaller parts are described. Table IV has been repeated because some of the information that it contains refers to the parts described in the following.

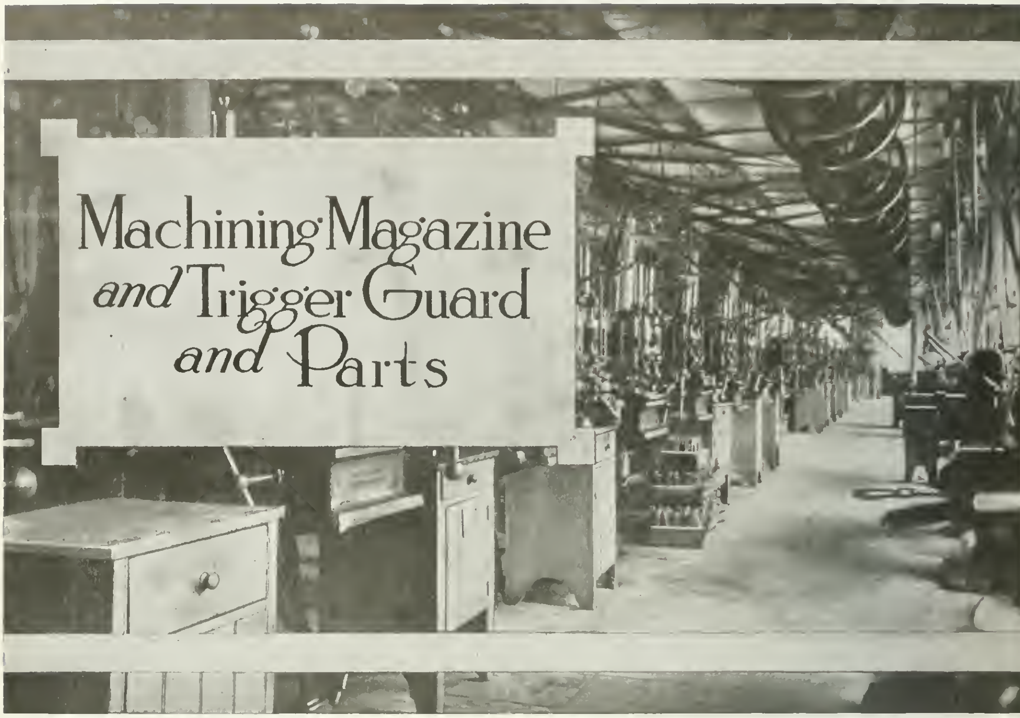
TABLE IV. LIST OF RIFLE PARTS GIVING SYMBOLS USED IN SPECIFYING MATERIAL, TREATMENT AND FINISH

No. of Part	Name of Part	Kind of Material	Specification Symbol	Treatment and Finish
1	Barrel	Steel forging	45-120	An-Pl-Po-Br
2	Front sight	Steel	15-72	Po-Bn
3	Front sight base	Steel	15-72	Po-Bn
4	Front sight base screw	Steel	15-45	Po-Bn
5	Rear sight base	Steel forging	15-72	An-Pi-Po-Bn
6	Cleaning rod	Steel	15-45	Use as mach'd
7	Rear sight leaf	Steel	15-72	Po-Bn
8	Rear sight leaf spring	Steel	39-80	Ha-Po-Te 750° F.
9	Rear sight leaf spring screw	Steel	15-45	Po-Bn
10	Rear sight leaf pin	Steel	120-22	Po-Bn
11	Rear sight slide	Steel	15-72	Po-Bn
12	Rear sight slide catch	Steel	15-72	CH Po-Bn
13	Rear sight slide catch pin	Steel	120 22	Ha-Po-Te 600° F.
14	Rear sight slide catch spring	Music wire	57-45	ST
15	Rear sight slide catch stop screw	Steel	15-45	Po Bn
16	Receiver	Steel forging	32-120	An Pl-PH-Po-Bg
17	Retaining bolt	Steel	15-72	CH Po-Bn
18	Retaining bolt spring	Steel	39-80	Ha-Po-Te 750° F.
19	Ejector	Sheet steel	100-32	Ha-Te 600° F.
20	Ejector fulcrum screw	Steel	120-22	Ha-Te 600° F.
21	Bolt	Steel forging	32-120	An Pl-PH-Po-Bg-Po
22	Bolt plug	Steel forging	32-120	An Pi-PH-Po-Bn
23	Cocking-piece	Steel	32 120	PH-Po-Bn
24	Striker	Steel	118-28	Ha-Te 450° Po
25	Extractor	Steel	39-80	Ha-Te 750° Po
26	Extractor collar	Steel	39 80	Ha-Te 750° Po
27	Main spring	Music wire	57-45	ST
28	Safety lock	Steel forging	75-35	An-Pi-Ha-Te 600°-Po-Bn
29	Magazine and trigger guard	Steel forging	15-72	An-Pi Po-Bg
30	Magazine floor-plate	Steel forging	15-72	An-Pi-Po-Bn
31	Floor-plate catch	Steel	15-72	CH
32	Floor-plate pin	Steel	120 22	Ha-Te 600° F.
33	Floor-plate spring	Music wire	57-45	ST
34	Magazine platform	Steel forging	15-72	An Pl-CH-Po-Bn
35	Magazine spring	Steel ribbon	100-32	Ha-ST 740°-Cl
36	Stock	Wood	W	Oi
37	Hand guard	Wood	W	Oi
38	Butt plate	Steel forging	15-72	Po-Bn
39	Sear	Steel	75-35	Ha-Tn Te 600° F.
40	Trigger	Strip steel	75-35	Po-Ha Po-Te
41	Sear pin	Steel	120-22	Ha-Po-Te 600° F.
42	Sear spring	Music wire	57-45	ST
43	Trigger pin	Steel	120-22	Ha Po-Te 600° F.
44	Stock mortice band	Sheet steel	14 45	Po-Bn
45	Guard screw, front	Steel	15-45	Po-Bn
46	Guard screw, rear	Steel	15-45	Po-Bn
47	Guard screw, bushing	Steel	15-45	Use as machined
48	Butt plate screw, lower	Steel	15-45	Po Bn
49	Butt plate screw, upper	Steel	15-45	Po Bn
50	Butt sling swivel	Steel	15-45	Bn
51	Butt sling swivel block	Steel	15-72	Po Bn
52	Butt sling swivel pin	Steel	120-22	Ha-Te 600° F.
53	Butt sling swivel block screws (two)	Steel	15-45	Po-Bn
54	Lower band	Steel forging	15-72	An Pi Po-Bn
55	Lower band spring catch	Steel forging	75-35	An Pi Ha Te 600° F. Po Bn
56	Lower band swivel	Steel	15-45	Po Bn
57	Lower band swivel screw	Steel	15-45	Po Bn
58	Lower band swivel screw nut	Steel	15-45	Po-Bn
59	Upper band	Steel forging	15-72	An Pi-Po-Bn
60	Upper band spring catch	Steel forging	75-35	An Pi-Ha Te 600° F Po Bn
61	Upper band nose plate	Sheet steel*	14 45	Po Bn
62	Upper band nose plate pin	Steel	120 22	Ha-Te 600° F

Machinery

* Electrically welded.

Machining Magazine and Trigger Guard and Parts



THE magazine and trigger guard (see Fig. 47) is drop-forged from a 1⅞ by ¾ inch rectangular hot-rolled bar of gun steel. Owing to the large amount of material to be displaced it is impracticable to complete this part in one drop-forging operation, and two heats are necessary. The first drop-forging consists in "breaking down" the bar and distributing the material to the desired points. A second drop-forging operation is then accomplished, after which the forging is heated for trimming and then annealed and pickled. The first machining operation consists in milling the bottom surface for locating in drilling and reaming the guard screw holes which, in connection with the bottom surface, act as locating and gaging surfaces in subsequent operations. For additional details on feeds, speeds, and production, see Table XXIV. The sequence of operations is illustrated in Figs. 48 to 53.

Operation 1: Forge, Rough. The rough-forging operation is performed by an 800-pound drop-hammer. Two forging operations are necessary on account of the large amount of material to be displaced. The bar for rough-forging is heated to from 1850 to 1900 degrees F.

Operation 2: Forge, Finish.—This operation, which calls for a second heat to about 1900 degrees F., is done by a 1200-pound drop-hammer.

Operation 3: Trim.—Owing to the shape of this part the trimming must be done hot, and a third heat of about 1200 degrees F. is necessary. The trimming punch is made from a phosphor-bronze casting to prevent distortion from the heat, which would occur if the punch were made of steel.

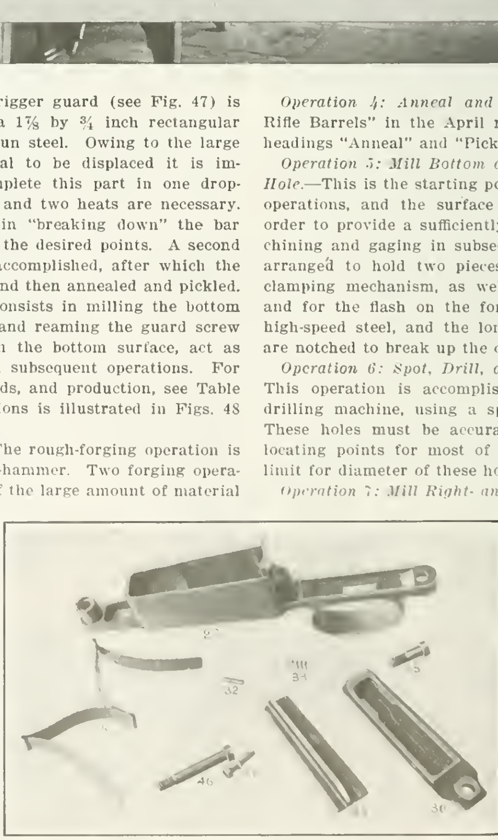


Fig. 47. Spanish Mauser Magazine and Trigger Guard and Parts

Operation 4: Anneal and Pickle.—See "Specifications for Rifle Barrels" in the April number of MACHINERY under the headings "Anneal" and "Pickle."

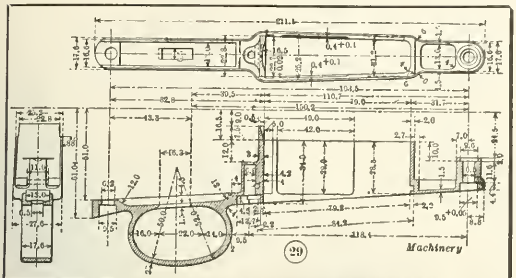
Operation 5: Mill Bottom and Flat Over Rear Guard Screw Hole.—This is the starting point in the sequence of machining operations, and the surface must be carefully machined in order to provide a sufficiently accurate locating point for machining and gaging in subsequent operations. The fixture is arranged to hold two pieces, and is provided with a rigid clamping mechanism, as well as liberal clearance for chips and for the flash on the forging. The cutters are made of high-speed steel, and the long cutter has spiral teeth which are notched to break up the chips.

Operation 6: Spot, Drill, and Ream Guard Screw Holes.—This operation is accomplished on a four-spindle sensitive drilling machine, using a special jig for holding the work. These holes must be accurately finished, as they form the locating points for most of the subsequent operations. The limit for diameter of these holes is $\pm$ 0.00025 inch.

Operation 7: Mill Right- and Left-hand Sides of Magazine.—This is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces. The work is milled on each side, locating from the guard screw holes and using an adjustable stop that comes up against the lower portion. The teeth of the cutters are cut at a helix angle of 15 degrees, and are nicked in order to break up the chips.

Operation 8: Mill Top, Ends, Front of Boss and Top and Angle of Plunger Lock Boss.—This is done on a Lincoln type milling machine, using a

TABLE XXIV. OPERATIONS ON MAGAZINE AND TRIGGER GUARD—PART NO. 29



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Forge, rough	800-pound drop-hammer	Forge dies	..	..	45	1
2	Forge, finish	1200-pound drop-hammer	Forge dies	..	..	45	1
3	Trim	Punch press	Punch and die	..	..	80	1
4	Anneal and pickle	Annealing furnace	......	..	..	25	See text
5	Mill bottom and flat over rear guard screw hole	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	1/16	60	2
6	Spot, drill and ream guard screw holes	4-spindle sensitive drill. mach.	Spec. jig	50-75	Hand	45	1
7	Mill right- and left-hand sides of magazine	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	1/16	30	3
8	Mill top, ends, front of boss and top and angle of plunger lock boss	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	1/16	50	2
9	Mill left side and corners	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	1/16	20	2
10	Mill right side and corners	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	1/16	20	2
11	Mill sides of magazine back of ribs	Hand mill. mach.	Spec. fixt. holds one piece	70	3/64	45	1
12	Counterbore, drill and ream catch lock pin hole	3-spindle sensitive drill. mach.	Spec. jig	50-65	Hand	25	1
13	Hollow-mill and face front guard screw boss	2-spindle sensitive drill. mach.	Spec. jig	60-65	Hand	50	1
14	Drill, ream and counterbore floor-plate catch hole and drill for front lightening recess	6-spindle sensitive drill. mach.	Spec. jig	50-65	Hand	25	1
15	Spline-mill magazine opening	P. & W. spline mill. mach.	Spec. fixt.	80	0.005	4	4
16	Broach magazine opening	Lapointe duplex broach. mach.	Spec. fixt. Spec. broach	5	..	40	1
17	Profile catch lock boss, top of guard and front lightening cut	Profiling machine	Spec. fixt.	70	Hand	30	1
18	Profile inside of guard and round corners	Profiling machine	Spec. fixt.	70	Hand	25	1
19	Profile outside of guard and round corners	Profiling machine	Spec. fixt.	70	Hand	20	1
20	Profile front and rear end angles	Profiling machine	Spec. fixt.	70	Hand	20	1
21	Profile floor-plate lock slots	Profiling machine	Spec. fixt.	70	Hand	30	1
22	Mill clearance slot in top of guard	Hand mill. mach.	Spec. fixt. with former	70	Hand	25	1
23	Mill clearance bevel on magazine rib	Hand mill. mach.	Spec. fixt.	70	Hand	65	1
24	Mill slot for trigger	Hand mill. mach.	Spec. fixt.	70	Hand	60	1
25	Profile magazine clearance	Profiling machine	Spec. fixt.	70	Hand	55	1
26	Oscillate mill clearance at rear of magazine opening	Hendey oscillating milling machine	Spec. fixt.	..	0.010" per osc.	55	1
27	Broach trigger slot	Punch press	Spec. fixt.	..	..	100	1
28	C.bore front and rear guard screw holes	3-spindle sensitive drill. mach.	Plate jig	60-65	Hand	70	1
29	Stamp	Bench work	Hand stamps	..	..	250	1
30	File corners and burr	......	......	..	..	10	1
31	Polish	Polishing lathe	Leather covered wheels	5000	..	6-8	1
32	Blue	American "bluing" gas furnace	......	..	..	20	..

special fixture that holds two pieces. This fixture has special clamping jaws and is so constructed that the locating pins can be forced up into the work from beneath by the action of a cam lever. The cutters are made of high-speed steel, with the center cutter nicked to break up the chips.

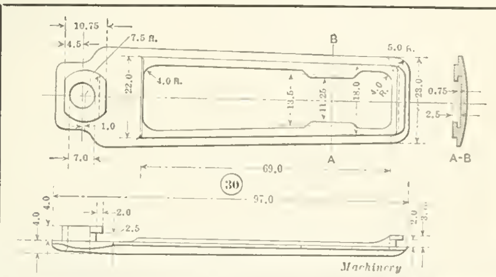
Operation 9: Mill Left-hand Side and Corners.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces. The fixture is provided with adjustable stops located beneath the work to relieve the pressure of the cut on the locating pins. The cutters are made of high-speed steel and have nicked teeth.

Operation 10: Mill Right-hand Side and Corners.—This is similar to Operation 9.

Operation 11: Mill Sides of Magazine Back of Ribs.—This operation is accomplished on a hand milling machine, using a special fixture that holds one piece.

Operation 12: Counterbore, Drill and Ream Catch Lock Pin Hole.—This is accomplished on a three-spindle sensitive drilling machine, using a special jig of the box invertible type, in which the work is located from the guard screw holes and clamped against the bottom by two quick-acting clamps. Removable slip bushings are used in the jig. The milling counterboring is done on each side of the piece with an

TABLE XXV. OPERATIONS ON MAGAZINE FLOOR-PLATE—PART NO. 30



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-pound drop-hammer	Forging dies Trim. punch and die	..	..	50	1
2	Anneal and pickle	Anneal furn. Pickling bath	......	..	..	60	See text
3	Mill bottom surface and ends, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.032	80	2
4	Mill top surface, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	60	0.032	80	2
5	Mill right-hand edge	Lincoln type mill. mach.	Spec. vise jaws; hold six pieces	60	0.040	120	2
6	Mill left-hand edge	Lincoln type mill. mach.	Spec. vise jaws; hold six pieces	60	0.040	120	2
7	Profile magazine spring clearance, rough and finish	Two-spindle profiling mach.	Spec. fixt. and formers	70	Hand	30	1
8	Profile locating ledge and locking lugs, rough and finish	Two-spindle profiling mach.	Spec. fixt. and formers	70	Hand	50	1
9	Profile front and rear locking lug slots, rough and finish	Two-spindle profiling mach.	Spec. fixt. and formers	70	Hand	40	1
10	Profile magazine locking spring T-slot	One-spindle profiling mach.	Spec. fixt. and formers	70	Hand	60	1
11	Mill bottom, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	80	2
12	Mill contour on lower front and rear ends	Hand mill. mach.	Spec. fixt. and form. plate	70	Hand	60	1
13	Drill and countersink floor-plate catch clearance hole	Two-spindle drilling mach.	Drill jig	60	Hand	75	1
14	Profile entire edge outline	One-spindle profiling mach.	Spec. fixt. and form. plate	70	Hand	60	1
15	Stamp	Bench work	Hand stamps	..	Hand	250	1
16	Polish	Polishing lathe	Leather cov. wheels	5000	..	80	1
17	Blue	Niter bath	......	..	..	See text	

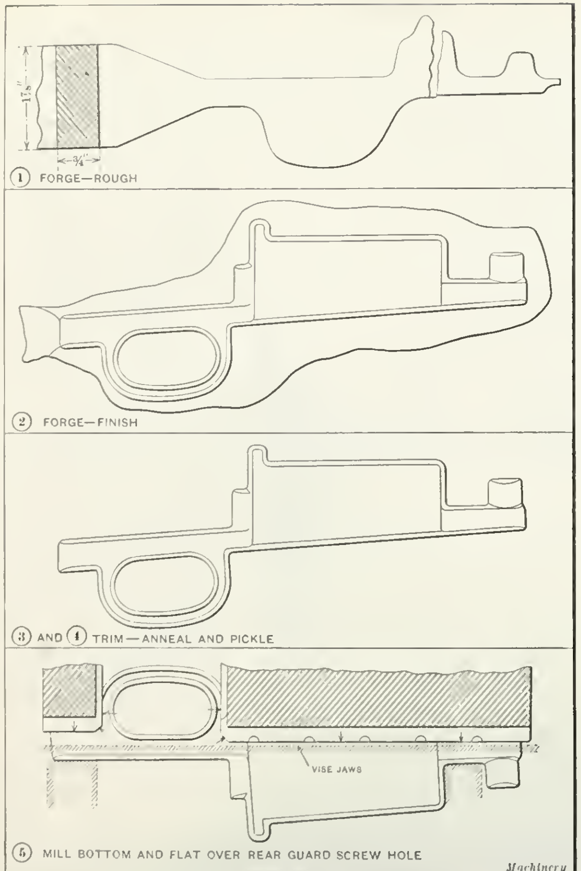


Fig. 48. Operations on Magazine and Trigger Guard

end-mill, which prepares the piece so that the drill will start properly.

Operation 13: Hollow-mill and Face Front Guard Screw Boss.—This operation is accomplished on a two-spindle sensitive drilling machine using a box jig. Roughing and finishing hollow-mills are used.

Operation 14: Drill, Ream and Counterbore Floor-plate Catch Hole, and Drill for Front Lightening Recess.—This is done on a six-spindle sensitive drilling machine, using a box jig with slip bushings. Feet are provided on two sides of the jig so that the holes can be drilled from one side, the jig inverted, and the reaming done from the other side.

Operation 15: Spline-mill Magazine Opening.—This operation is accomplished on a Pratt & Whitney spline milling machine, using special cutters of the fish-tail type having four teeth, instead of the former two-tooth type. A special fixture is used that is supplied with sliding clamps for quickly inserting and removing the work.

Operation 16: Broach Magazine Opening.—This is performed on a Lapointe duplex broaching machine, using a special broach, ground to the required form, and a special fixture for holding the work.

Operation 17: Profile Catch Lock Boss, Top of Guard, and Front Lightening Cut.—This operation is accomplished on a two-spindle profiling machine, using roughing and finishing cutters, the finishing cutter working only on those surfaces where a radius is required. The fixture used is provided with adjustable roughing and finishing former blocks.

Operation 18: Profile Inside of Guard and Round Corners.—This is performed on a two-spindle profiling machine, using a fixture similar to that used for Operation 17.

Operation 19: Profile Outside of Guard and Round Corners.—This is done in a similar manner to Operation 18.

Operation 20: Profile Front and Rear End Angles.—This operation is accomplished on a two-spindle profiling machine, using roughing and finishing cutters.

Operation 21: Profile Floor-plate Lock Slots.—This is accomplished on a two-spindle profiling machine, using a special fixture that holds one piece. Two cutters are used, one of the end milling type for roughing out the clearance for the floor-plate lock slot, and the other of the T-type for milling the locking slots.

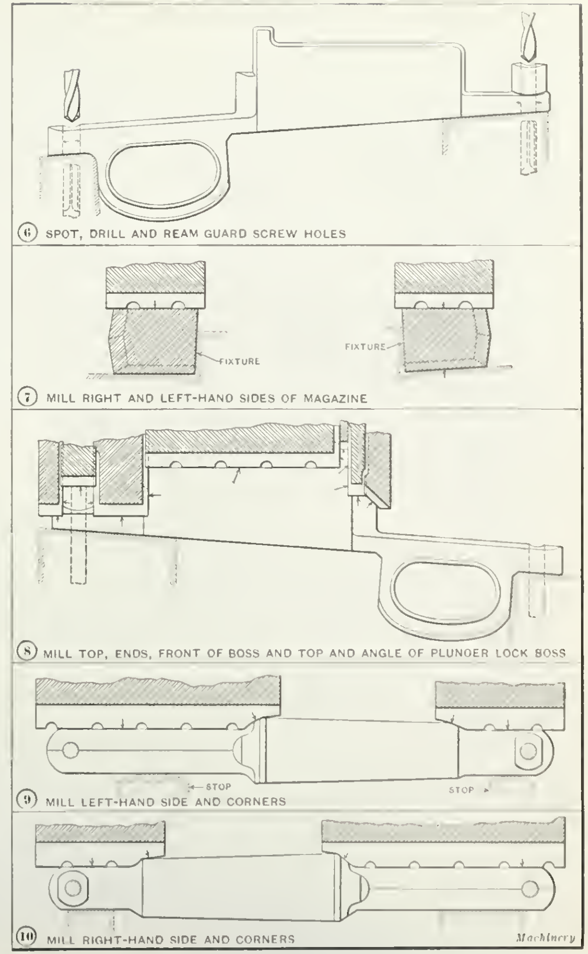


Fig. 49. Operations on Magazine and Trigger Guard (Continued)

Operation 22: Mill Clearance Slot in Top of Guard.—This is done on a hand milling machine, using a fixture that holds one piece. The

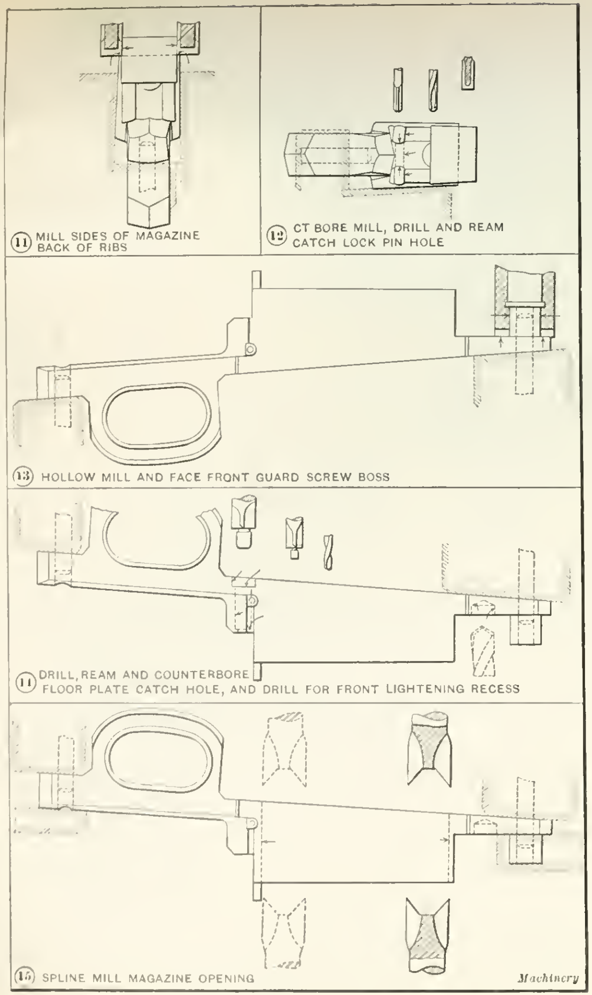


Fig. 50. Operations on Magazine and Trigger Guard (Continued)

fixture is provided with a former plate on which a hardened and ground roller on the spindle rides. This plate controls the movement of the cutter when finishing the shallow cut at the end. The cutter does not have teeth on the sides.

Operation 23: Mill Clearance Bevel on Magazine Rib.—This is accomplished on a hand milling machine, using a special fixture that holds one piece. The cutter is tapered to provide for adjustment and for maintaining the proper radius.

Operation 24: Mill Slot for Trigger.—This operation is accomplished on a hand milling machine, using a special fixture that holds one piece. The cutter is dropped down into the work, without any traverse movement of the table.

Operation 25: Profile Magazine Clearance.—This is performed on a one-spindle profiling machine, using a special fixture in which provision is made for holding the piece rigidly to prevent chatter. The thin walls on the sides make it necessary to clamp the work from the sides with a metal to metal contact.

Operation 26: Oscillate Mill Clearance at Rear of Magazine Opening.—This operation is accomplished on a Hendey oscillating milling machine provided with a special fixture for holding the work and supporting it at the sides to prevent chatter. The cutter is made with close-spaced teeth, and cuts in both directions.

Operation 27: Broach Trigger Slot.—This is performed on a punch press, using a special block fixture on which the work is located from the trigger guard and is additionally supported at the front end.

Operation 28: Counterbore Front and Rear Guard Screw Holes.—This operation is accomplished on a three-spindle sensitive drilling machine, using a jig provided with feet on two sides.

Operation 29: Stamp.—This is a hand operation and consists in stamping the number on the part.

Operation 30: File Corners and Burr.—This is a hand operation and consists in removing all burrs and sharp corners.

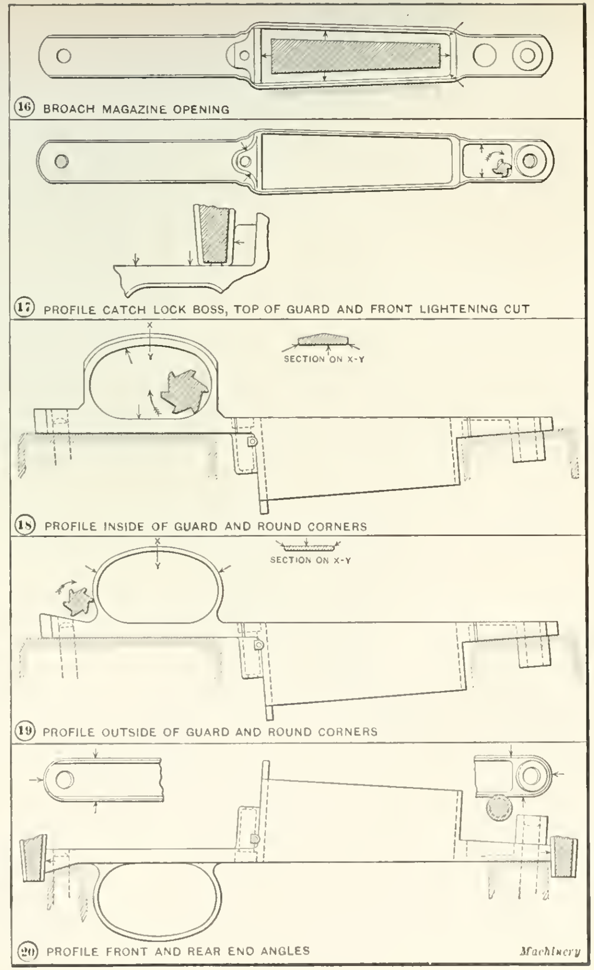


Fig. 51. Operations on Magazine and Trigger Guard (Continued)

Operation 31: Polish.—See "Polish."

Operation 32: Blue.—See "Blue—Gas Furnace Process."

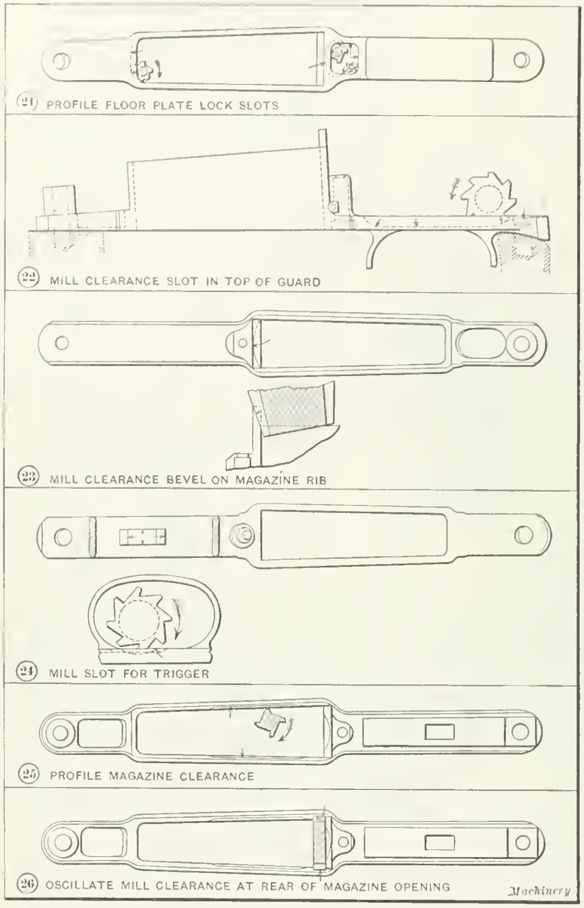


Fig. 52. Operations on Magazine and Trigger Guard (Continued)

OPERATIONS ON MAGAZINE FLOOR-PLATE

The magazine floor-plate (see Fig. 47) is drop-forged from a 5/16 by 1 1/8 inch rectangular bar of gun steel and trimmed, after which it is annealed and pickled. The bottom surface and ends are next milled on a Lincoln type milling machine having a fixture that holds two pieces, after which a cut is taken across the top to remove most of the superfluous stock, and at the same time the two edges are milled. For the subsequent gaging and machining operations, the bottom and top surfaces and the ends are used as locating points. For additional details, such as feeds, speeds and production, see Table XXV.

Operation 1: Drop-forge and Trim.—This operation is done on an 800-pound drop-hammer. One man attends to the furnace, trimming press and drop-hammer.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Mill Bottom Surface and Ends, Rough.—This is accomplished on a Lincoln type milling machine, using special vise jaws in which two pieces are held. The jaws are formed to the same contour as the piece by milling previous to hardening.

Operation 4: Mill Top Surface, Rough.—This operation is done on a Lincoln type milling machine, using a quick-acting vise that holds two pieces.

Operation 5: Mill Right-hand Edge.—This is done on a Lincoln type milling machine, using a special set of vise jaws that hold six pieces, arranged to be milled lengthwise, and held at the required angle.

Operation 6: Mill Left-hand Edge.—This is similar to Operation 5, except that the vertical location is determined by the previously finished surfaces.

Operation 7: Profile Magazine Spring Clearance, Rough and Finish.—This is performed on a two-spindle profiling machine and consists in cutting out the pocket in which the magazine spring works, the roughing and finishing cuts being made by the two spindles on the machine. A special fixture with suitable formers is used for producing the correct form.

Operation 8: Profile Locating Ledge and Locking Lugs, Rough and Finish.—This operation is accomplished on a two-spindle profiling machine, using a special fixture with formers, as in Operation 7.

Operation 9: Profile Front and Rear Locking Lug Slots, Rough and Finish.—This is done on a two-spindle profiling machine, using a special fixture and formers. A special T-cutter is used for under-cutting.

Operation 10: Profile Magazine Locking Spring T-slot.—This operation is accomplished on a one-spindle profiling machine, using a T-cutter for under-cutting the slot in which the magazine spring is locked.

Operation 11: Mill Bottom, Finish.—This is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces and eccentrically relieved cutters.

Operation 12: Mill Contour on Lower Front and Rear Ends.—This operation is accomplished on a hand milling machine, using a special fixture having a forming plate by which the movement of the spindle is controlled.

Operation 13: Drill and Countersink Floor-plate Catch Clearance Hole.—This is done on a two-spindle drilling machine, using a drill jig in which the piece is located from the locating ledge and the finished surface, and which is so arranged that the drilling is done from one side of the jig through a bushing, while the opposite side is left open so that a countersink can be used.

Operation 14: Profile Entire Edge Outline.—This is accomplished on a one-spindle profiling machine, using a special fixture and forming plate, so that the piece will conform in its outline to the portion of the magazine and trigger guard which it fits.

Operation 15: Stamp.—This is a hand operation.

Operation 16: Polish.—See "Polish."

Operation 17: Blue.—See "Blue—Niter Process."

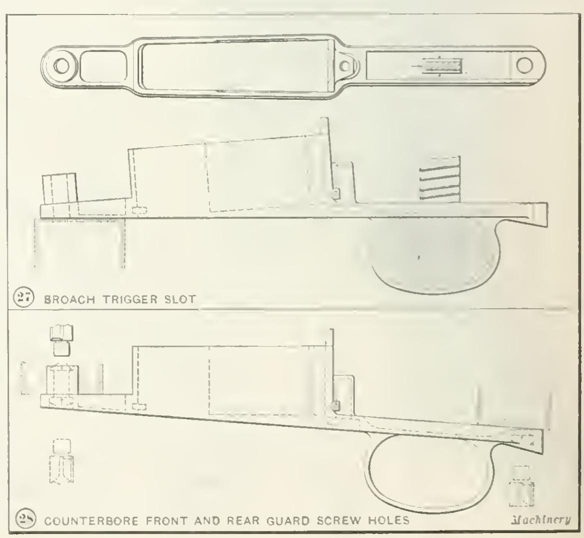


Fig. 53. Operations on Magazine and Trigger Guard (Continued)

OPERATIONS ON MAGAZINE PLATFORM

The magazine platform (see Fig. 47) is drop-forged from a 3/4 by 5/16 inch rectangular hot-drawn bar of gun steel. After forging, trimming, annealing and pickling, the bottom and ends are rough-milled on a Lincoln type milling machine, using a special fixture that holds two pieces. This roughly milled surface acts as a locating point for the subsequent roughing operations which are: rough-milling the top and partition and milling the right- and left-hand edges. These operations remove the surplus stock from the forging and relieve the strains in the metal. The bottom and ends are then finish-milled, and these surfaces are used for locating.

Operation 1: Drop-forge and Trim.—This operation is accomplished on an 800-pound drop-hammer, using forging dies; the trimming is done on a trimming press.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

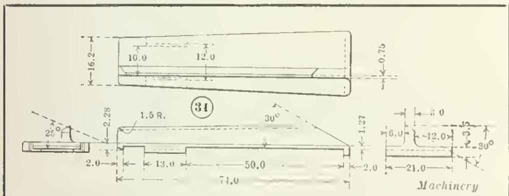
Operation 3: Mill Bottom and Ends, Rough.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces, and interlocking cutters to preserve the shoulder distances.

Operation 4: Mill Top and Partition, Rough.—This is done on a Lincoln type milling machine, in a special fixture that holds two pieces which are located by the bottom surface and ends previously milled.

Operation 5: Mill Right-hand Edge.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces and is so arranged that the pieces lie with their upper edges in a horizontal plane. The pieces are clamped against the previously milled bottom surface and rest with their lower edges on pins.

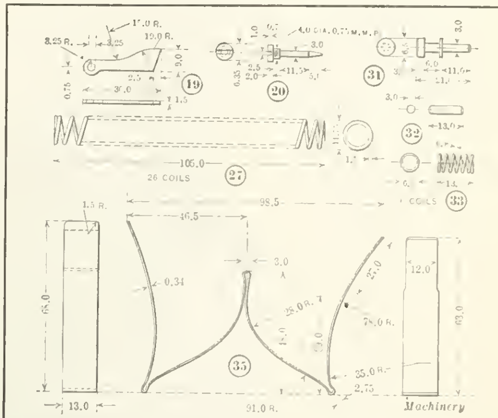
Operation 6: Mill Left-hand Edge.—This is similar to Operation 5, except that the finished edge rests on the pins.

TABLE XXVI. OPERATIONS ON MAGAZINE PLATFORM—PART NO. 34



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-pound drop-hammer	Forge dies	..	..	50	1
2	Anneal and pickle	Annealing furnace	......	..	..	60	See text
3	Mill bottom and ends, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.032	80	2
4	Mill top and partition, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.032	50	2
5	Mill right-hand edge	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.032	50	2
6	Mill left-hand edge	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.032	50	2
7	Mill bottom and ends, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	80	2
8	Mill taper and bevel on partition	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.020	50	2
9	Mill bevel on rear end of partition	Hand mill. mach.	Spec. angular fixt.	70	Hand	80	1
10	Mill clearance slot for magazine spring	Hand mill. mach.	Spec. fixt.	60	Hand	60	1
11	Mill locking T-slots for magazine spring	Hand mill. mach.	Spec. fixt.	60	Hand	50	1
12	Mill bevel on lower front end	Hand mill. mach.	Spec. fixt.	70	Hand	80	1
13	Stamp	Bench work	Bench work	..	..	250	1
14	File corners and burr	Bench work	Files	..	..	50	1
15	Caseharden	Cyanide furnace	......	..	..	75	1
16	Polish	Polishing lathe	Leather cov. wheels	5000	..	40	1
17	Blue	Niter bath	......	..	..	See text	

TABLE XXVII. OPERATIONS ON MISCELLANEOUS PARTS



Part. No.	Operation	Mach. Used	Hourly Product per Mach.	Machs. per Operator
19	Pierce and blank	No. 5 punch press	1500	1
19	Harden and temper	Hard. furn. Temper. bath	200	1
20	Turn, form, thread, cut off and slot	Auto. screw mach. with slotting attach.	200	3
20	Harden and temper	Hard. furn. Temper. bath	200	1
27	Wind, set and cut off	No. 1 spring coiling mach.	3000	4
27	Grind ends	Disk grinder, cup wheel	100	1
27	Spring temper	Temper. bath	200	1
31	Turn, form, cut off and burr	Auto. forming mach. with burring attach.	300	3
31	Caseharden	Cyanide furnace	250	2
32	Cut off and burr	Auto. forming mach. with burring attach.	1000	2
32	Harden and temper	Hard. furn. Temper. bath	250	2
33	Wind, set and cut off	No. 1 spring coiling mach.	5000	4
33	Grind ends	Disk grinder, cup wheel	200	1
33	Spring temper	Temper. bath	200	1
35	Blank and trim	No. 5 punch press	1800	1
35	First bend	No. 5 punch press	360	1
35	Second bend	No. 5 punch press	360	1
35	Set bends	Bench fixture	240	1
35	Harden	Hard. furnace and fixt.	20	1
35	Temper	Temper. bath	100	1
35	Compress	Special fixture	60	1
35	Test compress	Special fixture	20	See text

Operation 7: Mill Bottom and Ends, Finish.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces, these being located on the finished top to give the vertical position, and against a swinging stop to give end location. This stop is arranged so that it can be swung out of the way while milling.

Operation 8: Mill Taper and Bevel on Partition.—This is performed on a Lincoln type milling machine, using a special fixture that holds two pieces. These pieces are so located that the upper surface of the partition lies in a horizontal plane. The cutters are angular so as to produce the desired form.

Operation 9: Mill Bevel on Rear End of Partition.—This is done on a hand milling machine, using a special fixture.

Operation 10: Mill Clearance Slot for Magazine Spring.—This operation is done on a hand milling machine, using a special fixture that holds one piece. An end-mill is used.

Operation 11: Mill Locking T-slots for Magazine Spring.—This is also accomplished on a hand milling machine, using a special fixture that holds one piece. A T-cutter cuts the slot on one side, and the spindle is then dropped sufficiently to bring it into the correct position for cutting the other slot. Suitable stops are provided to give the correct distance.

Operation 12: Mill Bevel on Lower Front End.—This operation is accomplished on a hand milling machine, using a special fixture that holds one piece.

Operation 13: Stamp.—This is a hand operation.

Operation 14: File Corners and Burr.—This consists in removing the burrs and rounding the corners by hand.

Operation 15: Caseharden.—See "Caseharden."

Operation 16: Polish.—See "Polish."

Operation 17: Blue.—See "Blue—Niter Process."

Machining Gun Stocks

To machine a military rifle stock successfully is no easy proposition, as has been proved by many of the manufacturers who have gone into this business since the outbreak of the present war. Prior to the year 1822, rifle stocks were made by hand and, of course, were much cruder than they are at the present day, when highly developed machines are used. The output was one stock in ten hours. In 1822, Thomas Blanchard, then employed at the Springfield Armory, Springfield, Mass., invented a special gun-stock turning lathe which was subsequently known as the Blanchard lathe. This lathe revolutionized the method of making rifle stocks, and while the construction has been improved to a considerable extent, the original design remains practically the same. The original lathe, designed and built by Thomas Blanchard, is shown in Fig. 55. Here it will be noticed that the main structure of the machine is made from heavy timber, bolted together, and with the exception of the gears, center frame and copying wheel, most of the parts are made from wood. A metal copying pattern was used, which controlled the frame carrying the revolving stock to be turned. The movement of this frame was controlled by a wheel running on the metal pattern which, as will be seen, is rotated. The copying wheel is held on the frame to which the cutter-head is attached. It is evident, therefore, that as the gun stock rotates, the cutter-head is moved in and out according to the shape of the pattern, and consequently produces a similar form on the wood stock. The cutters are of the scoop type, and are held to the rotating cutter wheel.

At the outbreak of the present war, practically none of the rifle manufacturers were in a position to turn out a military rifle stock to meet the specifications and requirements of the foreign governments. At first glance, it appeared to be a comparatively simple proposition, but when it was considered that rifle stocks must be turned out in large numbers and must be absolutely interchangeable with as little hand work as possible, the difficulty of the task was realized. The Defiance Machine Co. of Defiance, Ohio, entered this line of manufacture early and undertook to design and build special machinery for handling rifle stocks so as to eliminate practically all hand operations. The result has been that a complete line of rifle machinery has been designed and built which will turn out military rifle stocks on an interchangeable basis at a speed giving a production in the neighborhood of one and one-quarter man-hour for the stock and about one-quarter man-hour for the hand guard. The operations which follow cover the manufacture of the stock and give an idea of the difficult nature of the work.

OPERATIONS ON STOCK

The stock (see Fig. 54) and hand guard (Fig. 66) are made from various grades of wood, walnut being most generally used. This has to be seasoned for approximately three years and is received by the rifle plant in the rough sawn condition. It is again seasoned and the first machining operation is to joint one side so as to take out any twist. It is then planed on the opposite side to straighten it and bring it to approximately the required thickness. The stock is then rough-turned, after which it is grooved for the barrel and inletted for the receiver. The barrel groove and top edge, after being machined, act as locating points for the subsequent machining and gaging operations. For speeds, feeds and production, see Table XXVIII.

Operation 1: Joint One Side.—This is accomplished on a 16-inch hand feed planing and jointing machine, in which a three-knife cutter-head is used. The number of cuts required to take out the twist in the stock depends, of course, upon its condition.

Operation 2: Plane Other Side to Thickness.—This operation is accomplished on a 26-inch four-roll surface planer which is capable of handling four stocks at one time. This machine also uses a three-knife cutter-head and has a power roll feed.

Operation 3: Trim Both Ends.—This is done by a single-head trimming or equalizing saw. The table of the machine is provided with gages for gaging the cuts on both ends of the stock.

Operation 4: Joint Top Edge.—This is accomplished on a facing saw. The stock is clamped to a metal pattern which is placed on the table of the sawing machine and is then moved past the trimming saw.

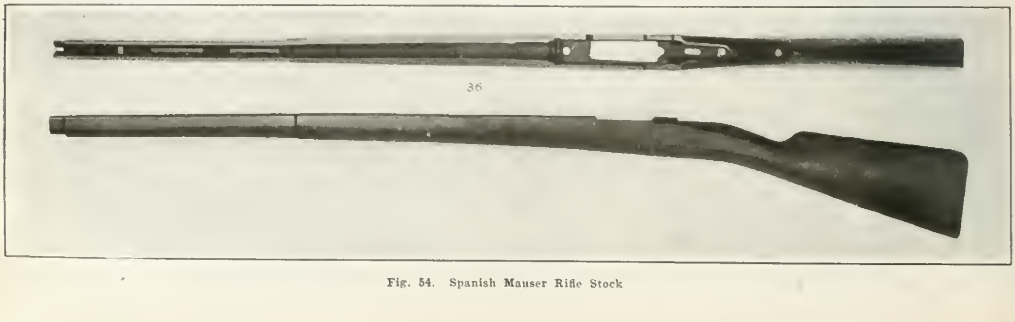


Fig. 54. Spanish Mauser Rifle Stock

Operation 5: Lay out to Pattern.—This is a hand operation and consists in scribing around the pattern, leaving sufficient stock for turning.

Operation 6: Band-saw to Shape.—This operation is accomplished by a 36-inch band sawing machine, using a saw ½ inch wide. The stock is roughed out to the previously outlined pattern marks.

Operation 7: Bore Driving Holes in Butt End.—This is accomplished on a two-spindle horizontal boring machine. The stock is located from the previously jointed top surface and ordinary boring bits are used.

Operation 8: Inspect.—This is done to see if the stock has any shakes or defects after a cut has been taken all around.

Operation 9: Turn Butt End, Rough.—This operation is performed on a gun stock copying lathe. The stock is driven from the butt end by means of two driving pins and held by the muzzle end in a clamping fixture. The cutters are of the scoop type, twelve being fastened to a revolving head. This cut extends to a point slightly beyond the lower band groove.

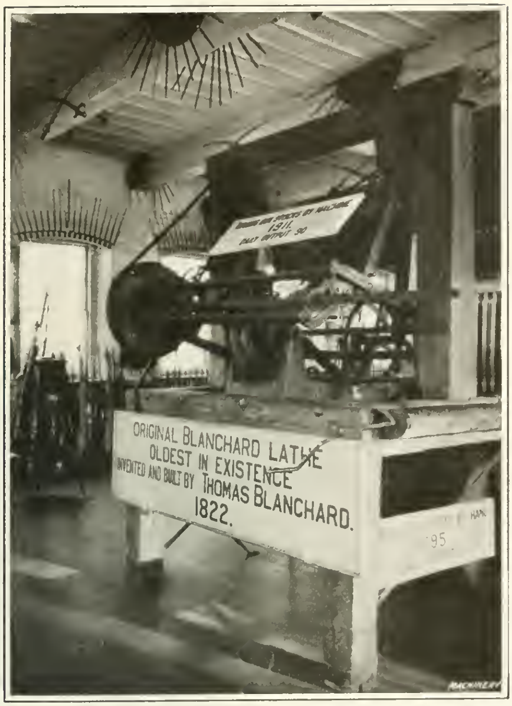


Fig. 55. Original Blanchard Lathe designed and built in the Springfield Armory in 1822 by Thomas Blanchard

Operation 10: Turn Fore End, Rough.—This is accomplished on a special gun stock fore end turning lathe. The stock is held in the same manner as for the previous operation, and the turning is done with a series of cutters which are clamped to a revolving cutter-head. The cutters are about 2 inches wide, and the cuts extend slightly beyond the previous roughing cut on the butt end.

Operation 11: Spot One Side for Bearing Points.—This is done on a special spotting machine which has a special clamping fixture, the stock being located from the previously finished top surface. The table moves up and down past a series of cutters which are about 1¼ inch wide, and are of the circular solid blade type.

Operation 12: Rout and Bed Barrel Groove, and Rough Inlet for Receiver.—This operation is performed on a six-spindle barrel inletting and bedding machine. The first series of operations consists in routing out the barrel groove with an expanding routing cutter controlled by taper guides. This makes the groove in the barrel tapered, and leaves as little stock as possible to be removed by the finish bedding cutters. The next operation consists in roughing out the impressions for the receiver, which is accomplished by means of routing cutters controlled by templets or guides. After the outline for the receiver has been rough-routed, the barrel bedding is finished by bringing down a long bar extending the full length of the stock and carrying a series of blade cutters overlapping each other and located spirally. This is fed directly down into the groove of the stock, and finishes the different shoulders to the required length and radius. For this operation the stock is held by being clamped up against the top surface and the five previously finished bearing points.

Operation 13: Inspect.—This is necessary to see that every operation has been properly conducted up to this point.

Operation 14: Inlet for Receiver and Lightening Cuts.—This operation is accomplished on a five-spindle inletting machine, using the same type of cutters as for the previous inletting

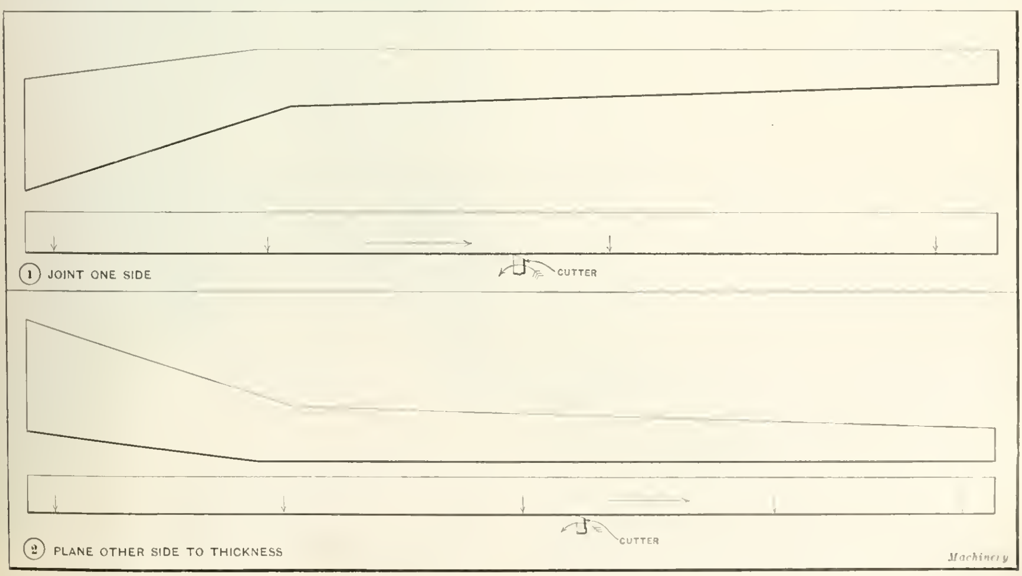
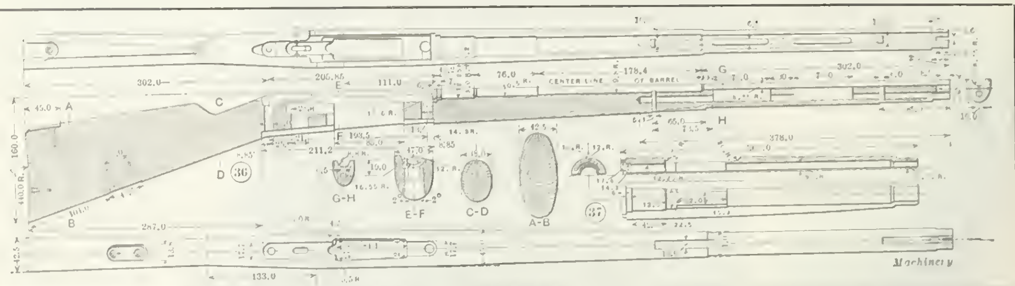


Fig. 56. Operations on Spanish Mauser Rifle Stock

TABLE XXVIII. OPERATIONS ON STOCK AND HAND GUARD



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed, Feet per Min.	Hourly Product per Mach.	Machs. per Operator
1	Joint one side	16-inch planing and jointing mach.	Three-blade cutter-head	6500	Hand	100	1
2	Plane other side to thickness	26-inch four-roll surface planer	Three-blade cutter-head	6500	50	800	2 men
3	Trim both ends	Trimming saw	Gages Roller table Cut-off saw	9000	Hand	100	1
4	Joint top edge	Facing saw	Roller table Clamp. fixt.	9000	Hand	100	1
5	Lay out to pattern	Bench work	Templet	..	..	200	1
6	Band-saw to shape	36-inch band saw. mach.	½-inch band saw	4500	Hand	100	1
7	Bore driving holes in butt end	Two-spindle horiz. boring mach.	Clamp. fixt. Wood bit	2000	Hand	200	1
8	Inspect	Bench work	Gages	..	..	50	1
9	Turn butt end, rough	Gun stock copying lathe	12-knife cutter-head	7000	¾	12	3
10	Turn fore end, rough	Semi-auto. gun stock lathe	Spec. cutter-head	6500	Hand	55	2
11	Spot one side for bearing points	Spec. spotting mach.	Clamp and movable table	960	Hand	135	1
12	Rout and bed barrel groove and rough inlet for receiver	Six-spindle inletting and barrel bedding mach.	Clamp. fixt. Forms and special cutter-bar	400-1800	Hand	8	1
13	Inspect	Bench work	......	..	..	25	1
14	Inlet for receiver and lightening cuts	Five-spindle inletting mach.	Clamp. fixt. Forms and spec. cutter	400-600	Hand	25	1
15	Center sides with barrel groove	Two-spindle vertical shaping mach.	Spec. clamp. fixt.	5000	Hand	100	1
16	Face top to barrel center line	Two-spindle vertical shaper	Spec. clamp. fixt.	5000	Hand	100	1
17	Shape top and lower edges of butt	Two-spindle vertical shaper	Spec. clamp. fixt.	5000	Hand	100	1
18	Trim butt and fore end and profile butt	Comb. vertical profiler and trim. saw	Spec. clamp. fixt.	5000-9000	Hand	90	1
19	Inlet for butt plate tang and drill butt plate holes	Inlet. and drill. mach., four spindles	Spec. clamp. fixt.	400-600	Hand	100	1
20	Inlet and drill for butt sling swivel block	Three-spindle inlet. mach.	Spec. clamp. fixt.	400-600	Hand	120	1
21	Inlet for magazine and trigger guard	Five-spindle inlet. mach.	Spec. clamp. fixt.	400-600	Hand	40	1
22	Inspect	Bench work	Gages	..	..	25	1
23	Turn butt end, finish	Gun stock copying lathe	Twelve-blade cutter-head	7000	⅝	6	4
24	Turn for band seats	Semi-auto. gun stock lathe	Spec. cutter-head	6500	Hand	50	1
25	Turn in between bands	Semi-auto. gun stock lathe	Spec. cutter-head	6500	Hand	50	1
26	Profile bolt, retaining bolt and cartridge clearance cuts	Three-spindle profiling mach.	Profiling cutters	400 600	Hand	50	1
27	Bore cleaning rod hole	One-spindle horiz. boring mach.	Spec. bush. Clamp. fixt.	140	Hand	50	1
28	Drill upper band nose plate pin hole	Two-spindle horiz. drill. mach.	Spec. fixt.	70	Hand	200	1
29	Inlet for band spring catch seats	Three-spindle inlet. mach.	Spec. fixt. and guide	400-600	Hand	35	1
30	Slot for tang on upper band nose plate	Grooving mach.	Spec. fixt. Slitting saw	9000	Hand	240	1
31	Square band spring catch slots	Mortising mach.	Spec. fixt. Mort. cutter	50 st'k's	Hand	40	1
32	Shape around sides of butt end	Spec. shap. mach.	Spec. fixt. Three-blade cutter-head	6500	Hand	50	1
33	Finish-shape sides of stock	Two-spindle vertical shaping mach.	Spec. fixt. Three-blade cutter-head	6500	Hand	100	1
34	Square corners in receiver opening	Bench work	Hand tools	..	..	25	1
35	Hand scrape	Bench work	Wood shave	..	..	25	1
36	Hand sandpaper	Bench work	No. 0 sandpaper	..	..	25	1
37	Polish	Polishing lathe	Cotton wheel	5500	Hand	25	1
38	Oil	Dipping tanks	......	..	..	25	1
39	Wipe	......	Waste	..	..	150	1
40	Inspect	....	Gages	..	..	25	1

OPERATIONS ON HAND GUARD

Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed, Feet per Min.	Hourly Product per Mach.	Machs. per Operator
1	Plane one side of block	16-inch hand-fed jointer	Three-blade cutter-head	6500	Hand	1400	1
2	Rip to seven taper blanks	Slide-table saw	Spec. hollow-ground saw	9000	Hand	175	1
8	Saw to turning length	Double-ended equalizing saw	Cut-off saws	9000	Hand	240	1
4	Rout and bed barrel groove	Barrel routing and bedding mach.	Spec. clamp. fixt.	400-1800	Hand	50	1
5	Face to center line of barrel groove	Two-spindle vertical shaper	Three-blade cutter head	6500	Hand	100	1
6	Turn outside diameter—two at a time	Semi-auto. gun stock lathe	Spec. cutter-head	6500	Hand	120	1
7	Cut off stubs to length	Double-ended equalizing saw	Spec. fixt.	9000	Hand	180	1
8	Gaine sight slide clearance flat	Gaining mach.	Spec. fixt. Cutter-head	6500	Hand	100	1
9	Groove sighting clearance	Gaining mach.	Spec. cutter-head	400	Hand	100	1
10	Inlet for sight base	Three-spindle inlet. mach.	Spec. fixt.	400 600	Hand	50	1
11	Square out corners for sight base	Bench work	Hand tools	..	..	20	1
12	Gaine stock mortise band clearance	Gaining mach.	Spec. fixt. Spec. cutter-head	400	Hand	100	1
13	Hand sandpaper	Bench work	No. 0 sandpaper	..	..	45	1
14	Polish	Polish. lathe	Cotton wheel	5500	Hand	40	1
15	Oil	Dipping tanks	......	..	..	25	1
16	Wipe	......	Waste	..	..	250	1
17	Inspect	......	Gages	..	..	50	1

operation. In this case the inletting for the receiver is finished and the lightening cuts at the fore end of the stock are also produced.

Operation 15: Center Sides with Barrel Groove.—This is done on a vertical shaping machine of a special type, the spindles being located close together. The stock is clamped to a special fixture which fits in the barrel groove. This centering operation is necessary to insure the sides being parallel with the barrel groove, as in some of the previous operations the sides were used for locating points. In this operation these locating points are removed from the side of the stock.

Operation 16: Face Top to Barrel Center Line.—This is accomplished on a vertical shaping machine that has one cutter-head. The stock is located from the barrel groove and one of the finished sides.

Operation 17: Shape Top and Lower Edges of Butt.—This

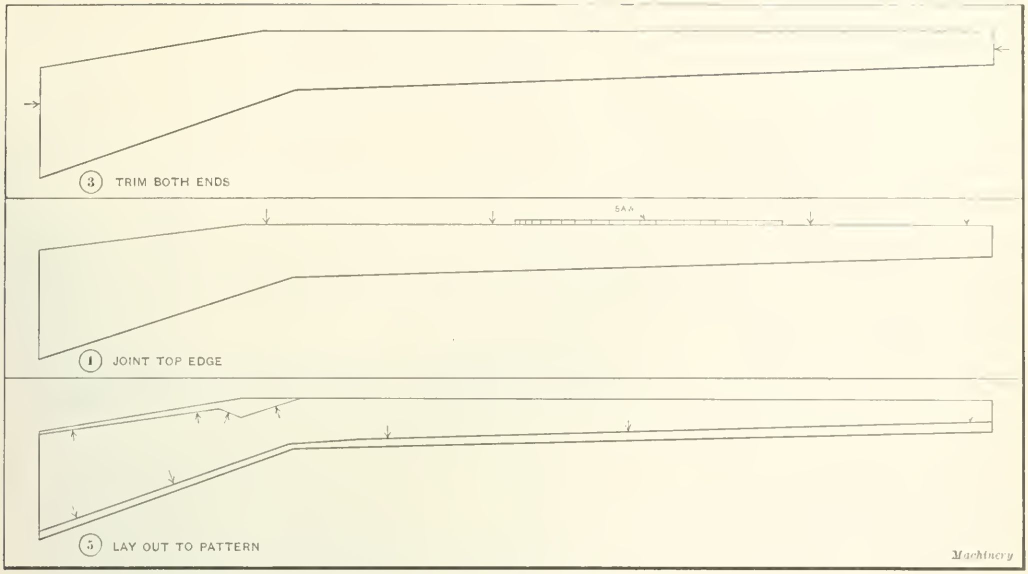


Fig. 57. Operations on Spanish Mauser Rifle Stock (Continued)

operation is performed on a special shaping machine. The stock is clamped in a fixture, and the cut is made on the butt end so as to get the proper drop on the butt portion of the stock for the following operation.

Operation 18: Trim Butt and Fore End and Profile Butt.—This is accomplished on a special combination vertical profiler and trimming saw, using a special fixture in which the stock is clamped from one side and the barrel inlet.

Operation 19: Inlet for Butt Plate Tang and Drill Butt Plate Holes.—This is done on a combination inletting and drilling machine having three inletting spindles and one horizontal drilling spindle. The stock is clamped from one side and the barrel groove, as in the previous operation.

Operation 20: Inlet and Drill for Butt Sling Swivel Block.—This operation is accomplished on a three-spindle inletting machine. The stock is held in the same manner as for Operation 19.

Operation 21: Inlet for Magazine and Trigger Guard.—This is accomplished on a five-spindle inletting machine, using profiling cutters which are controlled by special former plates.

Operation 22: Inspect.—This is necessary to see that the previous operations have been properly conducted before the stock is passed on to the final machining operations.

Operation 23: Turn Butt End, Finish.—This operation is accomplished in a special gun stock copying lathe, using the same type of cutters as in the rough-turning operation. The turning is carried on down to the lower band spring seat.

Operation 24: Turn for Band Seats.—This is accomplished in a semi-automatic gun stock lathe, using a fixture that holds the stock from the barrel groove, and a cutter-head similar to that used for turning the fore end of the stock. Cams control the shape of the cut.

Operation 25: Turn in between Bands.—This is done in a semi-automatic gun stock lathe, using a special cutter-head in which the blades are located in a helical path. In this case the work is turned by one straight-in cut.

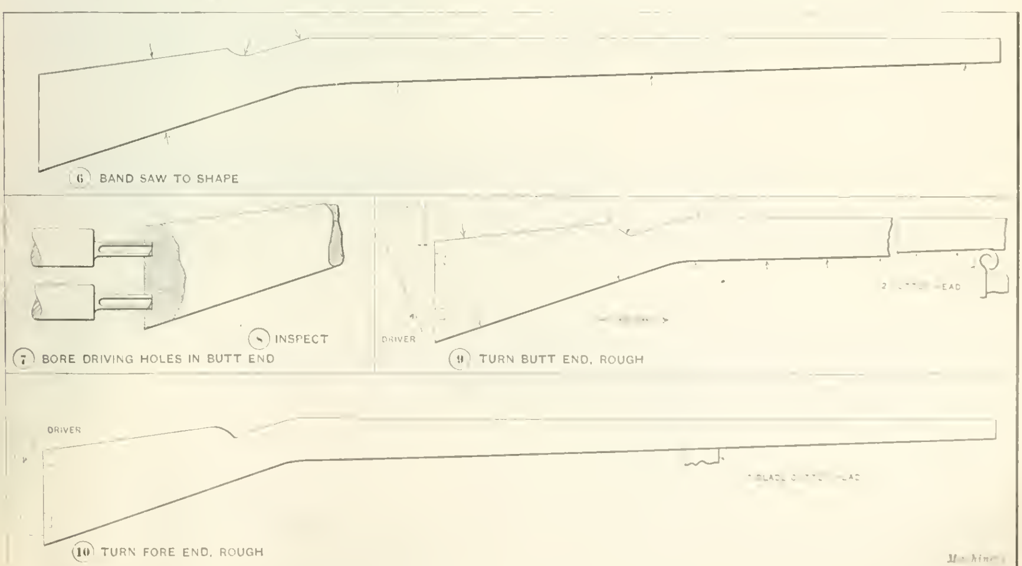


Fig. 58. Operations on Spanish Mauser Rifle Stock (Continued)

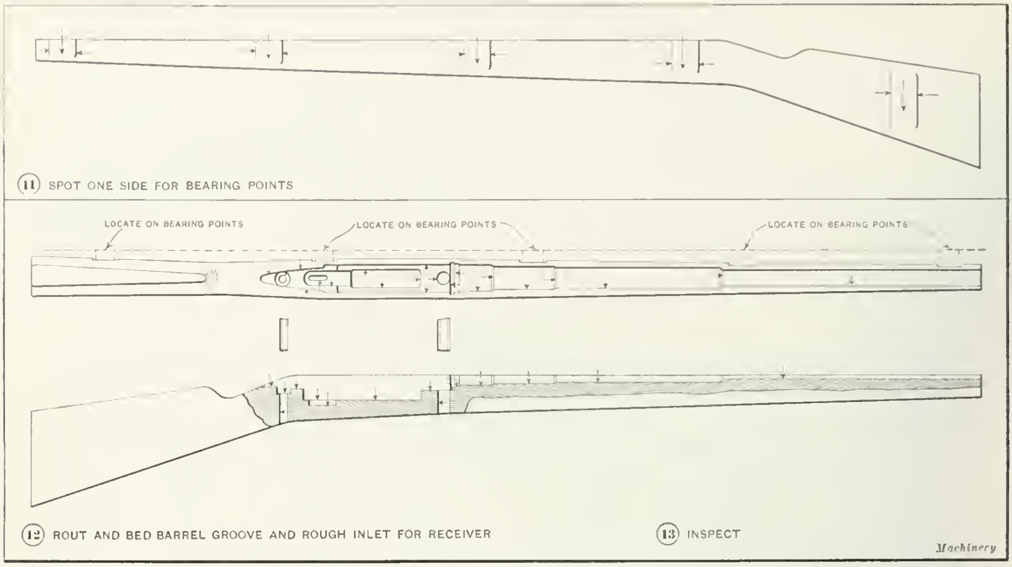


Fig. 59. Operations on Spanish Mauser Rifle Stock (Continued)

Operation 26: Profile Bolt, Retaining Bolt, and Cartridge Clearance Cuts.—This operation is accomplished on a three-spindle profiling machine, using profiling cutters of the regular type and former plates for controlling the movement of the cutters. The stock is located from the barrel groove.

Operation 27: Bore Cleaning Rod Hole.—This is accomplished on a one-spindle horizontal boring machine, using a special fixture for holding the work and an extension boring tool.

Operation 28: Drill Upper Band Nose Plate Pin Hole.—This is done on a two-spindle horizontal drilling machine, the hole being drilled from both sides.

Operation 29: Inlet for Band Spring Catch Seats.—This operation is performed on a three-spindle inletting machine, using regular profiling cutters controlled by former plates.

Operation 30: Slot for Tang on Upper Band Nose Plate.—This is accomplished on a special grooving machine, using a grooving cutter. The table is moved up past the cutter.

Operation 31: Square Band Spring Catch Slots.—This is done on a vertical mortising machine, using a hollow chisel and clamping the work in a special fixture.

Operation 32: Shape Around Sides of Butt End.—This operation is accomplished on a special horizontal shaping machine. The stock is held to a special former fitting in the butt plate profiled outline. At the same time, a roller on the cutter-bar operates on the opposite end of the stock near the point which is reduced for the "pistol grip." The stock is then rotated around on top of the cutter-head by hand, and finished off in this manner, removing all the previous spiral tool marks.

Operation 33: Finish-shape Sides of Stock.—This operation is accomplished on a two-spindle vertical shaping machine, using cutters of the form type. The stock is clamped to a special fixture and located from the top face and barrel groove. This fixture carries a pattern that controls the shape of the stock, or its position relative to the cutter-head.

Operation 34: Square Corners in Receiver Opening.—This is

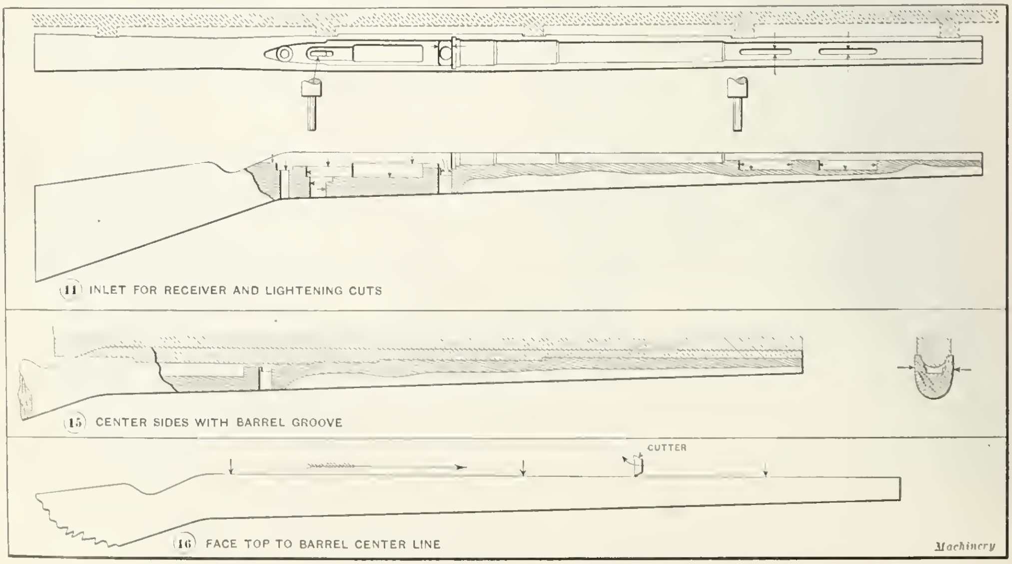


Fig. 60. Operations on Spanish Mauser Rifle Stock (Continued)

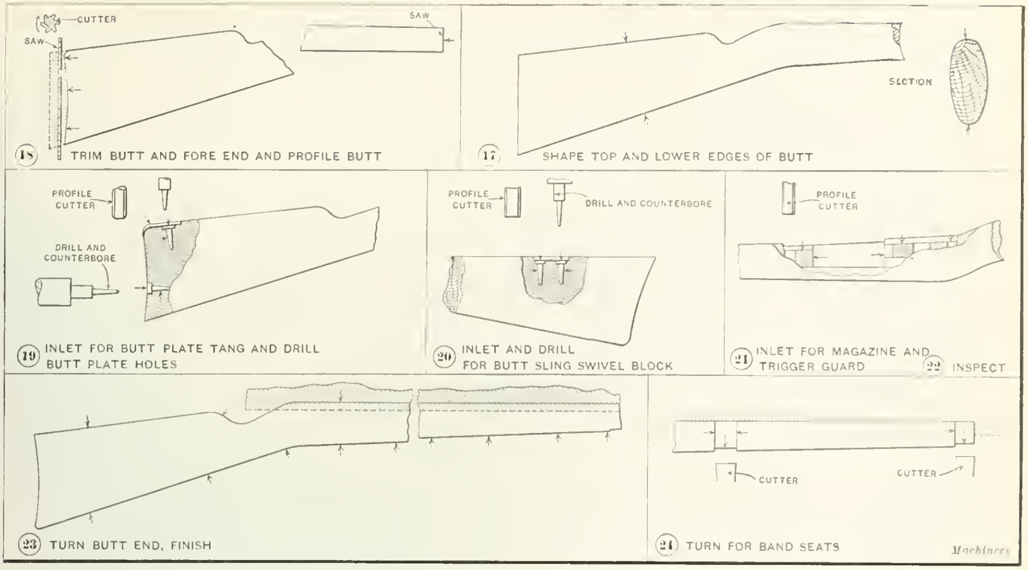


Fig. 61. Operations on Spanish Mauser Rifle Stock (Continued)

a bench operation and consists in using hand tools for squaring out the corners previously left round by the inletting operation.

Operation 35: Hand Scrape.—This is also a bench operation, consisting in using a wood shave for finishing the stock at those points where the cutter-heads have left feed marks. The stock is scraped down slightly below the depth of the feed marks.

Operation 36: Hand Sandpaper.—This is also a bench operation, and consists in sandpapering the stock, ready for polishing.

Operation 37: Polish.—This is accomplished by a cotton wheel rotated at a speed of about 5500 surface feet per minute. The surface of the wheel is generally left plain for finishing rifle stocks, because a high polish is not desired.

Operation 38: Oil.—This consists in dipping the stock in linseed oil and allowing the oil to penetrate about 1/16 inch.

Operation 39: Wipe.—This consists in drying off all the superfluous oil and cleaning the stock with cotton waste.

Operation 40: Inspect.—This is the final inspection and consists in going over all parts of the stock to see that it is up to the required dimensions and has no imperfections.

OPERATIONS ON HAND GUARD

The hand guard is made from the same material as the stock, and it is often made from stocks which have imperfections that prevent them from passing inspection; in such cases, the stock is cut up into strips and used for the hand guard, the imperfect portions being thrown away. When this plan is followed, the preliminary operations vary somewhat from those followed when the hand guard is made from blocks of the required size. In order to make the following description clear, we will start with a block of stock of a sufficient length and width to make seven hand guards. The operations on this part are somewhat

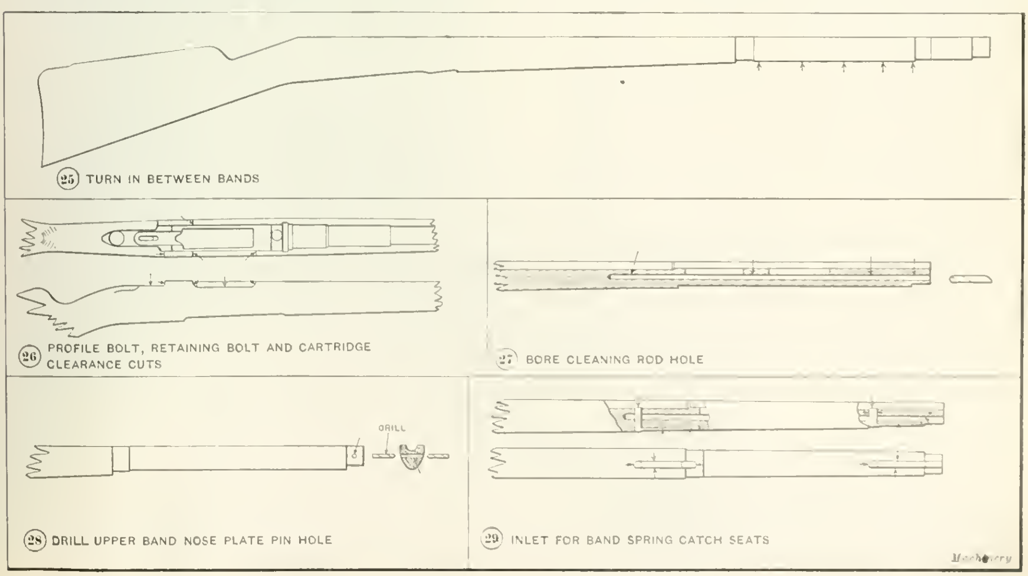


Fig. 62. Operations on Spanish Mauser Rifle Stock (Continued)

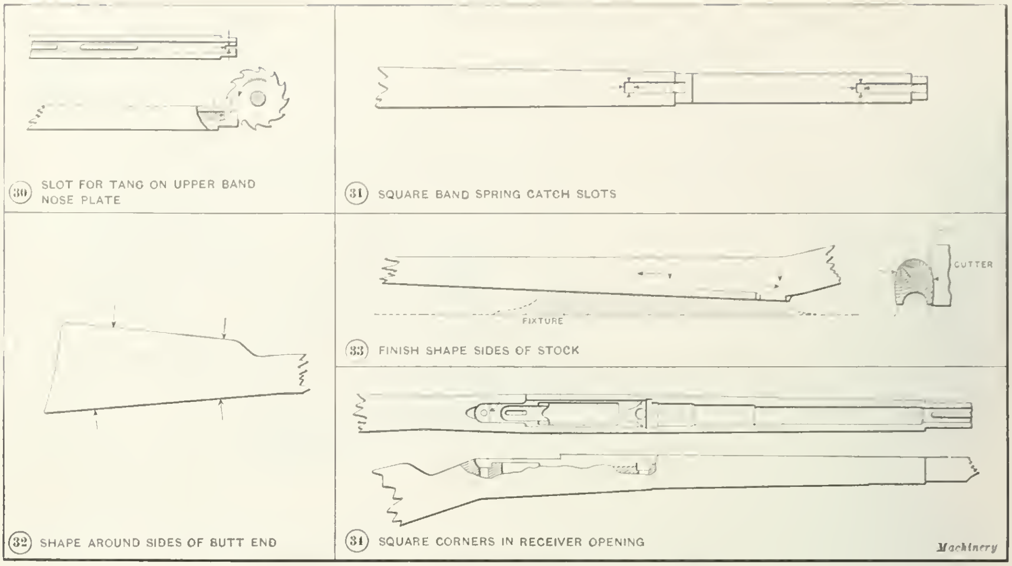


Fig. 63. Operations on Spanish Mauser Rifle Stock (Continued)

similar to those on the stock, with the exception of the inletting operation. For the finishing operations the groove and top face act as locating and gaging points.

Operation 1: Plane One Side of Block.—This operation is accomplished on a 16-inch hand-fed jointer, in which a three-blade type of cutter-head is used to straighten up one side of the piece.

Operation 2: Rip to Seven Taper Blanks.—This is accomplished by a slide-table saw, using a special hollow-ground saw. The table has guides for controlling the dimensions of the pieces being cut up.

Operation 3: Saw to Turning Length.—This is done on a double-ended or equalizing saw that cuts off both ends at the same time.

Operation 4: Rout and Bed Barrel Groove.—This operation is accomplished on a barrel routing and bedding machine, which is operated in a somewhat similar manner to the machine described for inletting the groove for the barrel in the stock, with the exception that it has fewer spindles and uses a much shorter bedding cutter-bar.

Operation 5: Face to Center Line of Barrel Groove.—This is accomplished on a two-spindle vertical shaping machine, only one spindle of which is used. The hand guard is held in a special fixture and the machining is done with a three-blade cutter-head.

Operation 6: Turn Outside Diameter—Two at a Time.—This is done in a semi-automatic gun stock lathe with a special holding fixture for holding two hand guards. These pieces are gripped from the end by a clamping device, and the turning is done with a special cutter-head having blades arranged spirally on the head.

Operation 7: Cut Off Stubs to Length.—This operation is accomplished on a double-ended equalizing saw, using a special fixture for holding the work. The stubs are cut off so as to bring the hand guard to approximately the required length. The stubs were used in the previous operation for clamping the two pieces to the holding fixture while turning the external diameter.

Operation 8: Gaine Sight Slide Clearance Flat.—This is accomplished on a single-head semi-automatic gaining machine in which the work is held in a special fixture, and the flat is cut with a series of cutters held in a special cutter-head.

Operation 9: Groove Sighting Clearance.—This operation is also accomplished on a gaining machine, using a special fixture for holding the work and a special cutter-head.

Operation 10: Inlet for Sight Base.—This is done on a three-spindle inletting machine, using a special fixture for holding the work.

Operation 11: Square Out Corners for Sight Base.—This operation is accomplished on the bench by means of hand tools. While the corners are being squared out, the groove in the front end of the guard for clearing the stock mortise band is also finished.

Operation 12: Gaine Stock Mortise Band Clearance.—This is accomplished on a gaining machine of the single-head semi-automatic type in which the work is held in a special fixture and the cutting is done with a three-blade cutter-head.

Operation 13: Hand Sandpaper.—This is done on the bench and consists in sandpapering the hand guard with No. 0 sandpaper.

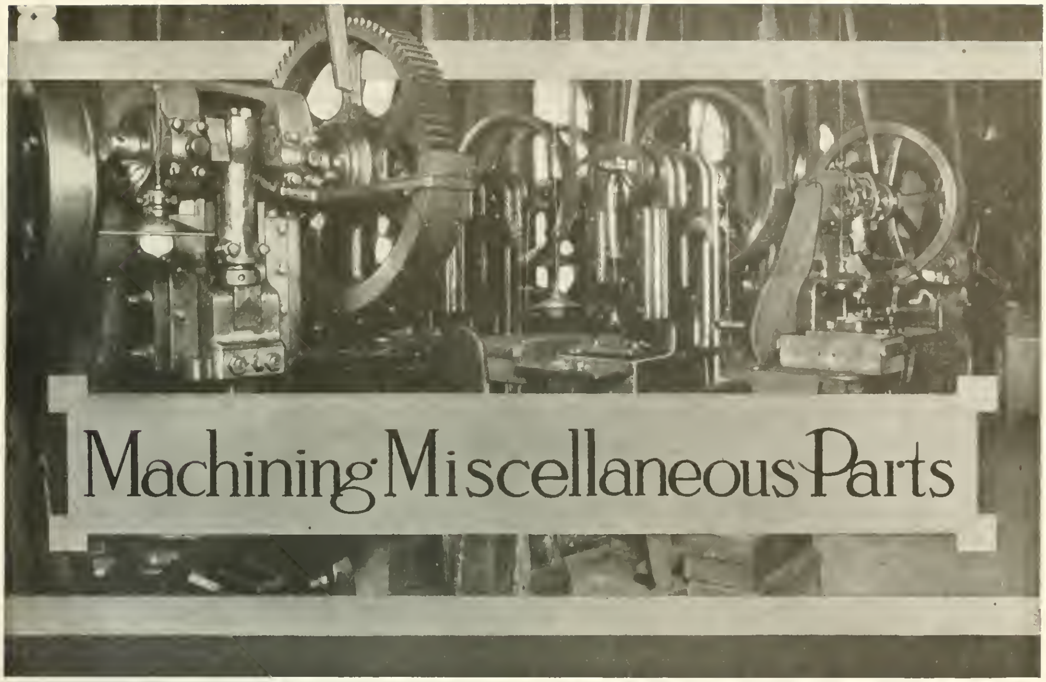
Operation 14: Polish.—This operation is accomplished in a polishing lathe with a cotton wheel rotated at 5500 surface feet per minute. No polishing material is used on the wheel.

Operation 15: Oil.—This consists in dipping the hand guards into tanks and allowing them to remain immersed until the linseed oil has soaked in.

Operation 16: Wipe.—This consists in wiping off the excess linseed oil with cotton waste.

Operation 17: Inspect.—This consists in giving the hand guard a final inspection for size and other defects.

In the preceding description, it will be noticed that no reference was made to machine sandpapering. In the general wood-working industry, there are two principal methods used for this work. One consists in using a drum to which sandpaper is fastened; this can only be used for sandpapering portions that are straight, and not of irregular outline. The other, which is known as the strap method, makes use of a belt mounted on pulleys which can be adjusted to keep the belt taut. The exposed surface of this belt is coated with special sand crystals of the desired "grain." The first method has been used with success for sandpapering the fore end of rifle stocks, and in some cases the second method has been used for sandpapering the irregular surfaces of the stock. In connection with the manufacturing operations outlined, neither of these methods has been recommended for the reason that the specifications for military rifle stocks are more exacting as regards interchangeability than as regards surface finish. An endeavor is made as far as possible to do all the machining by the cutters, which leaves little or no feed marks, and then to smooth the upper surfaces by hand with sandpaper. This is to prevent gouging of the stock, which sometimes occurs when using the belt sandpapering method.



Machining Miscellaneous Parts

OPERATIONS ON BUTT PLATE

THE butt plate (see Fig. 66) is made from a forging of gun steel. This part can either be produced by forging direct or can be made from a blank upset in a power upsetting and forging machine; the latter method has been adopted in this case. After blanking and upsetting, the upset part is again heated and bent to shape, after which it is annealed and pickled. As the inner surfaces of this butt plate which lie next to the stock are not machined, a second forging is necessary. This is done with the work at a temperature of about 900 degrees F. The part is then allowed to cool off gradually, ready for machining. The first machining operations consist in drilling and reaming the screw holes which act as locating and gaging points for subsequent operations.

Operation 1: Blank.—This operation is accomplished on a No. 5 "Stiles" punch press, using a blanking punch and die.

Operation 2: Upset, Hot.—This is accomplished on a 2-inch upsetting and forging machine, using the ordinary type of gripping dies. The work is heated to about 1600 degrees F.

Operation 3: Bend, Hot.—This is done on a No. 5 "Stiles" punch press, using a bending punch and die. For bending, the piece is heated to about 1200 degrees F.

Operation 4: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 5: Re-strike, Hot.—This operation is performed on an 800-pound drop-hammer, and consists in re-striking the part so as to smooth up the inner surface and make machining unnecessary. The work is heated not higher than 900 degrees F.

Operation 6: Drill, Ream and Countersink Screw Holes.—This is accomplished on a three-spindle sensitive drilling machine, using a special jig with feet on two sides.

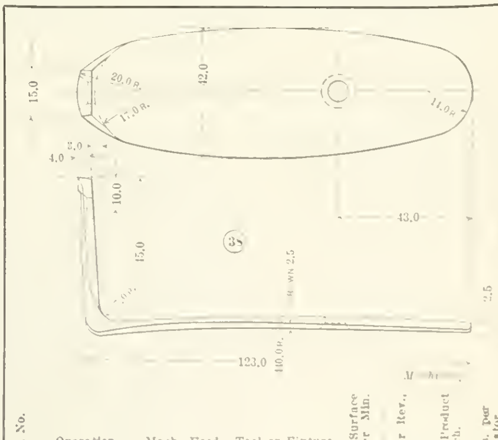
Operation 7: Profile Contour, Rough and Finish.—This is done on a two-spindle profiling machine, using a special fixture and a roughing and finishing profiling cutter.

Operation 8: Mill Circular Surface on Tang.—This is accomplished on a Lincoln type milling machine with a special fixture that holds two pieces. Two form milling cutters are used.

Operation 9: Profile Outline on Tang, Rough and Finish.—This operation is performed on a two-spindle profiling machine, using a special fixture for holding the work with the tang in a horizontal position. This necessitates using profiling cutters that are larger at the lower end than at the shank.

Operation 10: Profile Rear End Form, Rough and Finish.—This is accomplished on a two-spindle profiling machine, using a special fixture provided with a guide which controls the movement of the profiling cutters. The cutters are about 1½ inch in diameter, and have tangs, the regular profiling pins not being used.

TABLE XXIX. OPERATIONS ON BUTT PLATE PART NO. 38



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Blank	No. 5 punch press	Blanking punch and die	60 st'k's	Hand	300	1
2	Upset, hot	2 inch upsetting and forging mach.	Forging dies and plunger	70 st'k's	Hand	160	1
3	Bend, hot	No. 5 punch press	Bending punch and die	[illegible] st'k's	Hand	200	1
4	Anneal and pickle	Anneal. furn. Pickling bath				[illegible]	See text
5	Re-strike, hot	800 lb. drop-hammer	Forging dies	..	..	50	1

TABLE XXIX. OPERATIONS ON BUTT PLATE—(CONTINUED)

Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
6	Drill, ream and counter-sink screw holes	3-spindle sensitive drill. mach.	Spec. jig	30-70	Hand	40	1
7	Profile contour, rough and finish	2-spindle profiling mach.	Spec. fixt.	70-90	Hand	15	1
8	Mill circular surface on tang	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.040	60	2
9	Profile outline on tang, rough and finish	2-spindle profiling mach.	Spec. fixt.	70-90	Hand	20	1
10	Profile rear end form, rough and finish	2-spindle profiling mach.	Spec. fixt. Spec. cutters	60	Hand	20	1
11	Stamp	Bench work	Hand stamps	..	..	250	1
12	File and burr	Bench work	Files	..	..	50	1
13	Polish	Polishing lathe	Leather cov. wheels	5000	Hand	40	1
14	Blue	Niter bath	......	..	..	See text	

Operation 11: Stamp.—The number is stamped on the part.

Operation 12: File and Burr. This is a hand operation, consisting in removing the burrs and sharp corners.

Operation 13: Polish.—See "Polish."

Operation 14: Blue. See "Blue—Niter Process."

OPERATIONS ON SEAR

The sear (Fig. 33, April MACHINERY) must be hardened and tempered and is made from crucible or lockwork steel as shown in Table IV. The first operation is to shear off pieces of the required length from a 7/8 by 9/16 inch rectangular bar of hot-drawn stock. The piece is then finish-milled on one side and rough-milled on the bottom, after which it is finish-milled on the opposite side. The sides and the bottom then act as locating surfaces while milling the top. The bottom and top are then finish-milled and in the subsequent machining and gaging operations the sides and the bottom surfaces act as the locating points. For feeds, speeds, production, etc., see Table XXX.

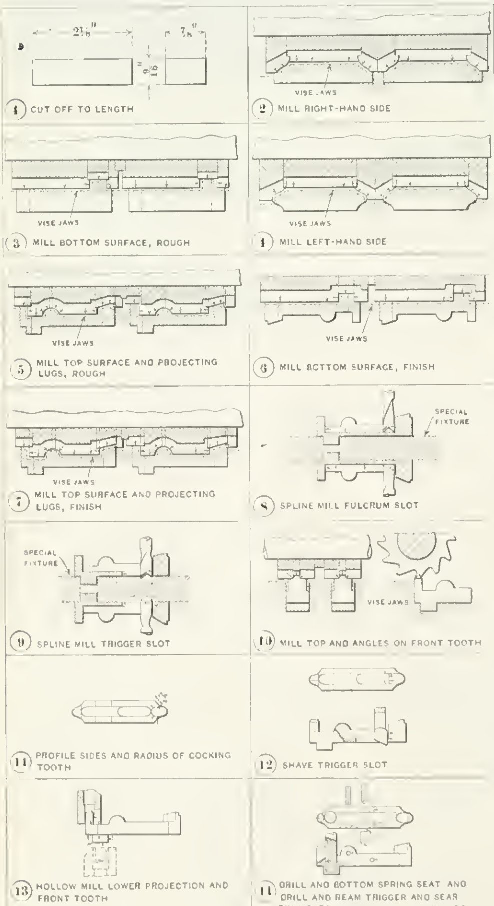
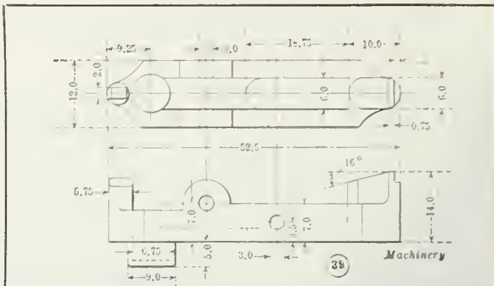


Fig. 64. Operations on Sear

TABLE XXX. OPERATIONS ON SEAR PART NO. 39



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off to length	Punch press	Shearing punch and die	60 st'k's	Hand	1500	1
2	Mill right-hand side	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	30	0.040	60	2
3	Mill bottom surface, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	30	0.040	90	2
4	Mill left-hand side	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	30	0.040	60	2
5	Mill top surface and projecting lugs, rough	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	30	0.032	55	2
6	Mill bottom surface, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	35	0.032	80	2
7	Mill top surface and projecting lugs, finish	Lincoln type mill. mach.	Spec. vise jaws; hold two pieces	35	0.032	70	2
8	Spline-mill fulcrum slot	P. & W. spline mill. mach.	Spec. fixt. holds two pieces	40	0.005	35	3
9	Spline-mill trigger slot	P. & W. spline mill. mach.	Spec. fixt. holds two pieces	40	0.005	60	2
10	Mill top and angles on front tooth	Hand mill. mach.	Spec. vise jaws; hold two pieces	40	Hand	45	1
11	Profile sides and radius of cocking-tooth	One-spindle profiling mach.	Spec. fixt.	40	Hand	40	1
12	Shave trigger slot	P. & W. vertical bench shav. mach.	Spec. fixt.	60 st'k's	..	50	1
13	Hollow-mill lower projection and front tooth	Two-spindle drilling mach.	Spec. jig	25	Hand	35	1
14	Drill and bottom spring seat, and drill and ream trigger and sear pin hole	Four spindle sensitive drill. mach.	Spec. jig	20-35	Hand	35	1
15	Stamp	Bench work	Hand stamps	..	..	250	1
16	File and burr	Bench work	Files	..	..	45	1
17	Harden and temper	Hard. fur. Temp. bath	......	..	..	150	..
18	Tumble	Tumbling barrel	......	20 R.P.M.	..	100	6

Operation 1: Cut Off to Length.—This operation is accomplished on a punch press, using a shearing punch and die. The press is operated at about sixty strokes a minute.

Operation 2: Mill Right-hand Side.—This is done on a Lincoln type milling machine, using a quick-acting vise with special jaws. The jaws are made to hold two pieces and formed milling cutters mill the side surfaces and the curve on each end.

Operation 3: Mill Bottom Surface, Rough.—This operation is performed on a Lincoln type milling machine, using a quick-acting vise with special jaws that hold two pieces. Three milling cutters are used for each piece, six being held on the arbor at once.

Operation 4: Mill Left-hand Side.—This is similar to Operation 2.

Operation 5: Mill Top Surface and Projecting Lugs, Rough.—This operation is accomplished on a Lincoln type milling machine, using a quick-acting vise with special jaws that hold two pieces. Formed milling cutters are used.

Operation 6: Mill Bottom Surface, Finish.—This is similar to Operation 3.

Operation 7: Mill Top Surface and Projecting Lugs, Finish.—This is accomplished in a similar manner to Operation 5.

Operation 8: Spline-mill Fulcrum Slot.—This is accomplished on a Pratt & Whitney spline milling machine, using a special fixture that holds two pieces.

Operation 9: Spline-mill Trigger Slot.—This is done on a Pratt & Whitney spline milling machine, using a special fixture. The milling is done with fish-tail cutters.

Operation 10: Mill Top and Angles on Front Tooth.—This is accomplished on a hand milling machine, using form milling cutters. A special fixture is used that holds two pieces.

Operation 11: Profile Sides and Radius of Cocking-tooth.—This operation is accomplished on a one-spindle profiling machine, using a special former plate.

Operation 12: Shave Trigger Slot.—This is accomplished on a Pratt & Whitney vertical bench shaving machine, using a special fixture.

Operation 13: Hollow-mill Lower Projection and Front Tooth.—This operation is performed on a two-spindle drilling machine. A special jig is used to hold the piece with bushings to receive and locate the hollow-milling tools.

Operation 14: Drill and Bottom Spring Seat, and Drill and Ream Trigger and Sear Pin Holes.—These operations are accomplished on a four-spindle sensitive drilling machine, using a special jig for holding the piece.

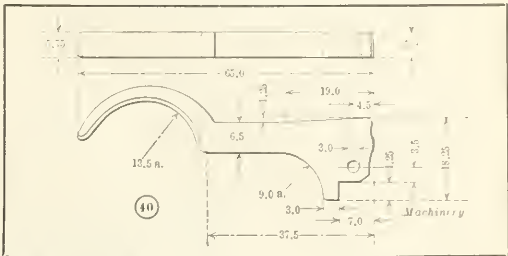
Operation 15: Stamp.—This operation consists in stamping the number on the part by hand.

Operation 16: File and Burr.—This is a hand operation.

Operation 17: Harden and Temper.—See "Harden" and "Temper."

Operation 18: Tumble.—See "Tumble."

TABLE XXXI. OPERATIONS ON TRIGGER—PART NO. 40



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Blank	No. 5 punch press	Blanking punch and die	60 st'k's	Hand	1000	1
2	Surface-grind both sides	Blanchard surf. grinder	Magnetic chuck	See text		250	1
3	Mill rear form	Lincoln type mill. mach.	Spec. vise and jaws	30	0.032	60	2
4	Drill and ream pin hole	Two-spindle sensitive drill. mach.	Spec. jig	15-30	Hand	70	1
5	Mill front form	Lincoln type mill. mach.	Spec. vise and jaws	30	0.032	60	2
6	Mill top form, rough and finish	Lincoln type mill. mach.	Spec. vise and jaws	30	0.032	60	2
7	Mill stop lug	Hand mill. mach.	Spec. vise and jaws	30	Hand	70	1
8	Profile finger piece radius	Two-spindle profiling mach.	Spec. fixt. holds two pieces	35	Hand	45	1
9	Profile serrations in finger piece	One-spindle profiling mach.	Spec. fixt. holds two pieces	85	Hand	60	1
10	Stamp	Bench work	Hand stamps	..	..	250	1
11	File and burr	Bench work	Files	..	..	60	1
12	Polish	Polishing lathe	Leather cov. wheels	4500	..	40	1
13	Harden	Hard. furn.	......	..	..	200	1
14	Polish	Polishing lathe	Leather cov. wheels	4500	..	60	1
15	Temper	Niter bath	Tongs	..	..	40	1

OPERATIONS ON TRIGGER

The trigger (see Fig. 33, April MACHINERY) is made from crucible or lockwork steel and is hardened and tempered. The top end is tempered just enough to relieve the strain, and the finger piece is drawn to a dark blue. The first machining operation consists in cutting out blanks of the required size and shape, leaving about 1/32 inch for finishing by milling. The blanks are then ground on both sides, after which the rear form is milled. The trigger pin hole is then drilled and reamed. The trigger pin hole and rear surface act as locating points for the subsequent machining and gaging operations. For additional details on feeds, speeds and production, see Table XXXI. The sequence of operations is illustrated in Fig. 65.

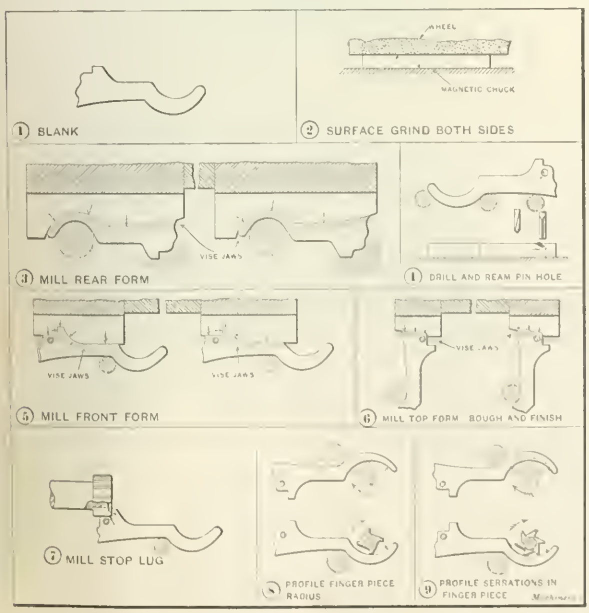


Fig. 65. Operations on Trigger

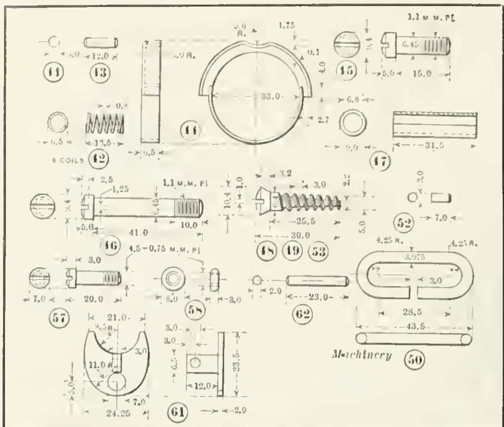
Operation 1: Blank.—This is accomplished on a No. 5 "Stiles" punch press, using a punch and die made from a high-grade tool steel, such as "purple Label Styrian." The stock is cut into strips of about five feet in length and is reversed after running through once, being fed by hand. Stock of a width slightly greater than the length of the trigger is used, and by reversing the stock considerable material is saved owing to the irregular shape of the part.

Operation 2: Surface-grind Both Sides.—These operations are accomplished on a Blanchard vertical surface grinder, which holds 175 pieces on the magnetic chuck. The wheel is 16 inches in diameter by $1\frac{1}{4}$ inch rim, grain 24, grade $\frac{3}{4}$ silicate, corundum, operating at 4190 feet surface speed per minute. The table speed is 13 R. P. M., roughing; 5 R. P. M., finishing. The down feed of the wheel is 0.001 inch per revolution of the table. The amount of material removed from each side is 0.015 to 0.030. The limits are $\pm$ 0.001 inch. The piece is ground with a taper on each side of about 0.004 inch.

Operation 3: Mill Rear Form.—This is done on a Lincoln type milling machine, using a quick-acting vise with special jaws that hold two pieces. Two eccentrically relieved high-speed milling cutters are used.

Operation 4: Drill and Ream Pin Hole.—This operation is performed on a two-spindle sensitive drilling machine, using an open type of jig with legs on both

TABLE XXXII. OPERATIONS ON MISCELLANEOUS SCREWS, PINS, ETC.



Part No.	Operation	Machine Used	Hourly Product per Mach.	Machs. per Operator
41, 43	Form, cut off and burr	Auto. forming mach. with burring attach.	1000	2
41, 43	Harden and temper	Hard. furn. Temp. bath	250	2
42	Coil, set and cut off	No. 1 spring coiling mach.	5000	4
42	Spring temper	Temper. bath	200	1
44	Blank and pierce	Punch press	1000	1
44	Draw	Punch press	1000	1
44	Trim lower end	Punch press	1000	1
44	Mill off inner flange	Hand mill. mach.	50	1
44	Polish	Polishing lathe	50	1
44	Blue	Niter bath	..	..
45	Form, turn, thread, cut off and slot	Auto. screw mach. with slotting attach.	100	3
45	Polish	Polishing lathe	120	1
45	Blue	Niter bath	..	..
46	Form, turn, thread, cut off and slot	Auto. screw mach. with slotting attach.	70	3
46	Polish	Polishing lathe	120	1
46	Blue	Niter bath	..	..
47	Turn, center, drill, ream, cut off and burr	Auto. screw mach. with slotting attach.	60	3
48-49-53	Turn, form, thread, and cut off	Hand screw mach. with thread chasing attach.	45	1
48-49-53	Shave head	No. 1 screw shav. mach.	120	1
48-49-53	Slot head	Screw slotting mach.	200	1
48-49-53	Blue	Niter bath	..	..
50	Cut off and form	No. 2 wire forming mach.	4500	4
50	Blue	Niter bath	..	..
52	Form, cut off and burr	Auto. forming mach. with burring attach.	1000	2
52	Harden and temper	Hard. furn. Temp. bath	250	2
57	Form, turn, thread, cut off and slot	Auto. screw mach. with slotting attach.	200	3
57	Polish	Polishing lathe	120	1
57	Blue	Niter bath	..	..
58	Form, spot, drill, tap, cut off and burr	Auto. screw mach. with burring attach.	250	3
58	Polish	Polishing lathe	120	1
58	Blue	Niter bath	..	..
61	Blank and pierce plate	Punch press	1000	1
61	Blank tang	Punch press	2500	1
61	Electric spot weld tang to plate	Butt welding mach.	60	1
61	Mill off burr	Hand mill. mach.	100	1
61	Drill hole in tang	One-spindle drill. mach.	200	1
61	File and burr	Bench work	60	1
61	Polish	Polishing lathe	150	1
61	Blue	Niter bath	..	..
62	Form, cut off and burr	Auto. forming mach. with burring attach.	1000	2
62	Harden and temper	Hard. furn. Temp. bath	200	2

sides so that the drilling can be done from one side and the reaming from the other.

Operation 5: Mill Front Form.—This is accomplished in a similar manner to Operation 3.

Operation 6: Mill Top Form, Rough and Finish.—This is done on a Lincoln type milling machine, using a quick-acting vise with special jaws that hold two pieces. The pieces are roughed in one side of the vise and finished in the other.

Operation 7: Mill Stop Lug.—This operation is accomplished on a hand milling machine, using a quick-acting vise that has special jaws.

Operation 8: Profile Finger Piece Radius.—This is accomplished on a two-spindle profiling machine, using a roughing and finishing cutter. Two pieces are held in the fixture at one time, and roughing and finishing cuts are taken from each.

Operation 9: Profile Serrations in Finger Piece.—This is performed on a one-spindle profiling machine, using a special fixture that holds two pieces. The cutter is shaped somewhat like a hob, having a series of concentric teeth located on its periphery.

Operation 10: Stamp.—This is a hand operation, consisting in stamping the numbers on the part.

Operation 11: File and Burr.—This consists in removing the burrs and sharp corners from the part.

Operation 12: Polish.—See "Polish."

Operation 13: Harden.—See "Harden."

Operation 14: Polish.—See "Polish."

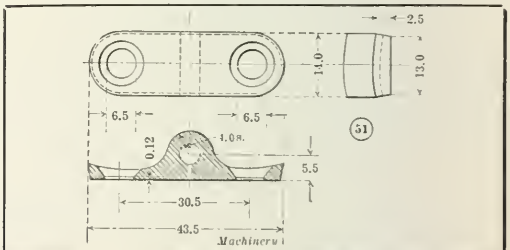
Operation 15: Temper.—In this operation the pieces are dipped in a niter bath with the finger piece down. They are held in a pair of tongs, and one piece is dipped at a time and allowed to remain in the bath until the top part of the trigger has reached a light straw color. It is then removed and immersed in water or oil.

OPERATIONS ON BUTT SLING SWIVEL BLOCK

The butt sling swivel block (see Fig. 66) is made from a hot-drawn bar of gun steel 7/16 inch thick by 1 3/4 inch wide. The most economical method of making this part is to rough out strips to the approximate shape and then cut them up into blocks of a width slightly greater than that of the finished piece. For making this particular part, strips 5 9/32 inches long are used. These are cut up in a cutting-off machine, and the first machining operation consists in milling the top surface. Then the bottom surface is milled and the strips are milled on the ends and cut up into eight pieces. The holes are now drilled and reamed, the screw holes acting as locating points for the subsequent machining operations. For speeds, feeds and production, see Table XXXIII.

Operation 1: Cut Off to 5 9/32 Inch Lengths.—This operation

TABLE XXXIII. OPERATIONS ON BUTT SLING SWIVEL BLOCK—PART NO. 51



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off to 5 9/32-inch lengths	Cutting-off mach.	Insert-tooth H. S. steel	40	0.060	480	2
2	Mill right-hand edge of strip	Lincoln type mill. mach.	Spec. vise jaws	60	0.040	960	2
3	Mill left-hand edge of strip	Lincoln type mill. mach.	Spec. vise jaws	60	0.040	960	2
4	Mill top surface of strip	Lincoln type mill. mach.	Special fixt. holds two strips	60	0.040	240	3
5	Mill bottom surface of strip	Lincoln type mill. mach.	Special fixt. holds two strips	60	0.040	240	3
6	Cut up into eight pieces	Lincoln type mill. mach.	Vise jaws; hold four strips	50	0.032	400	2
7	Drill and ream screw holes, swivel hole and swivel pin hole	Six-spindle sensitive drill. mach.	Drill jig	30-60	Hand	25	1
8	Profile outline, rough and finish	Two-spindle profiling mach.	Special magnetic fixt.	70	Hand	30	1
9	Profile bottom surface, rough and finish	Two-spindle profiling mach.	Special magnetic fixt.	70	Hand	25	1
10	Countersink screw holes	One-spindle sensitive drill. mach.	Holding fixt.	50	Hand	60	1
11	Stamp	Bench work	Hand stamps	..	..	250	1
12	Polish	Polishing lathe	Leather cov. wheels	5000	Hand	75	1
13	Blue	Niter bath	......	..	..	See text	

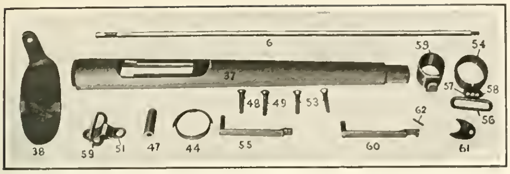


Fig. 66. Miscellaneous Parts used on Spanish Mauser Rifle

is accomplished on a cutting-off machine, using a high-speed steel inserted-tooth cutter. Six pieces are held in the vise at one time.

Operation 2: Mill Right-hand Edge of Strip.—This is accomplished on a Lincoln type milling machine, holding six strips in special vise jaws, and milling lengthwise of the strip.

Operation 3: Mill Left-hand Edge of Strip.—This is similar to Operation 2.

Operation 4: Mill Top Surface of Strip.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two strips.

Operation 5: Mill Bottom Surface of Strip.—This is similar to Operation 4, except that form milling cutters are used.

Operation 6: Cut Up into Eight Pieces.—This is accomplished on a Lincoln type milling machine, using a special vise with special jaws that hold four strips. The jaws are cut out so that the saws used for cutting up the strips pass through them. At the same time, the ends of the strips are milled.

Operation 7: Drill and Ream Screw Holes, Swivel Hole and Swivel Pin Hole.—These operations are accomplished on a six-spindle sensitive drilling machine, using a special jig of the invertible type with feet on three sides.

Operation 8: Profile Outline, Rough and Finish.—This is done on a two-spindle profiling machine, using a special magnetic fixture for holding the work. The work is located from the two screw holes. Two profiling cutters are used, one of which is straight and the other tapered.

Operation 9: Profile Bottom Surface, Rough and Finish.—This operation is accomplished on a two-spindle profiling machine, using roughing and finishing profiling cutters. The work is held on a special fixture designed to hold the work magnetically. Roughing and finishing cuts are taken from this surface.

Operation 10: Countersink Screw Holes.—This is done on a one-spindle sensitive drilling machine, using a special open jig for holding the work.

Operation 11: Stamp.—This consists in stamping the number on the part.

Operation 12: Polish.—See "Polish."

Operation 13: Blue.—See "Blue—Niter Process."

OPERATIONS ON LOWER BAND

The lower band (see Fig. 66) is drop-forged from a ½ by 1 inch rectangular hot-drawn bar of gun steel. After drop-forging, the part is trimmed, annealed and pickled, then both sides are ground on a vertical surface grinder, after which the hole is broached. In the subsequent operations, one face and the hole act as locating points. For additional details on feeds, speeds and production, see Table XXXIV.

Operation 1: Drop-forge and Trim.—This operation is accomplished by an 800-pound drop-hammer, using forging dies, and the trimming is done in a trimming press, using trimming punches and dies.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Grind Both Sides.—This is done on a Blanchard vertical surface grinder, which holds eighty pieces on the chuck at one time. The wheel is 16 inches in diameter, 1¼ inch rim, grain 24, grade 1, silicate corundum, operating at 4190 surface feet per minute. The feed of the table is 13 R. P. M., roughing; 5 R. P. M., finishing. The down feed of the wheel is 0.0012 inch per revolution of the table, and from 0.015 to 0.020 inch is removed from each side.

Operation 4: Broach Hole.—This operation is performed on a Lapointe duplex broaching machine, using a special fixture that holds two pieces. Two broaches are required to finish the work.

Operation 5: Profile Outline, Rough and Finish.—This is accomplished on a two-spindle profiling machine, using a special fixture for holding the work, and two form cutters, one for roughing and the other for finishing.

Operation 6: Profile Groove on Outline.—This is done on one-spindle profiling machine, using a special fixture for holding the work and a special cutter for cutting the groove.

Operation 7: Mill Radius on Lug.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces, and form milling cutters.

Operation 8: Straddle-mill Swivel Lug and Mill Slot.—This is done on a Lincoln type milling machine, using a special fixture that holds two pieces.

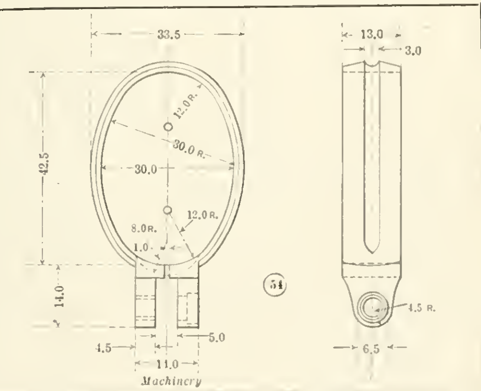
Operation 9: Mill Remainder of Outline.—This is accomplished on a hand milling machine, using a special radial fixture that holds one piece.

Operation 10: Mill Spring Catch Locking Slot.—This operation is accomplished on a hand milling machine, using a special fixture that holds one piece. The cutter-spindle is dropped down into the work without traversing the table.

Operation 11: Drill, Counterbore and Ream Swivel Screw Hole.—This is done on a three-spindle sensitive drilling machine, using a special jig for holding the work.

Operation 12: Tap Swivel Screw Hole.—This is accomplished on a bench tapping machine, using a special fixture for holding the work.

TABLE XXXIV. OPERATIONS ON LOWER BAND—PART NO. 54



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-pound drop-hammer	Forg. and trim. dies	..	..	40	1
2	Anneal and pickle	Anneal. furn. Pickling bath	......	..	..	60	See text
3	Grind both sides	Blanchard surf. grinder	Magnetic chuck	See text		250	1
4	Broach hole	Lapointe duplex broach. mach.	Spec. fixt. holds two pieces	..	..	60	1
5	Profile outline, rough and finish	Two-spindle profiling mach.	Spec. fixt. Spec. cutters	70	Hand	20	1
6	Profile groove on outline	Single-spindle profiling mach.	Spec. fixt. Spec. cutter	70	Hand	45	1
7	Mill radius on lug	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.020	40	2
8	Straddle-mill swivel lug and mill slot	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.020	40	2
9	Mill remainder of outline	Hand mill. mach.	Spec. radial fixt.	60	Hand	50	1
10	Mill spring catch locking slot	Hand mill. mach.	Spec. fixt.	60	Hand	50	1
11	Drill, counterbore and ream swivel screw hole	Three-spindle sensitive drill. mach.	Drill jig	70	Hand	40	1
12	Tap swivel screw hole	Bench tapp. mach.	Spec. fixt.	20	Hand	50	1
13	Saw cut slot	Hand mill. mach.	Spec. fixt.	50	Hand	45	1
14	Stamp	Bench work	Hand stamps	..	250	..	1
15	File and burr	Bench work	Files	..	..	50	1
16	Polish	Polishing lathe	Leather cov. wheels	5000	..	40	1
17	Blue	Niter bath	......	..	See text		..

Operation 13: Saw Cut Slot.—This operation is performed on a hand milling machine, using a special fixture that holds one piece.

Operation 14: Stamp.—This consists in stamping the number on the part.

Operation 15: File and Burr.—This consists in removing all the sharp corners and burrs.

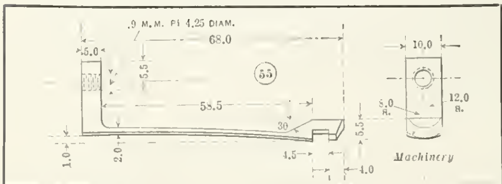
Operation 16: Polish.—See "Polish."

Operation 17: Blue.—See "Blue—Niter Process."

OPERATIONS ON LOWER BAND SPRING CATCH

The lower band spring catch (see Fig. 66) is drop-forged from a ½ by ⅜ inch rectangular hot-drawn bar of crucible or lockwork steel. Two heats are necessary, the first being a breaking-down operation and the second a finish-forging operation. After forging, trimming, annealing and pickling, the part is ready for machining. The first operation is to grind both sides on a Blanchard vertical surface grinder, providing a surface for milling the top outline and cleaning rod projection. This surface and the finished sides then act as locating points for the subsequent machining and gaging operations. For additional details on feeds, speeds and production, see Table XXXV.

TABLE XXXV. OPERATIONS ON LOWER BAND SPRING CATCH—PART NO. 55



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-pound drop-hammer	Forg. and trim. dies	..	..	50	1
2	Anneal and pickle	Anneal. furn. Pickling bath	......	..	..	60	See text
3	Grind both sides	Blanchard surf. grinder	Magnetic chuck	See text		200	1
4	Mill top outline, cleaning rod projection and ends	Lincoln type mill. mach.	Spec. fixt. holds four pieces	50	0.032	80	2
5	Mill bottom surface	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.040	50	2
6	Mill locking catch slot	Hand mill. mach.	Spec. rotary fixt.	55	Hand	60	1
7	Mill locking catch radius and bevel end	Hand mill. mach.	Spec. rotary fixt.	60	Hand	70	1
8	Drill and tap cleaning rod hole	Two-spindle drilling mach.	Drill jig Tapp. attach.	20 60	..	40	1
9	Bend	Bench beading mach.	Bending dies	..	Hand	60	1
10	Stamp	Bench work	Hand stamps	..	Hand	250	1
11	File and burr	Bench work	Files	..	Hand	150	1
12	Harden and temper	Hard. furn. Temp. baths	......	..	..	150	1
13	Polish	Polishing lathe	Leather cov. wheels	5000	..	80	1
14	Blue	Niter bath	......	..	See text		..

Operation 1: Drop-forge and Trim.—This operation is accomplished on an 800-pound drop-hammer, using forging dies, the trimming being done on a trimming press with trimming punches and dies. Two forging heats are necessary to complete this part.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Grind Both Sides.—This is accomplished on a Blanchard vertical surface grinder, holding eighty pieces on the magnetic chuck. The wheel is 16 inches in diameter, 1¼ inch rim, grain 30, grade ¾, silicate corundum, operating at 4190 surface feet per minute. The table speed is 17 R. P. M., roughing; 5 R. P. M., finishing. The down feed of the wheel is 0.001 inch per revolution of the table. The amount removed from each side is 0.010 to 0.020 inch.

Operation 4: Mill Top Outline, Cleaning Rod Projection and Ends.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds four pieces. The jaws of this fixture are cut away to clear the cutters used in facing off both ends of the pieces.

Operation 5: Mill Bottom Surface.—This is done on a Lincoln type milling machine, using a special fixture that holds two pieces. The cut is made lengthwise of the piece by form cutters.

Operation 6: Mill Locking Catch Slot.—This operation is accomplished on a hand milling machine, using a special rotary fixture that holds one piece.

Operation 7: Mill Locking Catch Radius and Bevel End.—This is done on a hand milling machine, using a special rotary fixture that holds one piece.

Operation 8: Drill and Tap Cleaning Rod Hole.—This operation is performed on a two-spindle sensitive drilling machine, using a tapping attachment.

Operation 9: Bend.—This is done in a bench bending fixture.

Operation 10: Stamp.—This is a hand operation, consisting in stamping the number on the part.

Operation 11: File and Burr.—This is a hand operation.

Operation 12: Harden and Temper.—See "Harden" and "Temper."

Operation 13: Polish.—See "Polish."

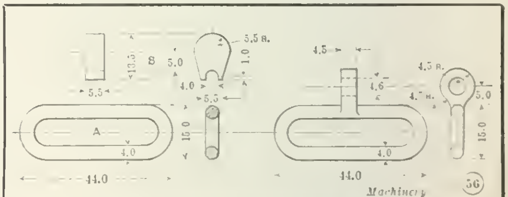
Operation 14: Blue.—See "Blue—Niter Process."

OPERATIONS ON LOWER BAND SWIVEL

The lower band swivel (see Fig. 66) can be most satisfactorily made from two pieces by electric welding. The first operation consists in making the swivel ring on a wire forming machine, the top part of the swivel being cut out in a punch press. Following electric welding, the projecting lug is straddle-milled and the hole is then drilled and reamed. For additional details, such as feeds, speeds and production, see Table XXXVI.

Operation 1: Cut Off and Bend Part A to Shape.—This operation is accomplished in an automatic wire-forming machine. Cold-rolled wire of the correct diameter is fed into the machine, cut off and bent to shape in one operation.

TABLE XXXVI. OPERATIONS ON LOWER BAND SWIVEL—PART NO. 56



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Cut off and bend Part A to shape	Wire forming mach.	Dies	..	..	4500	3
2	Butt-weld ends of Part A	Electric butt-weld. mach.	Special dies	..	..	150	1
3	Mill off fins left after welding on Part A	Hand mill. mach.	Spec. fixt. holds two pieces	70	Hand	60	1
4	Punch out Part B to shape	Punch press	Spec. dies	60 st'k's	..	1500	1
5	Butt-weld Parts A and B	Electric butt-weld. mach.	Punch and die	..	..	125	1
6	Mill contour on right-hand side of lug	Hand mill. mach.	Spec. fixt. holds one piece	70	Hand	50	2
7	Mill contour on left-hand side of lug	Hand mill. mach.	Spec. fixt. holds one piece	70	Hand	50	1
8	Straddle-mill lug	Hand mill. mach.	Spec. rotary fixt.	60	Hand	50	1
9	Drill and ream hole	Two-spindle sensitive drill. mach.	Drill jig	30-60	Hand	90	1
10	Stamp	......	Hand stamps	..	..	250	1
11	File and burr	......	Files	..	..	40	1
12	Polish	Polishing lathe	Leather cov. wheels	5000	..	30	1
13	Blue	Niter bath	......	..	See text		..

Operation 2: Butt-weld Ends of Part A.—This is done by an electric butt-welding machine of the chain welding type, in which the electrodes are presented at an angle to the work.

Operation 3: Mill Off Fins Left after Welding on Part A.—This is accomplished on a hand milling machine, using a special fixture that holds two pieces, and locating the work and gripping it from the loop hole.

Operation 4: Punch Out Part B to Shape.—This operation is performed on a punch press, using a punch and die.

Operation 5: Butt-weld Parts A and B.—This is accomplished by a butt-welding machine, using special shaped clamping electrodes.

Operation 6: Mill Contour on Right-hand Side of Lug.—This is done on a hand milling machine, using a special fixture that holds one piece, and a form milling cutter.

Operation 7: Mill Contour on Left-hand Side of Lug.—This is similar to Operation 6.

Operation 8: Straddle-mill Lug.—This operation is accomplished on a hand milling machine, using a rotary fixture and a straddle-milling cutter.

Operation 9: Drill and Ream Hole.—This is done on a two-spindle sensitive drilling machine, using a jig for holding the work.

Operation 10: Stamp.—This is a hand operation, consisting in stamping the number on the part.

Operation 11: File and Burr.—This is a hand operation.

Operation 12: Polish.—See "Polish."

Operation 13: Blue.—See "Blue—Niter Process."

OPERATIONS ON UPPER BAND

The upper band (see Fig. 66) is drop-forged from a $\frac{7}{8}$-inch square hot-drawn gun steel bar, then trimmed, annealed and pickled. The first machining operation consists in grinding both sides on a Blanchard vertical surface grinder, after which the hole is broached, two pieces being broached at a time. The hole and the ground sides act as locating and gaging points for the subsequent machining operations. For additional details on feeds, speeds and production, see Table XXXVII.

Operation 1: Drop-forge and Trim.—This operation is performed on an 800-pound drop-hammer, using drop-forging dies, the trimming being done in a trimming press.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Grind Both Sides.—This is accomplished on a Blanchard vertical surface grinder, holding eighty pieces on the magnetic chuck. The wheel is 16 inches in diameter, $1\frac{1}{4}$ inch rim, grain 24, grade 1, silicate corundum, operating at 4190 surface feet per minute. The table speed is 13 R. P. M., roughing; 5 R. P. M., finishing. The down feed of the wheel is 0.0012 inch per revolution of the table and the amount removed is from 0.010 to 0.020 inch.

Operation 4: Broach Hole.—This is accomplished on a duplex Lapointe broaching machine, using two broaches.

Operation 5: Mill Right-hand Side and Bayonet Lock, Rough.—This operation is performed on a Lincoln type milling machine, using a special fixture that holds two pieces.

Operation 6: Mill Left-hand Side and Bayonet Lock, Rough.—This is performed in a similar manner to Operation 5.

Operation 7: Mill Right-hand Side and Bayonet Lock, Finish.—This is similar to Operation 5.

Operation 8: Mill Left-hand Side and Bayonet Lock, Finish.—This is similar to Operation 6.

Operation 9: Straddle-mill Bayonet Lock and Bevel.—This operation is accomplished on a Lincoln type milling machine, using a special fixture that holds two pieces.

Operation 10: Profile Radius on Bayonet Lock, Rough and Finish.—This is accomplished on a two-spindle profiling machine, using roughing and finishing profiling forms and cutters.

Operation 11: Mill Spring Catch Slot.—This is done on a hand milling machine, using a cutter of the required width and diameter. The cutter is dropped down into the work, and the table is not traversed.

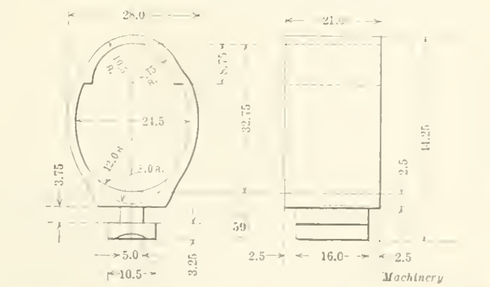
Operation 12: Stamp.—This is a hand operation, consisting in stamping the number on the part.

Operation 13: File and Burr.—This is a hand operation.

Operation 14: Polish.—See "Polish."

Operation 15: Blue.—See "Blue—Niter Process."

TABLE XXXVII. OPERATIONS ON UPPER BAND—PART NO. 59



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-pound drop-hammer	Forg. and trim. dies	..	..	40	1
2	Anneal and pickle	Anneal. furn. Pickling bath	......	..	..	60	See text
3	Grind both sides	Blanchard surf. grinder	See text		25	250-300	1
4	Broach hole	Lapointe broach. mach.	Spec. fixt. holds two pieces	..	..	50	1
5	Mill right-hand side and bayonet lock, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.040	60	2
6	Mill left-hand side and bayonet lock, rough	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.040	60	2
7	Mill right-hand side and bayonet lock, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.032	60	2
8	Mill left-hand side and bayonet lock, finish	Lincoln type mill. mach.	Spec. fixt. holds two pieces	70	0.032	60	2
9	Straddle-mill bayonet lock and bevel	Lincoln type mill. mach.	Spec. fixt. holds two pieces	60	0.032	70	2
10	Profile radius on bayonet lock, rough and finish	Two-spindle profiling mach.	Spec. fixt.	70	Hand	45	1
11	Mill spring catch slot	Hand mill. mach.	Spec. vise jaws	60	Hand	50	1
12	Stamp	Bench work	Hand stamps	..	Hand	250	1
13	File and burr	Bench work	Files	..	Hand	50	1
14	Polish	Polishing lathe	Leather cov. wheels	5000	Hand	50	1
15	Blue	Niter bath	......	..	See text		..

OPERATIONS ON UPPER BAND SPRING CATCH

The upper band spring catch (see Fig. 66) is drop-forged from a $\frac{1}{2}$ by $\frac{3}{4}$ inch rectangular bar of crucible or lockwork steel. Two heatings are necessary for this part. After drop-forging, trimming, annealing and pickling, the first machining operation consists in grinding both sides on a Blanchard vertical surface grinder. The sides then act as clamping points while milling the top outline, the cleaning rod projection, and both ends. The finish-milled top surface and the sides act as locating points for the subsequent gaging and machining operations. For additional details on feeds, speeds and production, see Table XXXVIII.

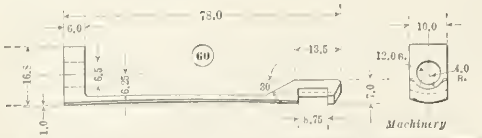
Operation 1: Drop-forge and Trim.—This operation is accomplished on an 800-pound drop-hammer, using forging dies; two heats are necessary for this piece because of the thin web in the center. The trimming is done in a trimming press, using a trimming punch and die.

Operation 2: Anneal and Pickle.—See "Anneal" and "Pickle."

Operation 3: Grind Both Sides.—This is accomplished on a Blanchard vertical surface grinder, holding eighty pieces on the magnetic chuck. The wheel is 16 inches in diameter, $1\frac{1}{4}$ inch rim, grade 30, grain $\frac{3}{4}$, silicate corundum, rotating at 4190 R. P. M. The table speed is 17 R. P. M., roughing; 5 R. P. M., finishing. The down feed of the wheel per revolution of the work is 0.001 inch. The amount to be removed from each side is 0.010 to 0.020 inch.

Operation 4: Mill Top Outline, Cleaning Rod Projection and Ends.—This is done on a Lincoln type milling machine, using a special fixture that holds four pieces.

TABLE XXXVIII. OPERATIONS ON UPPER BAND SPRING CATCH PART NO. 60



Oper. No.	Operation	Mach. Used	Tool or Fixture	Speed, Surface Feet per Min.	Feed per Rev., Inches	Hourly Product per Mach.	Machs. per Operator
1	Drop-forge and trim	800-pound drop-hammer	Forg. and trim. dies	..	..	60	1
2	Anneal and pickle	Anneal. furn. Pickling bath	......	..	..	60	See text
3	Grind both sides	Blanchard surf. grinder	Magnetic chuck	See text		200-250	1
4	Mill top outline, cleaning rod projection and ends	Lincoln type mill. mach.	Spec. fixt. holds four pieces	50	0.032	80	2
5	Mill bottom surface	Lincoln type mill. mach.	Spec. fixt. holds two pieces	50	0.040	50	2
6	Mill cleaning rod clearance slot	Hand mill. mach.	Spec. fixt. Spec. cutter	50	Hand	60	1
7	Mill locking catch slot	Hand mill. mach.	Spec. rotary fixt.	60	Hand	70	1
8	Mill locking catch radius and bevel end	Hand mill. mach.	Spec. rotary fixt.	60	Hand	70	1
9	Drill and ream cleaning rod clearance hole	Two-spindle sensitive drill. mach.	Drill jig	30-60	Hand	60	1
10	Bend	Bench bending mach.	Bending dies	..	Hand	100	1
11	Stamp	Bench work	Hand stamps	..	Hand	250	1
12	File and burr	Bench work	Files	..	Hand	150	1
13	Harden and temper	Hard. furn. Temp. baths	......	..	..	150	1
14	Polish	Polishing lathe	Leather cov. wheels	5000	..	80	1
15	Blue	Niter bath	......	..	See text		..

Operation 5: Mill Bottom Surface.—This operation is performed on a Lincoln type milling machine, using a special fixture that holds two pieces, the cut being made longitudinally. Two form milling cutters are used.

Operation 6: Mill Cleaning Rod Clearance Slot.—This is accomplished on a hand milling machine, using a special fixture and a form milling cutter.

Operation 7: Mill Locking Catch Slot.—This is done on a hand milling machine, using a special rotary fixture.

Operation 8: Mill Locking Catch Radius and Bevel End.—This operation is accomplished on a hand milling machine, using a special rotary fixture and a special form cutter.

Operation 9: Drill and Ream Cleaning Rod Clearance Hole.—This is accomplished on a two-spindle sensitive drilling machine, using a special jig for holding the work.

Operation 10: Bend.—This is done on a bench type bending machine, using a bending punch and die.

Operation 11: Stamp.—This consists in stamping the number on the part.

Operation 12: File and Burr.—This is a hand operation.

Operation 13: Harden and Temper.—See "Harden" and "Temper."

Operation 14: Polish.—See "Polish."

Operation 15: Blue.—See "Blue—Niter Process."

* * *

ELECTRICALLY HEATED JAPANNING OVENS

BY GEORGE B. MORRIS*

In selling the product of a factory engaged in any line of manufacture, perfection of finish is of almost as great importance as the mechanical perfection of its mechanism. A competitor often wins out with an inferior product because he has provided it with a durable finish; and the man who is making a really superior product would only have to pay attention to this detail in order to greatly increase his sales. Provided it is properly applied and baked, there is no better finish than ordinary black enamel—commonly called black "japan"—for bicycle frames, automobile parts, hardware specialties, and a great variety of other products. The articles to be japanned should be thoroughly cleaned to remove all dirt, dust and grease; and for this purpose sandblasting will be found to give satisfactory results. The method of applying the japan will necessarily vary according to the product; dipping will be found most satisfactory in those cases where this method can be employed; in other cases, spraying will give the best results; and in certain instances, it will be found necessary to apply the japan with a brush. By consulting any reliable manufacturer of japan, advice may be obtained as to the best method to employ; and this advice should be followed, as the method of applying the finish will vary with the nature of the japan as well as with the character of the product to which it is applied.

One of the most important factors in obtaining a satisfactory finish by japanning consists in baking the japan properly after it has been applied. The best grades should be baked at a temperature of from 350 to 375 degrees F., and it is not practical to use steam coils for this purpose. Gas burners are commonly employed, but this method has so many disadvantages that numerous firms have resorted to the use of japans which can be baked at a lower temperature, sacrificing the quality of the finish applied to their product in order to overcome the objectionable features of this method of baking. With the japans that can be baked at a low temperature, heat is applied by steam coils.

About three years ago the firm by which the writer was employed had a discouraging experience with its gas heated baking ovens, but rather than resort to the use of japans which could be baked at a low temperature and thus sacrifice the quality of finish on its product, the engineers of this firm started to experiment with electrically heated ovens for baking the japan. For this purpose some discarded street car heaters were purchased from a local traction company and substituted in place of the gas burners in the ovens. After successfully overcoming a few preliminary obstacles, the results obtained were found to be very satisfactory, and it was a matter of surprise that the cost of the current consumed was less than the expenditure formerly made in operating the gas burners. Another important advantage of the electrical ovens was that three times the amount of work could be turned out as compared with the former method. Furthermore, the finish obtained by baking the japan in the electrically heated ovens was superior to that produced in any other way, owing to the fact that a uniform temperature could be maintained with an electrical regulating device. After these experiments had been completed, all the other baking ovens were equipped with electric heating coils, and three years' experience with the use of these ovens has fully justified the judgment of the engineers in deciding to make the change.

It is not within the scope of this article to enter into a discussion of the method of figuring the current consumption for any size of ovens, but the experience of the company using the method will serve to give an idea of the cost of baking japan by this method. The ovens used were 3 feet wide by 9 feet, 6 inches long by 6 feet high, and were heated by fifteen coils which cost less than $3 each. The current consumed was a little less than 25 kilowatts, and at a price of one cent per kilowatt-hour, this would make the cost of operation 25 cents per hour while the oven is in actual use. This does not include the time spent in cooling, loading or unloading the oven. Roughly speaking, this figures out at one kilowatt for every seven cubic feet of oven capacity, and the cost of the coils for heating the oven may be taken at about $1 for each four feet of oven capacity.

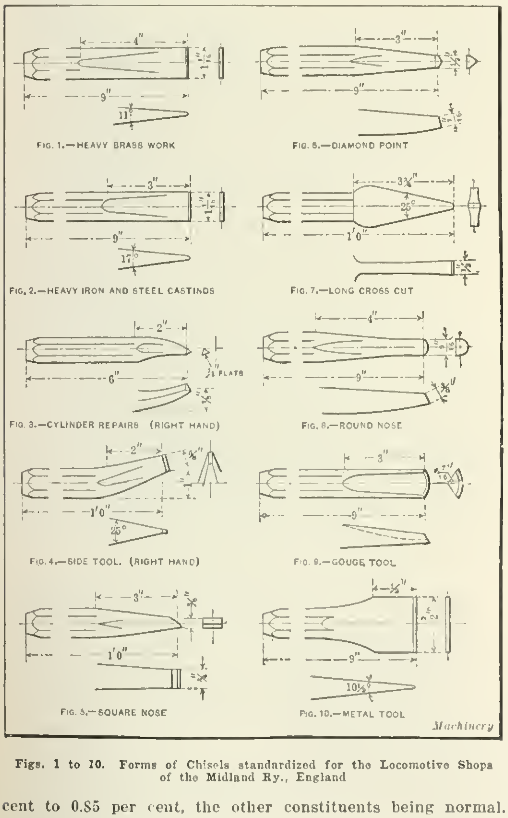
If it is found that the oven does not give sufficient heat to thoroughly bake the japan, it is an easy matter to add an extra coil at any time that it may be considered necessary to do so. All of the coils should be placed directly under the work, and the work is generally suspended in the oven while it is being baked. The coils should be protected by a perforated metal grating. In ordering coils for a japanning oven, it is merely necessary to tell the electrical contractor the current consumption required to heat the oven, as calculated by the preceding method, and the kind of current available in the factory in which the ovens are located.

* Address: Kenmore, N. Y.

CHISELS—SHAPES AND HEAT-TREATMENT*

Much attention has been given to the composition and treatment of tool steel used in machine tools, but the three implements of the hand worker—the file, the chisel and the hammer—have been comparatively neglected. Credit should be given for the work recently done in testing the file, and there is little need of improvement of the hammer, but the chisel has not received the systematic attention its importance deserves. A close examination of the new and used chisels in the shops of the Midland Ry., England, confirmed that view, and the result was an effort to induce the alloys research committee of the Institution of Mechanical Engineers to take up the matter, but it was not successful, and so the matter has been dealt with individually.

The material usually employed for chisels is not bought to specification, but a well-known and tried brand is purchased. In the chief mechanical engineer's department of the Midland Ry., after considerable experimenting, it was decided to order chisel steel to the following specifications: carbon, 0.75 per



Figs. 1 to 10. Forms of Chisels standardized for the Locomotive Shops of the Midland Ry., England

cent to 0.85 per cent, the other constituents being normal. This gives a complete analysis as follows: carbon, 0.75 to 0.85; manganese, 0.30; silicon, 0.10; sulphur, 0.025; phosphorus, 0.025.

It is perhaps interesting to note that the analysis of a chisel which had given excellent service was as follows: carbon, 0.75; manganese, 0.38; silicon, 0.16; sulphur, 0.028; phosphorus, 0.026. The heat-treatment is unknown.

At the same time that chisel steel was standardized, the form of the chisels themselves was revised, and a standard chart of these as used in the locomotive shops was drawn up. Figs. 1 to 10 show the most important forms, which are made to stock orders in the smithy and forwarded to the heat-treatment room where the hardening and tempering is carried out on batches of fifty. A standard system of treatment is employed, which to a very large extent does away with the personal element. Since the chemical composition is more or less constant, the chief variant is the section which causes the temperatures to be varied slightly. The chisels are carefully heated in a gas-fired furnace to a temperature of from 730 to 740 degrees C. (1340 to 1364 degrees F.) according to section. In practice, the chisel, Fig. 1, is heated to 730 degrees C.; chisel, Fig. 2, to 735 degrees C. (1355 degrees F.); and a 1-inch half round chisel to 740 degrees C., because of their varying increasing thickness of section at the points. Upon attaining this steady temperature, the chisels are quenched to a depth of 3/8 to 1/2 inch from the point in water, and then the whole chisel is immersed and cooled off in a tank containing linseed oil. This oil-tank is cooled by being immersed in a cold-water tank through which water is constantly circulated. After this treatment, the chisels have a dead hard point and a tough or sorbitic shaft. They are then tempered or the point "let down." This is done by immersing them in another oil-bath which has been raised to about 215 degrees C. (419 degrees F.). The first result is, of course, to drop the temperature of the oil, which is gradually raised to its initial point. On approaching this temperature the chisels are taken out about every 2 degrees C. rise and tested with a file, and at a point between 215 and 220 degrees C. (428 degrees F.), when it is found that the desired temper has been reached, the chisels are removed, cleaned in sawdust, and allowed to cool in an iron tray.

No comparative tests of these chisels with those bought and treated by the old rule-of-thumb methods have been made, as no exact method of carrying out such tests mechanically, other than trying the hardness by the Brinell or scleroscope method, are known; any ordinary test depends so largely upon the dexterity of the operator. The universal opinion of foremen and those using the chisels as to the advantages of the ones receiving the standard treatment described is that a substantial improvement has been made. The chisels were not "normalized." Tests of chisels normalized at about 900 degrees C. (1652 degrees F.) showed that they possessed no advantage.

* Abstract of paper read by Henry Fowler, chief mechanical engineer of the Midland Ry., England, before the Institution of Mechanical Engineers, February 18.

* * *

CLEVELAND MILLING MACHINE CO.

The Cleveland Milling Machine Co., Cleveland, Ohio, is a new concern incorporated under the laws of Ohio with a capital of $100,000, of which $75,000 is paid up, for the purpose of manufacturing milling machines, milling cutters and special tools. It is headed by Frank S. Shields, president, and J. A. Camm, vice-president, both of whom are thoroughly familiar with the machine tool business. Mr. Shields, for the past six years, has been factory manager and sales manager of the National Tool Co. of Cleveland, manufacturer of milling cutters and small tools. Mr. Camm has been engaged in the machine tool business all his business life, having been identified with a number of Cincinnati companies and for the last seven years employed by the Kearney & Trecker Co. of Milwaukee, in various capacities, recently as sales manager.

The company has broken ground at 18511 Euclid Ave., Cleveland, in the heart of a new industrial section, where seven acres of land have been acquired near the New York Central & St. Louis Railroad tracks and the new White Farm Tractor Corporation. The factory will be erected on the unit system and will be of approved up-to-date construction. The first unit, 100 by 200 feet, saw-tooth roof construction, will be completed about May 1, and 100 men will be employed. Plans have been made for increasing the plant so as to provide for the employment of 1000 men by January 1, 1917.

The growth of this new machine tool concern, which will specialize in the building of milling machines and the manufacture of small tools of the highest quality, will be watched with much interest. The organization of the new company adds one more to the already extensive list of machine tool concerns in Cleveland building lathes, boring mills, planers, automatic screw machines, etc. The addition of a high-grade milling machine establishment will still further increase the scope of the machine tool business in the "Sixth City."

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

ESTIMATING THE COST OF MACHINE WORK

The unscrupulous plumber has long been noted for spinning out jobs and charging high prices for work and material, and his craft is commonly regarded as conducting its business with as little system or regard for efficiency as can be found in any industry; but the following letter from a consulting mechanical engineer of wide experience indicates that some jobbing machinists are pressing the plumber hard for the inefficiency record:

We hear much about American manufacturing supremacy and the great things that we are doing. But an analysis of what we are accomplishing shows a lamentable lack of initiative and ability to estimate on the part of small manufacturers. By small manufacturers is meant establishments employing from ten to one hundred men. They simply cannot take a drawing or piece of machinery and analyze it piece by piece, and estimate the weight and cost of production or reproduction. This statement is based on the experience of years in attempting to get estimates on work from this class of men. As an individual example may serve as a demonstration of the truth of the statement, here is one.

I recently had a split cylinder to be made. The work involved the making of two half-cylinder patterns without core boxes. The machine work consisted of facing off the edges of the two half-cylinders where they came together; the drilling of holes by which they were to be bolted together; the boring out and facing of the ends and the drilling and tapping of stud holes in those ends. The length was about eighteen inches, and the bored diameter about ten inches. It was simple in every way, and any intelligent apprentice should have been able to make the estimate.

I sent complete drawings to ten machine shops. I received three bids for the work of $60, $90 and $150, respectively. In addition to these I received seven replies. Of these, two declined to make a bid and five quoted their regular hourly shop rates for machine work, which ranged from fifty cents to seventy-five cents an hour.

Of the ten firms there was only one whose bid checked with my own analysis of what the work should cost. That may have been an estimate or a guess; I don't know, and my own estimate may have been faulty, but the fact remains that only three out of the ten dared to give a price, and of those three, certainly not more than one could have been correct.

It looks as though there were a big field open for the education of machine shop owners in their own field of endeavor.

THE METRIC SYSTEM AGITATION

The report of Dr. Samuel W. Stratton, director of the Bureau of Standards, on the metric system has renewed the agitation which recurs periodically around that subject, and has stirred up vigorous protests from manufacturers whose business will be upset by any change. Henry R. Towne, in a recent letter to the New York *Evening Post*, says:

Decimal notation and the metric system are two distinct propositions, although very commonly confounded. The convenience of the metric system of weights and measures, especially in scientific work and in complex calculations, is largely due to its use of decimal notation, but still more to the interrelation of its units of length, volume and weight, whereas our present system lacks this latter admirable quality and permits of decimal notation only to a limited degree. On the other hand, for all the ordinary transactions of daily life, not the decimal but the *binary* system of division is in universal use, even in metric countries, and always will be, for the human mind naturally divides things into halves, quarters, etc.—not into tenths, hundredths, etc. Even in France today the unit of weight for domestic purposes is the livre (= one-half kilogram), and this is divided into half-livres, quarter-livres, etc.

No one denies the unfortunate complexity of our present system, nor its lack of coordination between the units of length, volume and weight, but neither can anyone deny that we now have that great desideratum which led France (and later Germany) to adopt the metric system, namely, *uniformity*—uniformity not only throughout our own country, but also, practically, throughout the British Empire.

The situation is one of great complexity, especially with regard to the export trade. To develop foreign trade it is necessary to conform to the system of weights and measures employed by the people to whom we sell, and that has been one strong feature of trade development by the Germans, who in that respect have always tried to please the customer rather than themselves. On the other hand, the English system of weights and measures is embedded in our practice and institutions, and any change, especially in the standard of measurement, would involve waste, expense and confusion for a long period. The change to the metric system is favored principally by scientists because of the interrelation of the units of length, volume and weight; but these interrelations are not of such importance in manufacturing practice as to warrant a revolution; in fact, they are virtually negligible.

The war orders placed with our machinery industry have familiarized some of our manufacturers and workmen with the metric system, and if the extension of our trade to foreign markets, where it is required, shows that it possesses advantages over the English system, the knowledge of those advantages will quickly spread and the metric system will establish itself by merit alone, which is the only basis that any system of measurement should stand upon.

* * *

SHOULD THE ENGINEER ADVERTISE?

Young engineers who are striving to build up a consulting practice frequently complain that the somewhat general prejudice against advertising by professional men places them at an unfair disadvantage in obtaining clients. They argue that there is no justice in making a distinction between advertising the services of an engineer and the products of manufacturers who seek his advice.

At first sight this may appear correct, but further investigation will show that there is an excellent reason for making the distinction. In seeking the advice of a consulting engineer, his reputation and experience constitute the most important means of guidance for the prospective client in making a selection. But this is not true to so great an extent with manufactured products, because the manufacturer's reputation is only one of several reliable criterions of value.

After accepting this principle as fair, the young engineer should not be long in seeing that his chance for advertising lies not in cleverly worded statements of his ability and experience, but in devoting to all of his work the necessary amount of time and care to insure satisfying every client. This is a form of advertising that will prove equally effective in holding old clients and in gaining new ones, and advertising of this kind tends constantly to raise the standard of efficiency in the profession.

A FORM OF PETTY GRAFT

BY F. B. JACOBS*

Some months ago, I chanced to hear of a concern in the Middle West that wanted toolmakers badly enough to pay above the normal rate to obtain them, and as I was looking for work at the time, I called on the superintendent. I got there early—about fifteen minutes before starting time—and as I sat close to the time clock, I had a good opportunity to observe the class of men employed. They were of the well dressed, clean-cut type, the black shirt and week's growth of beard being conspicuous by their absence. They reminded me of the better class of toolmakers I had associated with while working in some of the large, modern tool-rooms for which the Eastern states are noted.

After the last man had rung in, and the blast of the whistle had announced the beginning of another working day, I noticed that I was not alone; another man was waiting, and as he had his kit of tools with him, I concluded that he had reported for duty. He was a communicative chap and before long we were engaged in conversation.

"On the level," I asked, "what are they paying here?"

"Well," he replied, "if you are an A-1 workman, strike the old man for fifty cents an hour and you'll get it. I know that they are hard up for toolmakers, as they had a man in Chicago looking for some. That is why I am here F. O. B. destination."

Just then the superintendent came out, and after disposing of my newly found acquaintance, he turned to me with a brusque: "What can I do for you?" I told him I was looking for a job as a toolmaker, and he then proceeded to ask me the usual questions as to experience, places of previous employment, etc., after which he asked me what rate I wanted. I told him I wanted fifty cents per hour, and after a moment's hesitation he instructed me to report for duty as soon as possible.

The tool-room was well lighted and modern in every respect, and I began to think that I had landed a *real* job. The foreman assigned me a bench, and while he was looking up some work for me, I glanced at a few blueprints that were handy. The instruction: "One of cast iron," and the familiar B. S. F. (British standard form), proved the origin of the drawings, and further investigation revealed the fact that they showed rapid-fire gun parts, notwithstanding that the title blocks in the corners had been obliterated. The foreman brought me a drawing of a jig, together with a casting for its base, and as I found a shaper vacant I was soon at work. After I had started to rough out my casting I had an opportunity to glance about the shop. I noticed two things right away. There were altogether too many men for the number of machine tools, and they spent too much time visiting.

"What kind of a game is this?" I asked a fellow toolmaker.

"We are employed on war work for the British government, as you have probably noticed from the drawings," he answered with a grin. "The firm gets $1 an hour for each man's time, and as long as the men give the appearance of working, whether they really are or not, there is no kick coming; it's a regular cinch."

After about twelve hours' work on the shaper I was ready to bore my jig and, naturally, I turned to the miller. There were some ten or twelve millers in the shop, but every one was not only in use but spoken for by at least two other toolmakers; and some of them were tied up on insignificant jobs that should have been machined in other ways. As an illustration, one man had ten pieces to machine, 2 inches square by 5/16 inch thick. He was milling them at an abnormally slow speed—"to make his job last," he confided to me, "until he could get a lathe." I next turned my attention to the lathes, as I could use one on my job. It was the same story—every one taken and spoken for as soon as idle. The foreman noticed my predicament and remarked that ten new lathes had been on order for some time, and that he expected to receive them during the coming week. He also volunteered the information that the management would, in all probability, hire twelve men to operate them, stating that this was the usual custom.

As I had a little bench work to do, I managed to keep busy for two or three days, after which I began to follow the usual methods of killing time; I had to do this to hold my job. As an illustration of what the men did to get in their time, I recall one man who spent a whole day in drilling, reaming and counterboring six small holes in a ½-inch piece of stock. The tool crib was a popular place to appear to be busy. For instance, a man would get a 19/64-inch drill, that he had absolutely no use for. He would take this to his bench, indulge in a liberal chew of tobacco, and then go back to the tool crib for a 5/16-inch reamer. Then he would take a walk about the tool-room, making a few friendly calls for the purpose of discussing politics and the war, after which he would return the unused tools and call for others.

There are many concerns in the Middle West where these tactics are followed, as I have since learned, and conditions are about the same in all places. It is harder to kill time than to work, at least I have always found this to be the case, but I stuck it out for five days and then quit in disgust. Now this is a condition of affairs that should not be allowed to exist. It is petty graft, pure and simple, and should not for an instant be countenanced by manufacturers who purport to pride themselves on their business integrity. When we take a small job to a contract shop, we expect to be over-charged as a matter of course; but for highly capitalized concerns to resort to this dishonest practice is wholly uncalled for. Is it small wonder that European countries consider our charges exorbitant and hate us accordingly?

* Address: 109 W. St. Clair St., Indianapolis, Ind.

* * *

WHAT INDUSTRIAL PREPAREDNESS MEANS

The Committee of Industrial Preparedness of the Naval Consulting Board of the United States, Howard E. Coffin, chairman, is busy on the problem of securing data from 30,000 manufacturing plants in the United States, which are to be available in a time of emergency and which will give exactly the capacity of each and the character of munition work to which each can be most readily adapted. In connection with this work, Bascom Little, president of the Cleveland Chamber of Commerce of the United States, and chairman of the National Defence Committee, in an interview gave the following illuminative statement of the experience of his concern in the manufacturing of three-inch high-explosive shells as follows:

> The thing that has stirred up the business men of the Middle West during the past eighteen months has been the lesson they have learned in the making of war materials. It points a very vivid moral to all our people. It all looked very easy when it started a year and a half ago. The plant with which I am associated in Cleveland got an order for 250,000 three-inch high-explosive shells. It was a simple enough looking job, just a question of machining. The forgings were shipped to us and we were to finish and deliver. It began to dawn on us when the forgings came that this whole order, that looked so big to us, was less than one day's supply of shells for France or England or Russia, and we felt that in eight months by turning our plant, which is a first-class machine shop, onto this job we could fill the order. In a little while we got up against the process of hardening. That—and mark what I say—was fourteen months ago. To date we have shipped and had accepted 130,000 shells, and those, about half our order, are not complete. They still have to be fitted by the fuse maker, then fitted in the brass cartridge cases with the propelling charge, and somewhere, some time, maybe, they will get on the battlefield of Europe. Up to the present none of them has arrived there.
>
> Now this is the situation in a high-class, efficient American plant. This is what happened when it turned to making munitions of war. The same thing has occurred in so many Middle Western plants that their owners have made up their minds that if they are ever going to be called upon for service to their own country they must know more about this business. They feel that they are now liabilities to the nation and not assets in case of war. Proud as we may be of our industrial perfection, it has not worked here, and the country—particularly you in the East—may as well know it

* * *

For so-called "clash" gears, high-carbon tool steel is superior to casehardened machine steel. Gears made from the latter material are likely to have the hard case chipped off, thereby exposing the soft core to the impact of clashing.

RELATION OF PRESSURE, RAM DIAMETER AND TONNAGE IN HYDRAULIC PRESSES

BY W. B. UPDEGRAFF*

The relation of ram diameter, pressure in pounds per square inch, and total pressure in tons on the ram of a hydraulic press may be readily ascertained by using the diagram below. The vertical coordinates represent hydraulic pressures in pounds per square inch on ram; the intersecting diagonal lines represent ram diameters; and the horizontal coordinates represent total pressure on ram, in tons. Assume, for example, that there is a pressure of 8000 pounds per square inch in a hydraulic cylinder. The ram diameter is 8 inches; by following the vertical line from "8000" on the bottom scale to the diagonal line for 8 inches ram diameter, and from the intersection between these two lines following the horizontal line to the vertical scale at the side of the diagram, it is found that the total pressure on the ram is 200 tons. With any two quantities known, the third can easily be determined by reference to the diagram.

* Mechanical Engineer with the Watson-Stillman Co., New York City. Address: 522 Magie St., Elizabeth, N. J.

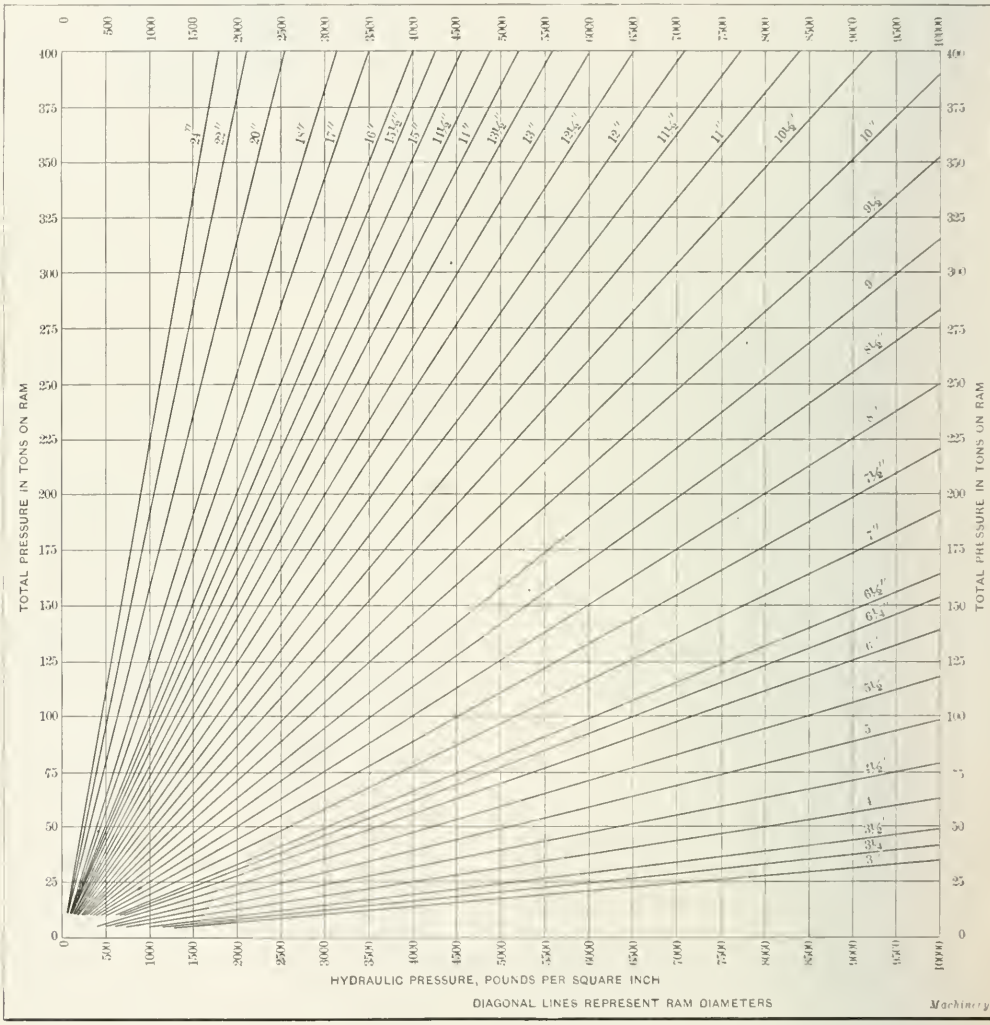


Diagram showing Relation between Ram Diameter, Hydraulic Pressure, and Total Pressure on Ram of Hydraulic Jacks and Presses

PLATINUM SUBSTITUTE IN LAMP MAKING

In the ordinary incandescent lamp, the platinum wire is sealed through red-hot glass. During the process of cooling, however, the platinum tends to shrink away from the glass slightly, owing to the fact that the coefficient of expansion of glass is somewhat greater than that of platinum. Since the lamp must be hermetically sealed, this is, of course, objectionable. To overcome this, the idea was conceived of making a wire with a coefficient of expansion a little less than that of the glass to which it was to be sealed so that, upon cooling, the glass would shrink down on the wire, compressing it slightly. This wire is composed of a core of nickel-steel, surrounded by a jacket of copper which is enveloped in platinum. The composition of the nickel-steel is such that its own expansion, averaged with that of copper and platinum, gives the wire, as a whole, a little less expansion than that of the glass, so that the desired compression seal can be obtained. The function of the copper in this combination is not only to give a greater electric conductivity—something much needed in these small leading-in wires—but also to make the expansion of the nickel-steel more regular.

THE DESIGN OF HYDRAULIC PRESSES*

PROPORTIONS OF CYLINDER AND RAM—CYLINDER PACKING—DESIGN OF COLUMNS AND HEAD

BY HUGO FRIEDMANN†

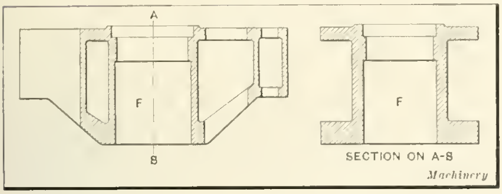


Fig. 1. Bed Casting designed with Hole F to receive Cylinder

HYDRAULIC presses have certain advantages as compared with plain mechanical presses. They are easily attended, noiseless and not subject to excessive wear; and they furnish heavy pressure without shock. On the other hand, their speed is lower than that of the mechanical press, and consequently their rate of production is not as great. Hydraulic presses, however, are ideal for many classes of work. There are baling presses for hay, cotton and rubbish; filter presses for the chemical industries; smoothing presses for paper mills; oil and seed presses; forging presses, hydraulic shears, punches, riveters, bending machines, drawing benches and extrusion machines for metal working; and hoists and elevators. The capacities range from a few hundred pounds up to 15,000 tons. Current practice in the design of hydraulic presses varies widely according to the different classes of work to be handled. In general, however, the main parts are the same and constitute the essential elements of every special machine of this class.

The Elements

The plain hydraulic press shown in Fig. 2 consists of the cylinder A, plunger or ram B, press plate C, columns D, and head or beam E. Sometimes the cylinder is a plain round body without lugs for the columns; and such cylinders are inserted into the center hole F of a separate bed as shown in Fig. I. Another variation occurs when the press plate is required to be of excessive size, but is only intended for a low unit pressure; in this case both bed and head are made of structural steel, and a counterplate G is added, such a design being shown in Fig. 3. Otherwise these parts, as well as the cylinder and press plate, are made of cast iron or cast steel. For very heavy machines, forged steel cylinders are used. Sometimes it is necessary to make the ram of bronze, and to avoid leakage caused by flaws in the casting, the cylinders may be lined with sheet copper. Fine pores in the metal are easily closed by applying silicate of potassium.

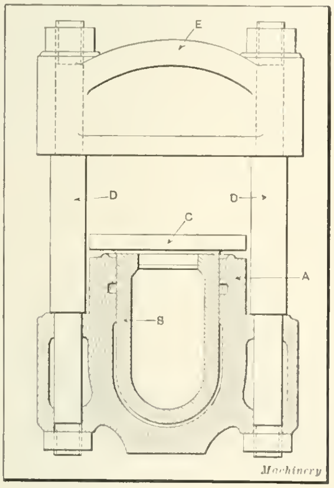


Fig. 2. Elements of Hydraulic Press

The Cylinder and Ram

In laying out a new hydraulic press, it is necessary to first decide upon the full load, length of stroke, width between press plate and head, and size of press plate to suit the work for which the press is to be used. The next step is to determine the diameter of the ram, which may be read directly from the diagram Fig. 4, or calculated by using Formula (1):

$$D = \sqrt{\frac{4L}{\pi P}} \qquad (1)$$

where L = full load;

P = working pressure of fluid in pounds per square inch.

Before using either method, one must assume the value of the unit pressure P, which may vary from about 100 to 7000 pounds per square inch. This range covers extreme conditions; but even for common medium sized presses the limits are wide, ranging from 1500 to 3500 pounds per square inch. In selecting the best value for each individual case, various conditions have to be considered, such as the available pumps and piping, the degree of care and attendance that may be required, and the general proportions of the design. These proportions usually make it necessary to increase the pressure in relation to the load. The size of the press plate, which is fixed by the special duty required of the machine, has some influence. The diameter of the ram should not exceed the height, nor should it be a great deal smaller if such a condition can possibly be avoided. Finally, a reasonable proportion should exist between the length of stroke and diameter of ram. A good method is to prepare a table of three or four sets of figures for diameters and corresponding values of pressure. The diagram presented in Fig. 4 is especially convenient for this purpose, making it easy to decide which lay-out comes nearest to meeting all the conditions referred to.

The next step is to consider the length of the cylinder. It is obvious that it must be nearly equal to the sum of the full stroke plus the length of the slideway and stuffing-box. The length of the slideway depends to some extent upon the arrangement of the press plate. If the plate is small or has reliable guides for itself, as in the case of a forging press, the slideway in the cylinder may be short, for there is no danger of getting eccentric loads upon the plunger. But the more the machine is exposed to eccentric pressure, the more attention must be given to the design of the slideway. That means that this question must be carefully studied in every case. The worst possible condition arises when the load W acts at some distance a from the center, so that the ram is forced against side A on the upper and side B on the lower end of the slideway, the condition being shown in Fig. 5. The pressure Q set up at points A and B is given by the following equation:

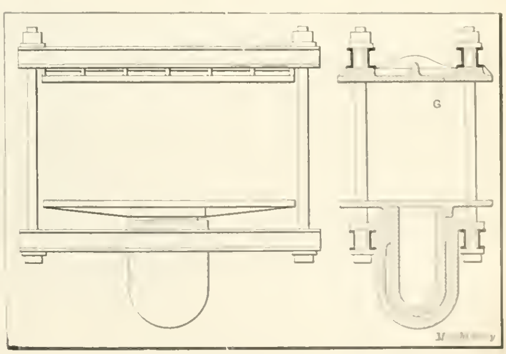


Fig. 3. Construction employed when Press Plate is unusually Large

* For other articles on the subject of hydraulic press design and allied subjects published in MACHINERY, see also "New Design of Hydraulic Cylinder Glands," July, 1910; "Design of Hydraulic Accumulator," December, 1911; "Improved Design of Hydraulic Accumulator," March, 1912; and "Design of Hydraulic Intensifier," September, 1912.

† Address: 5484 Kenwood Ave., Chicago, Ill.

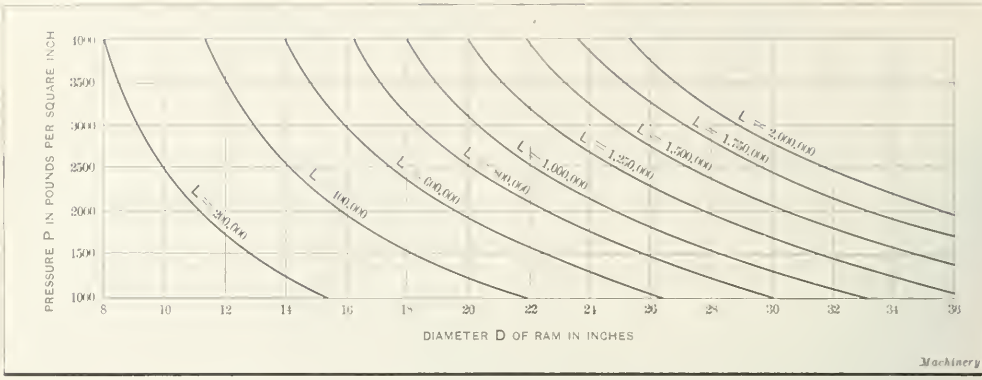


Fig. 4. Diagram showing Relation between Pressure per Square Inch on Ram, Diameter of Ram and Full Load Capacity of Press

$$Q=\frac{Wa}{b} \qquad (2)$$

To keep pressure Q within safe limits, the value of b must be increased as required. The value of b depends on both the length of the slideway and the diameter, so the length need not always be increased when the diameter is increased.

The Thickness of Cylinder and Ram

The required thickness of the cylinder may be determined by one of the following formulas:

$$T=R\left(\sqrt{\frac{H+P}{H-P}}-1\right) \qquad (3)$$

$$T=R\left(\sqrt{\frac{H+0.4P}{H-1.3P}}-1\right) \qquad (4)$$

where T = thickness of cylinder wall;
H = safe hoop stress of metal;
P = unit working pressure of fluid in pounds per square inch;
R = inner radius of cylinder.

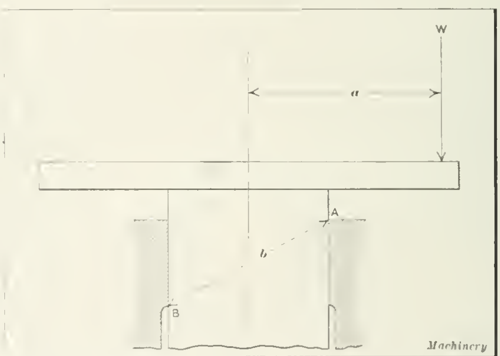


Fig. 5. Condition that exists when Eccentric Load is applied to Press Plate

Formula 3 (Lamé), which is generally used in this country, has been developed in a theoretical way; Formula 4 (Bach), generally accepted in Germany, has been derived by experiment. They give nearly the same results if the value of P is only a small part of H; for instance, when $H = 7000$ pounds per square inch and $P = 1500$ pounds per square inch. For higher values of P, Formula (4) indicates thicker walls than Formula (3), and as a result limits the use of high pressures sooner, in accordance with practical experience. Both formulas are only valid for internal pressure, and cannot be applied in designing the ram which is exposed to external pressure. For this case there is only one formula (Bach), which is as follows:

$$T=\frac{D}{2}\left(1-\sqrt{\frac{C-1.7P}{C}}\right) \qquad (5)$$

where C = safe compressive stress of metal;
D = diameter of ram.

The allowable stresses in parts of hydraulic presses are much higher than for other classes of machines, partly on account of the absence of shock. The following values are only to be used with the preceding formula. For cast iron the safe tensile stress may be assumed to be between 4000 and 7500 pounds per square inch; and the safe compressive stress between 14,000 and 19,000 pounds per square inch. The upper limits, of course, assume first-class material and foundry work. For cast steel, the corresponding figures are: 15,000 to 18,000 pounds per square inch for tension, and up to 22,000 pounds per square inch for compression.

In order to avoid the necessity of making repeated calculations, diagrams Figs. 6 and 7, have been developed, which represent the thickness of the cylinder and ram, according to

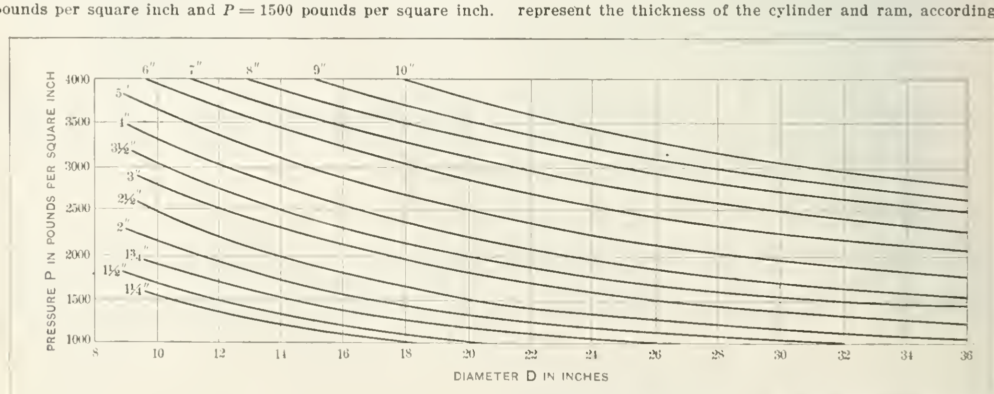


Fig. 6. Diagram giving Thickness of Cylinder for Various Pressures per Square Inch and Diameters. Tensile Stress, 7000 Pounds per Square Inch

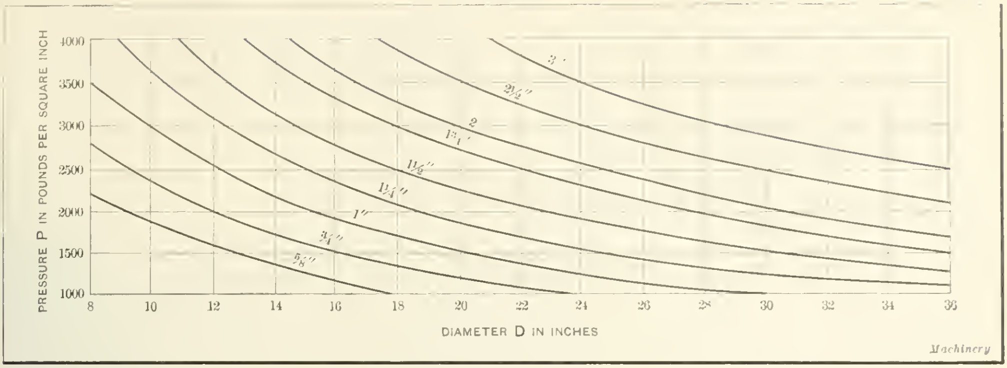


Fig. 7. Diagram giving Thickness of Ram for Various Pressures per Square Inch and Diameters. Compressive Stress, 14,000 Pounds per Square Inch

Formulas (4) and (5), for common sizes of machines and working pressures. They are based on unit working stresses of 7000 pounds per square inch for tension and 14,000 pounds per square inch for compression. For other conditions, similar diagrams may be easily developed.

Formulas (4) and (5) relate strictly to the cylindrical parts of the castings, but a plunger with a hemispherical bottom, as shown in Fig. 2, has greater strength than a tube and therefore requires less thickness. It is a practical foundry rule, however, to make the bottom at least as thick as the cylindrical part, and often even thicker, making an allowance for the shifting of the core and the introducing of the boring rod through a hole. These bottoms are, of course, very heavy. The form of plunger shown in Fig. 8 is a more economical form; it requires a good deal less material and is still safe.

The Packing

The best packing for the plunger is a U-shaped leather ring. It is self-acting and avoids needless friction, for its pressure against the ram starts and increases with the actual working pressure of the liquid. A tight hemp packing does not offer that advantage, because it produces full pressure continuously and high friction. For small cylinders a removable gland is necessary for introducing the leather ring, but it may be omitted from cylinders of 10 inches diameter and upward. It is often claimed that the application of a packing without a gland does not prove satisfactory, but when bad results are experienced, they are generally caused by careless manipulation.

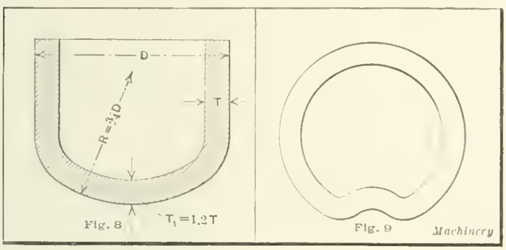


Fig. 8. Good Form of Hydraulic Press Plunger

Fig. 9. Packing Ring bent ready to be put in Place

The writer remembers one case where—when the press was first shown to him—the operators actually had to renew the packing every week, losing four or five hours each time. The custom was to soak the new ring in cold water for several hours, and introduce it in the usual way by first bending it to the shape shown in Fig. 9 and then driving it into the groove with a wooden mallet. In order to improve conditions, the operators of this press were taught to prepare the ring by dipping it into hot grease immediately before inserting it. This treatment makes the leather very soft, and in this particular case made the packing last four weeks instead of one. Later, the cast-iron ram was exchanged for a bronze one, on account of the fact that the water used in the plant contained traces of acid which destroyed the surface of the iron ram within a short time. The resulting roughness of surface naturally increased the friction and consequently the wearing of the leather ring; but the bronze resisted the action of the acid so that the surface was kept smooth, and the life of the packing was prolonged to fourteen months. Before these expedients had been tried, the whole blame for the trouble was laid upon the failure of the designer to provide a gland; but the results of the change in the method of applying the packing and the substitution of a bronze ram made it evident that the provision of a gland would not have been a real help.

The Columns

Hydraulic presses are usually built with either two or four columns. Although four columns are naturally preferable for heavy machines, there is sometimes no space for more than two; for instance, when the material has to be fed by a revolving table turning around one of the columns. Presses with a horizontal axis are often built with three columns, because this arrangement makes all parts readily accessible. The allowable tensile stress in the columns may be high on account of the absence of shock. For small and medium lengths, columns such as shown in Fig. 2 are cheaper than

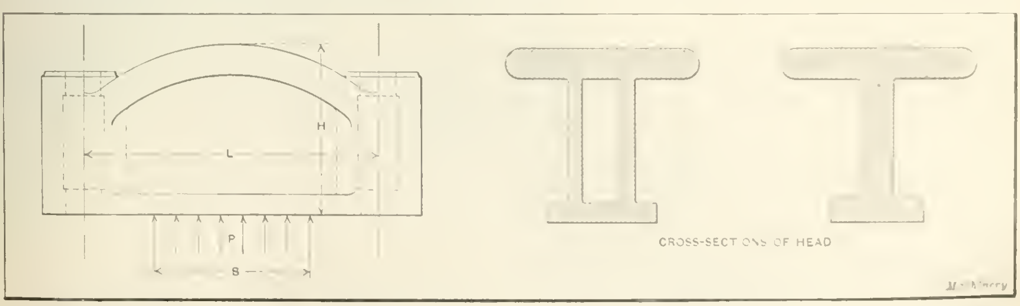


Fig. 10. Design of Head and Two Satisfactory Forms of Cross sections

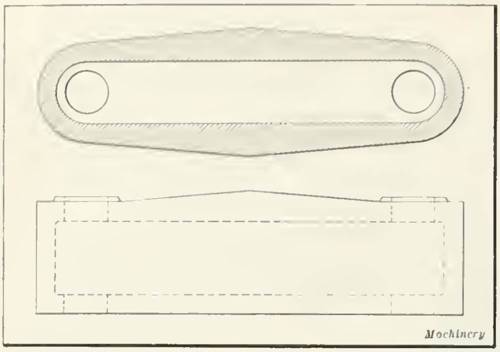


Fig. 11. Attempt made to strengthen Dangerous Section of Head by increasing Thickness of Web

columns of smaller diameter with forged collars. A shoulder ¼ inch in height is sufficient even for large machines.

The Head

The design of the head varies according to the size of the press plate, the space between the columns and the amount of the load. The head is required to perform two functions: first, that of a beam exposed to a bending load and supported by columns; second, that of a counterplate for the pressed work, corresponding to the press plate. If the plate is comparatively small, the type shown in Fig. 10, with either of the forms of cross-sections shown, will be found to give satisfactory results. This shape is especially adapted to the peculiar difference between the tensile and compressive strength of cast iron (proportion about 1 to 3). As the upper part is exposed to tension, it is made much stronger than the base, which supports the compressive stress. The dimensions cannot be determined by the usual method of figuring beams, because it assumes a uniform bending stress for the whole section and is good only for materials that have equal strength for both tension and compression. The correct way of calculating the required cross-section of cast-iron beams, as described in the following, takes a little more time but is not complicated and possesses the advantage of giving perfectly reliable and most economical results.

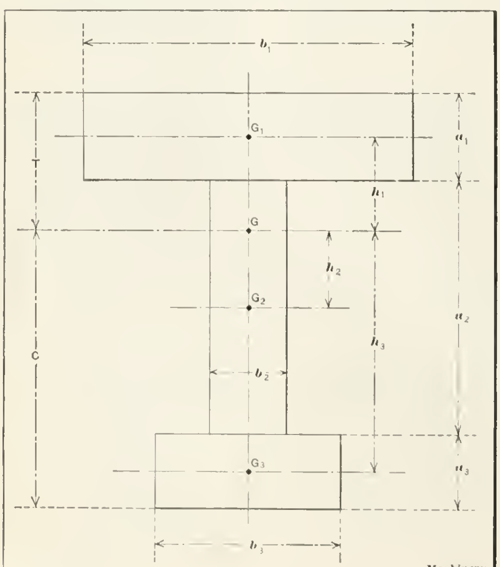


Fig. 12. Method of determining Moment of Inertia of Cross-section of Head

It is most practical to start by assuming the height of the middle section and reasonable outlines for the elevation; and they may be varied afterward, if necessary. Then the dangerous cross-section must be laid out according to either of the suggested cross-sections in Fig. 10. The design begins with the base part which depends upon the size of the press plate or counterplate. Concerning the vertical walls, it has to be remembered that they do not add much to the strength of the beam, although they add greatly to its weight. It is therefore economical to keep them as thin as possible, although the limitations of foundry work do not allow of decreasing them to the same extent as the webs of rolled steel sections. The design of head shown in Fig. 11, where an attempt has been made to strengthen the dangerous section by increasing the thickness of the web, represents very poor practice and clearly illustrates the advantage of the types of cross-sections shown in Fig. 10, which add the material where it is most efficient, by making the upper flange broader and thicker.

When a complete section is laid out according to these considerations, its moment of inertia has to be determined to prove its fitness for the required service. For this purpose the section is reduced to three rectangular parts, as shown in Fig. 12, which are equal in area to the main parts of the lay-

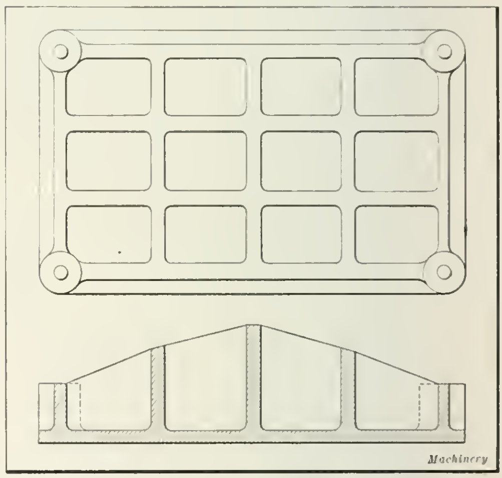


Fig. 13. Design of Head for Use on Press with Large Press Plate

out. The center of gravity G of the whole area may be determined either by a graphical method or by Formula (6):

$$G = \frac{A_1\left(\frac{a_1}{2} + a_2 + a_3\right) + A_2\left(\frac{a_3}{2} + a_3\right) + A_3\frac{a_3}{2}}{A} \qquad (6)$$

where A = area of the complete section;

$A_1 A_2 A_3$ = areas of the rectangular parts.

The moment of inertia I for the whole section may be calculated by Formulas (7) to (10):

$$I_1 = a_1 b_1^2 + a_1 b_1 h_1^2 \qquad (7)$$

$$I_2 = a_2 b_2^2 + a_2 b_2 h_2^2 \qquad (8)$$

$$I_3 = a_3 b_3^2 + a_3 b_3 h_3^2 \qquad (9)$$

$$I = I_1 + I_2 + I_3 \qquad (10)$$

Usually several parts of these formulas may be neglected because they are of little consequence. Finally the section moduli for the lay-out are:

For tension:

$$R_t = \frac{I}{T} \qquad (11)$$

For compression:

$$R_c = \frac{I}{C} \qquad (12$$

where T and C = distances of outer fibers from center of gravity of sections.

On the other hand, the actual bending moment M is:

$$M = \frac{W}{4}\left(L - \frac{B}{2}\right) \qquad (13)$$

Therefore, the section moduli required for the machine are:

For tension:

$$R_t = \frac{M}{t} \qquad (11a)$$

For compression:

$$R_c = \frac{M}{c} \qquad (12a)$$

where t = safe tension stress;

c = safe compression stress.

Of course, at the first attempt, there will be a difference between the actual and the required moduli. Then the dimensions have to be changed and the new section checked up by repeating the calculation. The design will be satisfactory when the results obtained from Formulas (11) and (12) nearly equal those obtained from Formulas (11a) and (12a). The following stresses may be allowed: For cast iron: tensile stress, up to 3500 pounds per square inch; compressive stress, up to 8000 pounds per square inch; for cast steel: tensile stress, up to 6000 pounds per square inch; compressive stress, up to 9000 pounds per square inch.

After determining the dangerous cross-section, the design of the head is completed by lowering the height toward both ends, and also decreasing the width, if the location of the columns makes it possible to do so. The section near the columns must be checked up to make sure that it has the necessary shearing strength.

Quite a different problem arises when the press plate is very large. In this case, the full load is usually not very high and the pressure per square inch of the pressed work is quite low. The head, Fig. 13, is not of the I-beam type; the best practice is to make it a plain plate stiffened with ribs. Its chief duty is as a counterplate, and allows no chance for an equal distribution of the stress. Most of the material is necessarily accumulated in the lower compressed part and much less in the tensile fibers. Heads of this type are designed by dividing them in strips of equal width on both sides of each rib and determining the stress of each part according to its share of the load. First, a sketch is laid out and dimensions assumed, then the figuring is done, and finally the dimensions are changed until they meet the required condition. The construction shown in Fig. 3, which employs a cast-iron counterplate and steel channels, is a logical result of the foregoing considerations. It transmits the full bending moment to the rolled steel sections, which are especially fit for that duty, and only exposes the casting to small local loads. The required dimensions of the counterplate may be determined in the same way as for the head.

* * *

The ability to be rated as a first-class man is only acquired by constant attention to work, and by always being on the lookout for information.

MACHINE FOR CUTTING POWDER TRAIN GROOVE

BY DONALD BAKER*

The difficulty of obtaining a standard machine adapted for cutting the powder train groove in time fuse rings led us to design the special machine described in the following article. Owing to the small size of the cutter used for this purpose, it is necessary for the machine to operate at a very high speed, and as an exceptionally smooth finish is required for the work to pass inspection, it is also imperative for the machine to be absolutely rigid. These were the requirements which we were called upon to fulfill in designing a special machine for doing the work. Fig. 1 shows one of the time fuse rings, in which the powder train groove is shown at *A*. Before coming to the machine, this groove has been roughed out on a machine equipped with a circular cutter instead of an end-mill, and this cutter leaves 0.005 inch on the sides and bottom of the groove which has to be removed by the finishing machine; also there is considerable stock left at each end of the groove, as it is obviously impossible for a circular cutter to work right up to the end of the groove and produce the required semi-circular form.

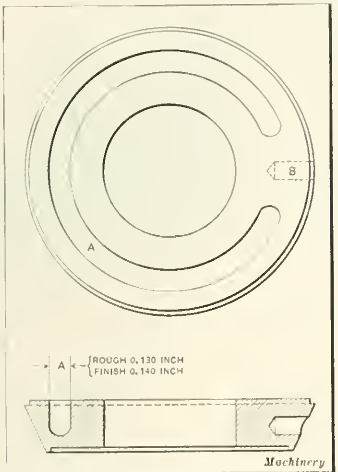


Fig. 1. Time Fuse Ring in which it is required to cut Powder Groove A

The machines originally purchased for doing this work were a modification of a high-speed drilling machine, and were equipped with a table similar to that of a milling machine with an auxiliary rotating table on which the work was held by a locating and clamping device operated by a foot-treadle. These machines were designed to run at about 8000 revolutions per minute, and they were made with so much overhang, and so many gibs and slides, that sufficient vibration was set up to produce chatter marks on the work. In designing our special machines we eliminated all gibs, and the overhang of all working parts was reduced to a minimum. Referring to Fig. 2, which shows the machine, it will be seen that headstock *A* is cast integral with the base; and at the outer end of the main spindle *B* there is a faceplate *C* provided with a locating pin *D* which enters hole *B*, Fig. 1, in the work. The spindle is hollow, and the outer end which projects beyond the faceplate is ground to a taper that acts in conjunction with the auxiliary draw-in spindle shown in Fig. 3 to form an expanding work-holding device that automatically adjusts itself to the high and low limits of the bore in the time fuse rings, and provides for holding the work back against the faceplate; at the same time, locating pin *D* prevents the ring from turning while the milling operation is being performed. The draw-in spindle can be operated by either a hand-lever or a foot-treadle.

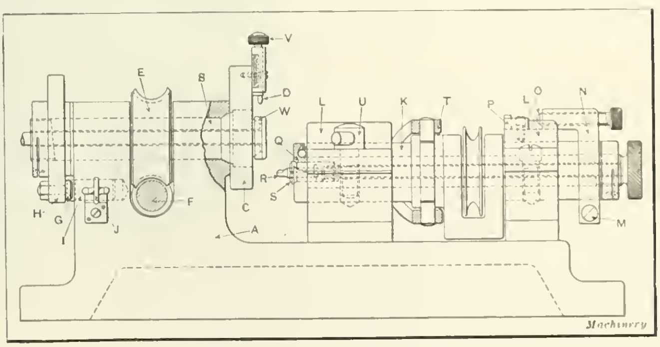


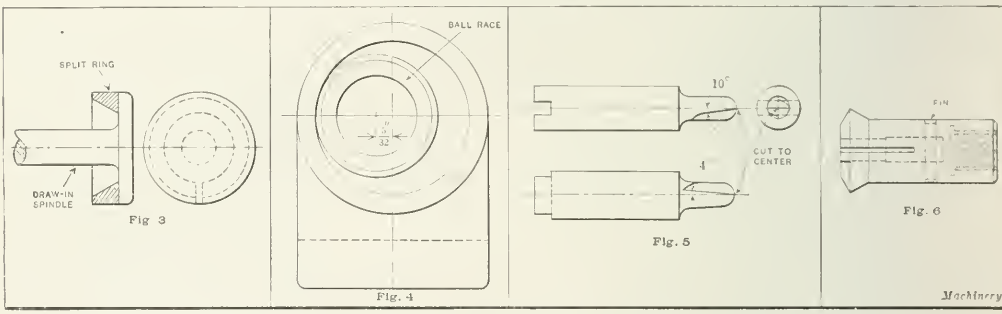
Fig. 2. Special Machine designed for cutting Powder Grooves in Time Fuse Rings for Shells

To provide for rotating the work-spindle, a worm-wheel *E* is mounted on the spindle; this meshes with worm *F* carried by a shaft, at the outer end of which there is a pulley driven by a round leather belt. This belt is not very tight and is in-

* Address: 41 Grant Ave., Jersey City, N. J.

tended to slip when the adjustable stop G is engaged; stop G is carried on a plate with a circular T-slot in which it is secured in the desired position. The plate is mounted on the work-spindle, as shown at H, and stop G strikes pin I when the work has been fed around to the desired position. In addition to the stop which determines the end of the groove in the ring, there is a second stop G which is brought into contact with pin I to locate the work in the starting position.

The opposite end of the machine, which carries the cutter-spindle, must have a considerable range of adjustment to provide for the different sizes of rings which have to be machined; but in designing the machine the use of slides and gibs was done away with, owing to the tendency of this form of construction to introduce trouble caused by lost motion. To accomplish the required result, spindle bearing K was made in the form of an eccentric bushing (shown in detail in Fig. 4) which was supported and guided at the ends by two cast-iron bearings L. To change the position of the cutter to provide for cutting slots of any required radius of curvature, it is merely necessary to revolve the eccentric bearing to either the left or right and then secure it in the desired position by tightening screw M which actuates clamp N; this clamp is similar in shape to a lathe dog, and the tail slides in a groove of the bearing cap, the adjusting screw O being set to strike against stop P to adjust the cutter for working to the required depth. The spindle which carries cutter R and draw-in chuck S (shown in Figs. 5 and 6, respectively) is operated by hand-lever T, and when the cutter is operating on the work, the longitudinal position of the spindle is maintained by tightening bolt U which draws the split spindle bearing together. When the work is finished, this bolt is loosened to allow the cutter to be drawn back out of the work by operating hand-lever T.



Figs. 3 to 6. Expanding Arbor, Adjustable Cutter-spindle Bearing, Cutter, and Draw-in Collet for holding Cutter

In operating the machine, locating pin D is withdrawn from the work by knurled knob V and a fresh blank put in position on the expanding arbor. Knob V is then released so that the spring may force pin D into position in the hole in the work, after which the draw-in spindle is pulled back to secure the work in position on expanding arbor W. To secure the maximum production, this work-holding device should be operated by a foot-treadle. After the work has been set up, the proper starting position is determined by bringing starting stop G into contact with pin I. The cutter is then brought forward by hand-lever T and clamped in the proper position, after which the work-spindle feed is started and the work revolved against the cutter until the second stop G strikes pin I, showing that the cutting of the groove has been completed. Then the cutter is drawn back ready for the work to be removed.

* * *

The following is a receipt for casehardening, which can be used in cases when a hard exterior with a soft and tough interior is desired on steel of grades ranging up to about 0.20 per cent carbon. First, carbonize in any suitable casehardening compound at 1650 degrees F. and then plunge in water; reheat to 1425 degrees F. and plunge in thin, cool oil. The process refines the grain and gives the core a maximum of toughness. This receipt has been used with success by the Pratt & Whitney Co.

IMPORTANCE OF FOUNDATIONS UNDER MACHINE TOOLS

Everyone knows that machinery, in general, operates better when mounted on a solid foundation than when supported by a springy floor, but very few comparative tests have been made to demonstrate the actual increase in efficiency due to a firm foundation. A correspondent of *Grits and Grinds*, published by the Norton Co. and the Norton Grinding Co., gives some results of comparative tests made with Norton wheels and machines, mounted on concrete foundations and on weak wooden foundations, as follows:

Average life of two wheels in No. 1 grinding room—wood floor—113 days per wheel—approximately 3.8 months.

Average life of two wheels in No. 2 grinding room—concrete floor—188 days per wheel—approximately 6.3 months.

Total increase in life per wheel due to solid foundations—75 days—approximately 2.5 months.

Average cost per wheel	$19.00
Average cost per month, per wheel on wood floor	5.00
Average cost per month, per wheel on concrete floor	3.00
Average saving per month, per wheel on concrete floor	2.00
Average saving per year, per wheel on concrete floor	24.00
Boiler Shop—three wheels on weak foundations—Machines Nos. 1119 and 1189—approximate saving per year	72.00
Tool Shed No. 1—two wheels on weak foundation—Machine No. 20628—approximate saving per year	48.00
Tool Shed No. 2—one wheel on weak foundation—Machine No. 20716—approximate saving per year	24.00
No. 1 Grinding Room—seven wheels on weak foundations—Machines Nos. 14209, 14210, 14211, 14212 and 14213—approximate saving per year	168.00

* * *

The effect of the war on many industries has been to force them to experiment in order to produce native substitutes for substances that had formerly been imported. The graphite crucible business has been particularly handicapped by the lack of raw materials. An embargo was declared on Ceylon plumbago, which, although it was lifted after a few months, left the market in a depleted condition. The result was a great advance in prices. Following this, the foreign clay which is used in crucible making as a binder was exhausted. This clay, it is said, has been obtained, as far back as crucible history in this country goes, from the little principality of Klingenburg in the Black Forest of Southern Germany, where the entire government expenses are paid out of the export duty collected from the clays. None of this clay has been shipped since the beginning of 1915. It therefore devolved upon American manufacturers to produce satisfactory crucibles from American clays. Thousands of chemical laboratory and practical foundry tests were made with this object in view, and it is claimed that the crucibles produced through this experimentation with American clays have stood a surprisingly long time in the fires. The advance in prices of crucibles is due to the unusually high price of Ceylon plumbago, but it is thought that as soon as the war insurances are a thing of the past, plumbago will reach a normal figure once more and crucibles will again be marketed at as low or lower prices than they have been for many years.

WELDING HIGH-SPEED STEEL ELECTRICALLY*

THE APPLICATION OF BUTT-WELDING AND SPOT-WELDING METHODS FOR SAVING TOOL STEEL

BY FRANK WARREN†

THE welding of high-speed steel or high-carbon steel to the same kind of stock or to low-carbon steel can be accomplished by the electric welding process as easily as the welding of any other kind of metal. The only difference is in the handling of the material after the weld is made. When butt-welding two pieces of iron or low-grade steel of the same kind, a perfect and homogeneous weld can be made without any subsequent operations. But when welding high-speed or high-carbon steel, it is necessary to overcome the stresses set up at the junction of the two pieces of metal by holding the heat in the pieces until they are of a uniform temperature. This heat-treatment relieves the tension caused by the unequal expansion and contraction of the metals. It is necessary to apply the same treatment when welding dissimilar metals, like high-speed steel and low-grade carbon steel.

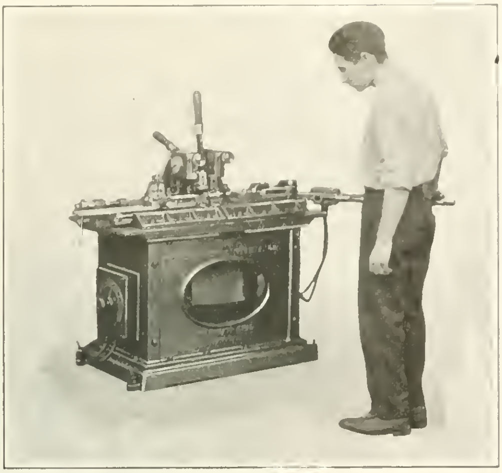


Fig. 1. Toledo Butt-welding Machine used for welding High-speed Steel or High-carbon Steel to a Shank of Low-carbon Stock. The Current Cost, at Three Cents per Kilowatt-hour, should not exceed $1.50 for 1000 Pieces of ¾-inch Square Steel which can be welded in a Day

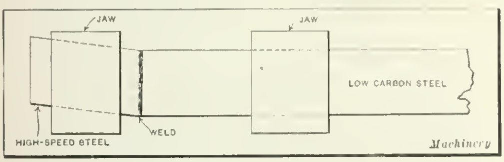


Fig. 2. Showing the Proper Relation of High-speed Steel and Low-carbon Steel Stock in the Welder Jaws

When this is done properly, the two pieces are united so that a lathe tool made in this manner can be forged, annealed and retempered, the same as though it were a solid piece of high-speed steel. Fig. 1 shows the operation of an electric butt-welding machine. The stock is clamped in the vise-like jaws, the current is turned on, and the pieces instantly begin to heat. In a few seconds, they have attained the welding temperature and a pull on the lever handle forces the abutting pieces together. When welding two pieces of stock of the

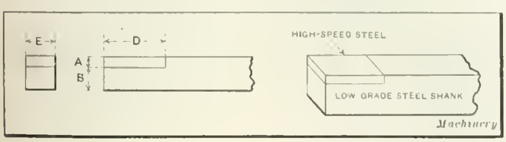


Fig. 3. Fitting High-speed Steel Pieces to Low-carbon Steel Shanks

same kind, the pieces extend an equal distance from the clamping jaws, but when welding high-speed or high-carbon stock to low-grade stock, the high-speed or high-carbon stock, being finer grained and offering more resistance to the flow of current, will heat more rapidly than the common stock. To overcome this, the stock should be placed in the jaws of the machine with the low-carbon stock extending out farther from the dies than the high-speed steel stock, as shown in Fig. 2. The difference depends somewhat on the diameter of the stock to be welded, but it should be approximately one-third high-speed to two-thirds low-grade stock. The proportions can be quickly determined, however, by watching the heat as it comes up. When both pieces heat equally, it will be known that they are placed just right. The amount of metal taken up in the weld will be approximately one-half the diameter of the stock. For example, in welding a one-inch bar of stock, one-half inch will be taken up in forcing the parts together —one-quarter inch on each side.

Butt-welding is the ideal method of utilizing high-speed steel, as stub ends can be welded to a cheap grade of carbon stock and used up. When the high-speed steel is entirely used up, the same shank may have another piece of high-speed steel welded to it. It is not necessary to saw or forge the high-speed steel to shape, as is required when preparing the stock for the spot-welding method as shown in Fig. 3. No welding compound is used, heat and pressure only being required.

After the weld is made, the stock must be immediately placed in a furnace for heat-treatment. Stresses are set up that will cause the high-speed steel to check or crack if it

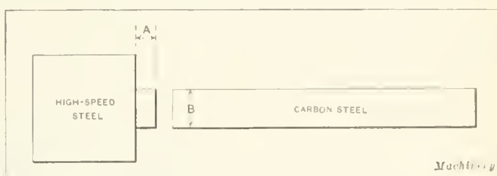


Fig. 4. Showing Reduction Necessary on Large Piece before it can be welded to a Small Diameter Shank

is allowed to drop in temperature to any appreciable extent after the weld is made. The parts are heated only at the junction of the two pieces as shown in Fig. 2, and when taken from the machine the heat radiates rapidly and unequally in the high-speed and carbon stock. This condition can be entirely overcome by proper heat-treatment. The welded pieces should be allowed to remain in the furnace for several

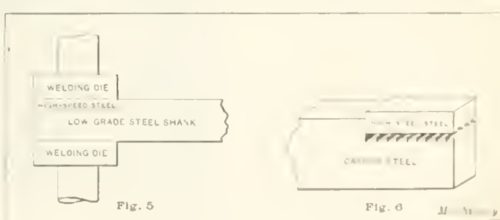


Fig. 5. Position of Parts to be welded relative to Welding Dies

Fig. 6. Grooving High-speed Steel Bit and Carbon Steel Shank for welding

* For previous articles on electric welding, see "Electric Butt-Welding Practice—1," March, 1915, and "Electric Butt-Welding Practice—2," April, 1915, and other articles there referred to.

† Secretary and general manager of the Toledo Electric Welder Co., Cincinnati, Ohio.

hours and should be cooled very slowly in order to anneal them thoroughly. After annealing, they may be reheated, forged and tempered, the same as solid stock. This process is being used by drill manufacturers and makers of tools of different kinds that require high-speed or high-carbon steel to be welded to low-grade carbon stock.

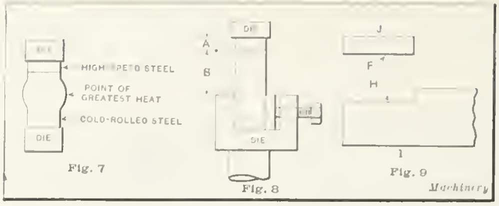


Fig. 7. Result of Improper Proportioning of High-speed and Low-carbon Steel

Fig. 8. Die for equalizing Heating Effect of Disproportioned Steel Stocks

Fig. 9. Surfaces to be welded that must be freed of Rust, Scale and Oil

Tools of various kinds may be welded, but the work in nearly all cases should be done in the rough blanks. When welding a large diameter to a small diameter, the larger diameter must be reduced to the diameter of the piece it is to be welded to, as shown at *A* in Fig. 4. The length of the reduced section should be one-half the diameter of *B*. In making the upset, allow one-quarter of diameter *B* and the same amount at *A*. For example, if *B* is one inch, one-half inch should be allowed for the upset. A taper reamer can be welded when broken in the shank, but a twist drill cannot be welded if broken at the ends of the flutes, owing to the difference in cross-section of the metal in the two parts.

TABLE I. BUTT-WELDER DATA

Area in Square Inches	K. W. Required	Time in Seconds to Make Weld	Cost per 1000 Welds at 1 Cent per K. W. Hour
0.05	2	3	0.02
0.11	3.5	5	0.05
0.20	5	5	0.07
0.31	7.5	10	0.21
0.44	12	15	0.50
0.60	15	18	0.75
0.79	18	20	1.00
0.99	25	25	1.73
1.23	35	30	2.90
1.77	50	40	5.55
2.41	65	45	8.12
3.14	75	50	10.42

Machinery

When it is desired to save small pieces of high-speed steel, a spot-welding machine may be used instead of a butt-welding machine. When the spot-welding method is used, the steel is shaped as shown in Fig. 3. The welds are made between two flat dies in either a spot-welding or a butt-welding machine, as shown in Fig. 5. If the stock is grooved, as shown in Fig. 6, it is easier to weld the flat surfaces. Any manufacturer can quickly determine whether the extra work of milling the pieces would prove profitable for his particular requirements or not. When welding small pieces of high-speed steel to low-carbon steel stock, the best results are obtained when dimension *A* in Fig. 3 is one-third and dimension *B* two-thirds of the total thickness. This proportion causes the greatest heat to be generated at the junction of the two pieces. If dimension *B* is made proportionately larger the hottest point will be below the junction of the pieces, resulting in the upsetting or blowing out of the stock, as shown in Fig. 7. If it is necessary to have *B* greater than the proportion given, a special copper die can be used which will clamp the low-grade stock as shown in Fig. 8. When this is done, dimension *B* is kept in the proper relation to the thickness of the high-speed steel.

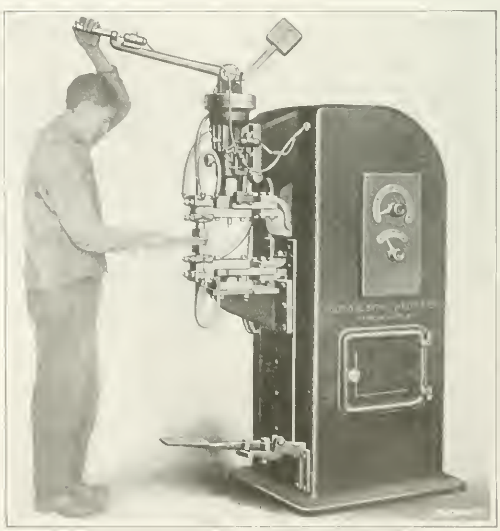


Fig. 10. Toledo Spot-welding Machine welding High-speed Steel Insert to a Lathe Tool. At a Current Cost of Three Cents per Kilowatt-hour, the Cost should not exceed $3 for welding 800 Pieces of ½ by ½ by 2 Inch High-speed Steel—a Day's Work

In all cases it is necessary to have the surfaces of the parts, Fig. 9, absolutely clean and free from oil, dirt, rust or scale. The surfaces where the copper dies make contact should also be clean and parallel. It is necessary to shape the pieces and have their meeting faces perfectly smooth and level in order to get the best results. The current must be applied long enough to bring the metal at the joint to a welding temperature and sufficient pressure must be applied to secure a perfect union at the joint. Spot-welding machines with the toggle joint in the head are particularly well adapted for this service, as they give an almost unlimited pressure when the toggle is straightened out to give the final squeeze, but the work can be done equally well with a butt-welding machine. Welds made by spot-welding can be ground to any desired shape, but they cannot be forged after the weld is made. They do not require the heat-treatment called for when a butt-weld is made, but they should be dropped in an oil bath or rapidly cooled as soon as the weld is completed.

TABLE II. SPOT-WELDER DATA

A Width, Inches	B Length, Inches	K. W. Required	Time in Seconds to Weld	Cost per 1000 Welds at 1 Cent per K. W. Hour
⅜	1½	5	30	0.416
½	2	10	45	1.250
¾	2½	15	60	2.500
1	2½	20	75	4.160

Machinery

Column A gives the width of the high-speed steel bit and column B the length.
The thickness of the stock makes no difference; the feature to be considered in making a weld of this kind is the meeting faces of the high-speed and carbon steel stock.

Alternating current must be used in all cases, as direct current cannot be employed. Single-phase current is required, but this may be obtained from any two- or three-phase source of supply. Any voltage from 110 to 550 volts can be used, and any frequency from 25 to 60 cycles.

In the foregoing, the welding of lathe and planer tools and drills has been chiefly dealt with, but it will be apparent that these processes may be used for welding many other articles, as, for example, shanks to end-mills, and the cutting edges of chisels and similar tools may be made of good tool steel and welded to a cheaper body with a consequent saving in cost. A great many other tools, such as small punches, taps, reamers, etc., are also suggested.

Tables I and II will serve to give a fairly good idea of the cost of welding, time required to do the work and amount of current necessary.

* * *

Gaskets for water and exhaust steam pipings are usually about ⅛ inch thick. Gaskets for live steam piping should not be more than 1/16 inch.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Machinery Company Allowed Change of Venue

(New York) In the recent case of Climax Road Machine Co. v. Central Bank of Medina, New York Supreme Court, the court allowed a change of venue on application of the machine company on the theory that to refuse the same would work a hardship upon such company.

The Climax Road Machine Co., plaintiff, sold one of its steam rollers to a road contractor, and the Central Bank of Medina took a chattel mortgage on the machine. The contractor became insolvent and made a consignment of his property to the bank for the benefit of creditors. The Climax Road Machine Co. then brought this suit to recover the steam roller, and asked the court for a change of venue to an adjoining county where twenty-five of its witnesses resided, and where the books and papers of the firm were located. The trial court refused to allow the change and an appeal was taken. The Supreme Court of New York held the Climax Road Machine Co. entitled to the change of venue on the theory that to deny the change would place an undue hardship upon the company. *(Climax Road Machine Co. v. Central Bank, 156 N. Y. S. 857.)*

Concealment of Insolvency

(Alabama) Where a buyer of machinery on credit was in failing circumstances and had no reasonable expectation of being able to pay therefor, but failed to disclose his financial condition to the seller, and the seller was ignorant of such condition, and thereby induced to make the sale, it could, upon ascertaining the facts, rescind the sale. Where a sale of machinery was induced by the buyer's concealment of his failing financial condition, the seller's right to rescind existed from the time the sale was made and antedated the lien of the buyer's landlord, and the landlord's lien was subject to the seller's prior right of rescission in the absence of any facts giving rise to an estoppel. *(Parker-Blake Co. v. Ladd, 70 S. 189.)*

What is a Sale of Machinery

(Iowa) A contract to allow a buyer of machinery to use it from the date of the contract to a certain time for a certain payment for its use, payable in installments at different times, evidenced by the buyer's notes, and whereby the buyer agreed to return it if any of the notes were not paid on maturity, and was to receive a bill of sale if the notes were paid on maturity, was a sale of the machinery with a retention of title, within the Iowa law making such sales or leases void as against subsequent innocent purchasers and creditors without notice unless duly acknowledged and recorded the same as chattel mortgages. Here the purchaser of the machinery before full payment of the purchase price made an assignment for the benefit of creditors. The manufacturer of the machinery seized it and claimed title. The court held that the assignment was good, the seller having failed to record the conditional sale contract. *(Haudlon-Buck Co. v. Waterloo Drop Forge Co., 155 N. W. 803.)*

Defective Appliances

(Pennsylvania) The failure of an employer to inspect tools furnished an employe, constitutes actionable negligence, where a reasonable inspection would have disclosed the defects.

Where the operator of a chipping machine in the plant of an engineering company complains to defendant's foreman that the tools with which he is working are dangerous by reason of their frequent breaking, but continues with his work without receiving any assurance that the defects will be remedied, he assumes the risk of injury from such defects. *(Wochner v. Penn. Engineering Works, 96 A. 470.)*

Operator of Defective Machine Allowed to Recover

(Pennsylvania) Where, in a mine employe's action for injuries from defects in a coal-cutting machine which he was operating, it appeared that plaintiff, a foreigner of limited education and unfamiliar with the operation of the machine, told the superintendent of the defects, but was told to return to work and an electrician would be sent to repair the machine, that the electrician, after examining the machine, instructed plaintiff that it could be operated safely in a certain way in spite of the defects, and that plaintiff was injured while trying to follow such instructions, the judgment for plaintiff was authorized. *(Protosenia v. Brothers Valley Co., 96 A. 477.)*

Railroad Held Responsible for Machinery

(Massachusetts) Where machinery was consigned to the shipper at the residence of the purchaser by bill of lading with draft attached providing for notice to purchaser, and the purchaser did not accept the machinery, it was the duty of the railroad company to notify the shipper within forty-eight hours of such refusal. Its failure to give such notice was a breach of the carriage contract, although the purchaser had not notified the railroad that he refused to unload the car. *(South Deerfield Co. v. N. Y., N. H. & H. R. Co., 111 N. E. 367.)*

Positive Duty to Furnish Safe Place to Work

(Kansas) The plaintiff sought to recover damages from his employer and another employe for injuries suffered while he was repairing the machinery of his employer, based on the negligence of the employe, who was an engineer, in starting the machinery while plaintiff was engaged in repairing it and also on the negligence of his employer in failing to furnish him a safe place to work or to give him such warning as would enable him to reach a place of safety before the machinery was put in operation. The jury found that the engineer, who started the machinery on signals given by others and did not see or know that plaintiff was at work upon the machinery, was not liable for the injury suffered by the plaintiff, but also found that the employer, whose duty it was to furnish plaintiff a safe place to work and to keep it safe, was culpably negligent and responsible for the damages sustained. Held, that the finding of the jury that the engineer was not negligent does not necessarily exonerate the employer from liability for nonperformance of the positive duties of a master toward the plaintiff, and that the evidence in the case justified the jury in returning a verdict against the employer. *(Orr v. Ellsworth-Klaner Const. Co., 153 Pac. 526.)*

* * *

UTILIZING SPOILED MUNITIONS

At the outbreak of the present war, many manufacturers went into the munitions business without definite ideas as to the requirements of this work. Consequently a large amount of material was spoiled or made in such a way that it would not pass inspection. One concern lost over 5000 18-pound British cartridge cases, but a novel use was made of these cases. They were placed in a punch press and smashed down so as to form a shallow cup. Soldered on the edges of this cup were two small curved holders which converted the cartridge case into a very satisfactory and attractive cigar and ash holder. The result was that the spoiled cartridge cases sold for a higher price in this form than they would have if sold for munition purposes.

Another large manufacturer, not to be outdone by this experiment, when he found that over 5000 cartridge cases had been spoiled, evolved the idea of making an ornamental beverage holder from a shrapnel shell fuse and cartridge case. The cartridge case contains a rack holding four glasses; inside the shell is a container which holds the beverage, and the fuse acts as a cover. The original shrapnel shell, loaded and ready for firing, sold for $15. This beverage holder, not "loaded" nor made to specifications, sells for $10.

* * *

Bolts are generally measured from beneath the head to the first thread at the end. There is usually a point about 1/16 inch beyond the first thread. Cap-screws with square and hexagonal heads are provided with a thread cut three-quarters of the length for screws one inch and less in diameter, when the screw is less than four inches long. For longer screws the thread is usually cut one-half the length. Fillister-head screws are threaded two-thirds of the length. Screws are classified as set-screws only when the head is not more than 1/16 inch larger in diameter than the body of the screw. When the head is larger they are classified as cap-screws.

AXIAL MOVEMENT FOR HOB

The usual method of cutting a spur or spiral gear in a gear-hobbing machine is to feed the hob downward in a direction parallel to the axis of the gear blank, after setting one of the hob teeth central with the gear blank axis, and inclining the hob in order to align the cutting teeth with the tooth spaces milled in the gear blank. With this method of hobbing, only a few of the hob teeth are used for any one position of the hob,

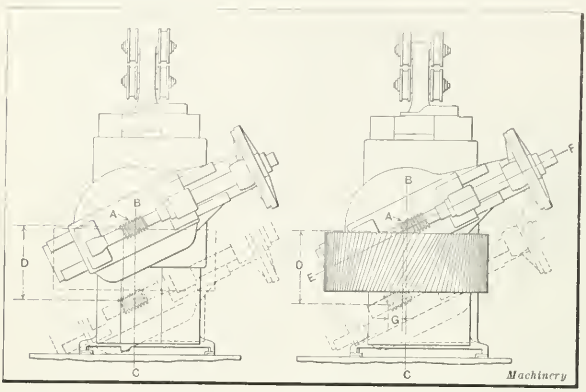
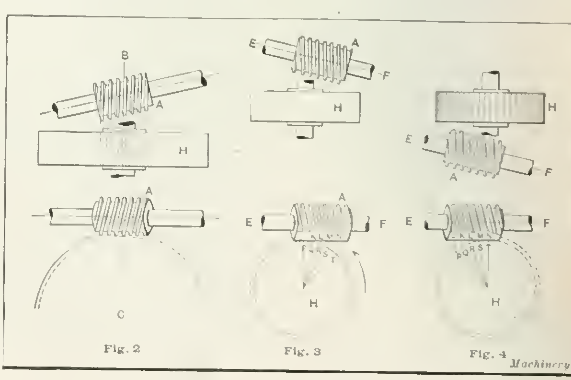


Fig. 1. Diagrams illustrating Ordinary Feeding Movement of Hob, and Method of changing Lateral Position of Hob to distribute Wear

and in order to distribute the wear it is common practice to change the axial position by centering a different hob tooth when setting up the machine for a different lot of gears. In order to insure more uniform distribution of wear, J. E. Reinecker, of Chemnitz-Gablenz, Saxony, has invented a hobbing machine which is so arranged that the hob is moved automatically in the direction of its axis as it feeds downward across the gear blank. The principle of this new process is illustrated by the accompanying diagrams. The view to the left in Fig. 1 represents the milling of a spiral gear in the ordinary way. The hob *A* moves in the direction *B–C*, and traverses a path *D*, the length of which is somewhat greater than the face width of the gear blank. The diagram to the right illustrates how this method is modified in the Reinecker machine. The hob not only travels downward a distance *D*, but it is gradually shifted in the direction of its axis *E–F*, so that it is displaced laterally a total amount *G*, as shown by the position of the dotted lines indicating the lower position of the hob and slide. The diagram Fig. 2 also shows the initial position of the hob as used in a machine of the ordinary type, whereas Figs. 3 and 4 show the initial and final stages of a hob that is automatically shifted in the direction of its axis. The hob moves in a direction *E–F* a distance represented by *J N*, and while the hob is traversed this distance laterally, the blank is given an additional rotary movement equal to *P–T*, so that the points *JKLMN* of the hob coincide with the points *PQRST* of the blank, respectively. In other words, the machine is so arranged that the speed of the gear blank differs from the normal speed which would be required with an ordinary hobbing machine, just enough to compensate for the lateral change in the position of the hob.



Figs. 2, 3, and 4. Relation between Hob Movements on Ordinary Hobbing Machine and New German Design

* * *

Someone poring over the old files in the United States Patent Office at Washington the other day, says the *Scientific American*, found a letter written in 1833 that illustrates the limitations of the human imagination. It was from an old employe of the Patent Office, offering his resignation to the head of the department. His reason was that as everything inventable had been invented, the Patent Office would soon be discontinued and there would be no further need of his services or the services of any of his fellow-clerks. He therefore decided to leave before the blow fell.

CIRCULAR SLIDE-RULE FOR SHAFT DESIGNERS*

BY EDWIN S OBERNDORF†

The illustration presented in this article, when cut out and mounted so that the dial with the inner scales may be revolved on a pivot at the center, provides a slide-rule by means of which problems in shaft design may be rapidly solved with a minimum chance of error. It has, in addition, the usual advantages of a slide-rule over charts with rectangular coordinates, in that a set of corresponding values of results for the given conditions is obtained and this set of results is distinctly shown without being confused with results representing other conditions. The use of the chart may be easily learned, even by those who are not familiar with an ordinary slide-rule. This is especially so in that the scales are arranged so that the placing of the decimal point does not have to be determined, the values being read directly; and the accuracy of the chart is sufficient for all practical work. The circular form was chosen, as it is mounted for use in various ways which will suggest themselves. By means of a pair of dividers, the illustration may even be used without cutting out the scales and mounting them. The formulas involved are:

$$M_t = \frac{63{,}025\ \text{H.P.}}{\text{R.P.M.}} \qquad (1)$$

$$D = \sqrt[3]{\frac{5.1\, M_t}{S}} \qquad (2)$$

$$M_{et} = M_b + \sqrt{M_b^2 + M_t^2} \qquad (3)$$

where M_t = twisting moment in inch-pounds;
M_b = bending moment in inch-pounds;
H. P. = horsepower;
R. P. M. = revolutions per minute;
D = diameter of shaft in inches;
S = stress in pounds per square inch;
M_{et} = twisting moment equivalent to or producing the same stress as a combined bending moment M_b and twisting moment M_t.

Instructions for the use of the instrument are given briefly under the illustration, so that they may be cut out with it and made a part of the finished rule. A more complete explanation is given in connection with the solution of problems that come under the various cases which may arise.

Case 1. *Shaft Subjected to Torsion Only.*—Given H. P. and R. P. M., find twisting moment and diameter for a

*For other articles on the subject of shaft design published in MACHINERY, see "The Angle of Torsion," November, 1914; "Heavy Duty Shafts with Two and Three Bearings," April, 1914; "On Determining Shaft Diameters," August, 1913; "Intermediate Supports for Long Shafts," January, 1913; "Calculation of Bending and Turning Moments for Round Shafts," July, 1911; "Hollow Shafts," April, 1911; "The Effect of Keyways on the Strength of Shafts," January, 1911; and "Table for Hollow and Solid Shafting," September, 1905.

†Address: 234 Fourth St., Jersey City, N. J.

given stress, or stress for a given diameter. Set the given H.P. on the outer scale and the given R. P. M. on the revolving scale against each other. On the outer scale read the twisting moment, if required, opposite the mark M_t on the k scale. With the same setting of the dial, read the required diameter under the stress which may be allowed in the material of the shaft. The stress in a shaft of any other diameter may be read at the same time. The values so obtained are those given by Formulas (1) and (2).

Example.—Given a shaft transmitting 35 H.P. at 800 R. P. M. (torsion only, as in a direct-connected motor-generator set). Set 800 on the R. P. M. scale against 35 on the H.P. scale. The twisting moment is read at M_t, and is found to be 2750 inch-pounds. For a shaft stress of 6000 pounds per square inch, the diameter necessary is 1¾ inch. In a shaft 2¾ inches in diameter, the stress would be 700 pounds per square inch.

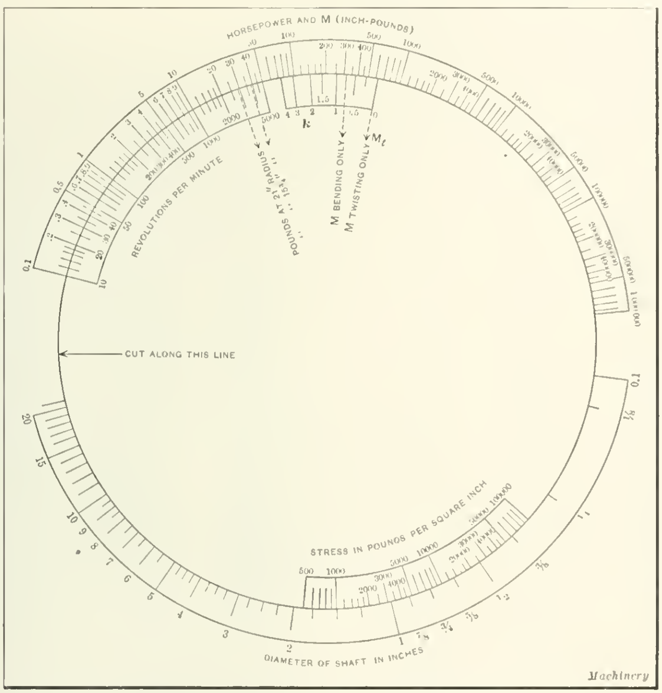
Given a twisting moment of 4000 pounds; set the mark M_t ($k = 0$) on the dial against 4000 on the M_t scale. Read diameter and stress as before; at 2500 pounds per square inch stress, the required diameter is 2 inches.

Case 2. Torsion and Bending.—Given H. P. and R. P. M., find shaft diameter, or stress when diameter is given. Find the bending moment in inch-pounds in the usual way. Obtain the twisting moment from the H.P. and R. P. M. scales. Divide the bending moment by the twisting moment, to obtain the ratio k. If this is less than 4, the highest value on the scale, turn the dial clockwise to bring this value of k to the point indicated by $k = 0$ in the first setting, *i. e.*, have the value of k against the given twisting moment. Corresponding stresses and shaft diameters may now be read as before. The constant k is based on Formula (3). If k is greater than 4, *i. e.*, when the bending moment is more than four times the twisting moment, the twisting moment may be neglected. Set the mark "M bending only" against the bending moment read on the outer scale, and read the diameter opposite the stress. With $k = 4$, neglecting the torsional moment gives a stress which is 1.5 per cent low.

Example.—Given a shaft transmitting 35 H.P. at 800 R. P. M. belted motor. The bending moment due to belt pull is calculated as 8000 inch-pounds. The twisting moment found by the instrument is 2750 inch-pounds. This may be used in calculating the bending moment. $k = \frac{8000}{2750} = 2.9$. Hold a pencil point on $M = 2750$, *i. e.*, opposite the zero point of the k scale, and turn the dial clockwise until a point on the k scale estimated at 2.9 is opposite the point located by the pencil. The shaft diameter for a stress of 6000 pounds per square inch is found to be 2 7/16 inches. The stress in a shaft 2¾ inches in diameter would be 5570 pounds per square inch.

Case 3. Bending Only.—To find the required diameter of a shaft or pin for bending only, set the mark "M bending only" against the bending moment read on the outer scale, and read the required diameter opposite the stress.

Example.—Find the diameter of a pin fixed at one end, having a load of 1000 pounds at the free end which is 8 inches from the support. The bending moment is therefore 8000 inch-pounds. Set the "M bending only" mark opposite 8000. With, say, 9000 pounds per square inch stress, the diameter required is about 2⅛ inches.



For twisting only, scales for H. P., R. P. M., stress and diameter are used. Set given H. P. opposite R. P. M.; then read diameter and corresponding stress opposite each other. Twisting moment may be read if desired, or set when known, on upper scale opposite M_t on dial.

For combined bending and twisting find $k = \frac{\text{Bending Moment}}{\text{Twisting Moment}}$. Set this value of k opposite twisting moment on M scale. Read value of stress opposite shaft diameter.

When k is greater than 4, twisting moment may be neglected. To find shaft diameter required to support a bending moment only, set "M bending only" mark opposite bending moment on M scale. Read value of shaft diameter opposite stress.

Circular Slide-rule for use in solving Problems in Shaft Design, with Condensed Instructions for its Use

* * *

ACCURACY REQUIRED IN ROUGHING CUTS

There is a prevailing idea that great accuracy is not essential in roughing cuts, and the expression is frequently heard in the factory, "Oh, that is only a roughing cut; it's plenty good enough," or something of the kind. A great deal of trouble is caused in factory work by neglect of ordinary precautions in keeping up the roughing tools so that they will leave the same amount of stock for the finishing tools to remove. In the manufacture of interchangeable work, variations in the roughing cuts are likely to make an appreciable difference in the sizes obtained after finishing. When boring operations are followed by reaming cuts in cylindrical work it is very important that the roughing tools be kept up so as to leave the same amount of stock for the finishing tools to remove. If this is not done variations will be found in the size of the reamed hole. The same rule applies to other machining operations. For example, large castings which vary in size in their rough state will be found to vary somewhat when finished unless the preliminary operations are so arranged as to leave a uniform amount of stock for the finishing tools to remove. When work is being milled, if one piece has an excessive amount of material on it to remove, more stock will remain for the finishing tool to take off, and therefore the size of the finished piece will vary somewhat.

In boring and reaming cast iron and malleable iron, when the holes are 2½ inches in diameter or larger, it is much better to take medium rough-boring and light finish-boring cuts, leaving from 0.010 to 0.015 inch for the reamer to remove. In this way, there is less likelihood of glazing during the reaming operation, and the results obtained will be much more uniform because the reamer will have sufficient stock to give it a good "bite" in the work. A. A. D.

SHAFTS FOR TORSIONAL STIFFNESS*

BY B. D PINKNEY†

Shafts for torsional stiffness differ from shafts for transmission purposes in that they are to transmit power through a predetermined angle of twist or torsion, while shafts for transmission purposes are figured according to a safe fiber stress of the material independent of the amount of torsion, the torsion usually being much greater than is permissible for shafts designed for torsional stiffness. The most common instances of shafts to resist torsion are those of double-geared machines, which were treated in my article on the "Angle of Torsion" in the November, 1914, number of MACHINERY.

In the article referred to the formula for the angle of torsion for length of shaft subjected to torsion was given as

$$\Delta = 687.5\frac{TL}{JG}$$

where Δ = angle of torsion for length of shaft, subjected to torsion;
T = torsional moment in inch-pounds;
L = length of shaft in feet;
J = polar moment of inertia;
G = modulus of torsion.

The angle of torsion per foot of shaft length, then, is:

$$A = 687.5\frac{T}{JG} \qquad (1)$$

where A = angle of torsion per foot of shaft length.

It was shown that the permissible angle of torsion of shafts varies according to the nature of the service, and is divided into the three following classes:

Class I shafts may have up to 0.05 degree per foot angle of torsion. These shafts are for very heavy service and, as such, are subjected to shocks or fluctuating loads and to reversal under full load.

Class II shafts may have up to 0.075 degree per foot angle of torsion. These shafts are for regular service and, as such, will safely withstand shocks but must not be reversed under full load.

Class III shafts may have up to 0.1 degree per foot angle of torsion. These shafts are for lighter service and not intended for fluctuating loads, unless the fluctuations are gradual; and they should not be reversed.

The value of J for a solid round shaft being

$$J = 0.098\,D^4$$

and, solving for D, Formula (1) becomes:

$$D = 9.15\sqrt[4]{\frac{T}{AG}} \qquad (2)$$

Inserting the values of the angle of torsion in Formula (2) for the three classifications, and substituting 11,500,000 for G (for cold-rolled or high-carbon steel shafts), we obtain Formulas (3), (4) and (5):

$$\text{For Class I,}\quad D = 0.33\sqrt[4]{T} \qquad (3)$$

$$\text{For Class II,}\quad D = 0.30\sqrt[4]{T} \qquad (4)$$

$$\text{For Class III,}\quad D = 0.28\sqrt[4]{T} \qquad (5)$$

Since, from elementary formulas $T = 63{,}025\frac{H}{N}$, Formulas (3), (4) and (5), expressed in terms of horsepower, are:

$$\text{For Class I,}\quad D = 5.23\sqrt[4]{\frac{H}{N}} \qquad (6)$$

$$\text{For Class II,}\quad D = 4.75\sqrt[4]{\frac{H}{N}} \qquad (7)$$

$$\text{For Class III,}\quad D = 4.41\sqrt[4]{\frac{H}{N}} \qquad (8)$$

where H = horsepower;
N = revolutions per minute.

SHAFTS FOR TORSIONAL STIFFNESS

(G=11,500,000)

Torsional Moment in Inch-pounds	Diameter of Shaft, Inches			Torsional Moment in Inch-pounds	Diameter of Shaft, Inches		
	Class I	Class II	Class III		Class I	Class II	Class III
100	1.044	0.949	0.885	60,000	5.165	4.695	4.382
200	1.241	1.128	1.053	70,000	5.368	4.880	4.554
300	1.373	1.249	1.165	80,000	5.550	5.045	4.709
400	1.476	1.342	1.252	90,000	5.716	5.196	4.850
500	1.560	1.419	1.324	100,000	5.868	5.335	4.979
600	1.633	1.485	1.386	125,000	6.205	5.641	5.265
700	1.697	1.543	1.440	150,000	6.494	5.904	5.510
800	1.775	1.595	1.489	175,000	6.750	6.136	5.727
1,000	1.856	1.687	1.575	200,000	6.979	6.344	5.921
1,250	1.962	1.784	1.665	300,000	7.723	7.021	6.553
1,500	2.054	1.867	1.743	400,000	8.299	7.545	7.042
2,000	2.201	2.006	1.872	500,000	8.775	7.977	7.446
2,500	2.333	2.121	1.980	600,000	9.184	8.350	7.793
3,000	2.442	2.220	2.072	700,000	9.545	8.678	8.099
4,000	2.624	2.386	2.217	800,000	9.869	8.972	8.374
5,000	2.775	2.523	2.355	900,000	10.164	9.240	8.624
7,500	3.071	2.792	2.606	1,000,000	10.436	9.487	8.854
10,000	3.300	3.000	2.800	1,250,000	11.034	10.031	9.362
15,000	3.652	3.320	3.099	1,500,000	11.548	10.498	9.798
20,000	3.924	3.568	3.330	1,750,000	12.003	10.912	10.185
30,000	4.343	3.948	3.685	2,000,000	12.410	11.282	10.530
40,000	4.667	4.243	3.960	2,500,000	13.122	11.929	11.134
50,000	4.935	4.486	4.187	......	......	......	......

Machinery

Engineers and machine designers invariably use the torsional moment in inch-pounds in preference to terms in horsepower in shafts for torsional stiffness.

The accompanying table is figured according to Formulas (3), (4) and (5). For shafts of medium carbon or machine steel, multiply the figures by 0.98; for bronze, multiply by 0.81; for phosphor-bronze, multiply by 0.83; for maple, multiply by 0.526; for hickory, multiply by 0.513.

Shafts other than of steel frequently are used in special machinery where the action of chemicals and the effects of corrosion are to be considered.

• • •

The appropriation for salaries for assistant examiners in the patent office averages about $10 for each application filed, which means roughly that the examiner may devote to each application about ten hours' time. In an address before the Patent Bar Association at Chicago, the commissioner of patents, Thomas Ewing, intimated that this was not enough time to do the work the patent office ought to do thoroughly. In his opinion, it would pay the public in the greater certainty respecting patents, reduced trouble in the courts, and in the avoidance of complications in business matters, if the government would appropriate at least twice as much as is now appropriated for the work of the examiners.

* For previous articles on the subject of shafting and angle of torsion, see "Distance Between Shaft Bearings" in the May, 1915, number, and other articles there referred to.

† Address: 524 E. 3rd St., Newport, Ky.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

THE CONSULAR SERVICE

In the March number of your journal there is an editorial on the consular service in which injustice has been done not only to that service but also to the Bureau of Foreign and Domestic Commerce, which publishes the daily *Commerce Reports*. Criticism is justifiable only when founded on fact, and the facts in this case do not justify this attack upon agencies that are working effectively and efficiently for the promotion of our foreign trade.

The net expense of the consular service for the fiscal year ending June 30, 1914, was $43,674. The expenditures for the service were $2,083,908.42, and the fees collected and deposited in the treasury amounted to $2,040,234.42.

Criticism of the American consular service is largely confined to Americans. Foreign business men, who are on the ground and who know what our consular service can and does accomplish, are as warm in its praise as some Americans are in their criticism. Just one illustration from many that can be cited will suffice to show the high regard in which the service is held abroad. During a discussion at a recent meeting of the British chambers of commerce, President Sterling of the Belfast delegation, and one of the largest linen producers in Great Britain, said that whenever he required exact technical details concerning linen, Belfast's chief industry, he was obliged to seek it in American consular reports, which contained better information concerning linen than the British government or the Belfast trade possessed. A Sheffield delegate, representing one of the great steel industries, said his factory was recently compelled to use a rare mineral alloy, and it was unable to learn about the alloy until it obtained complete details from American consular reports. In fact, the American consular service is considered abroad a service that should serve as a model for other countries.

The Department of Commerce is the sole agency for the dissemination of commercial information collected by the consular service, and the characterization of the items published in *Commerce Reports* as puerile, inaccurate and misleading is as much a criticism of the Bureau of Foreign and Domestic Commerce as of the consular service. In all events, it is extraordinary that MACHINERY should thus characterize reports to which British industrial leaders pay such high tribute.

There was a time when the consular service was used for political patronage, but that time is past. Appointments are now made only after examination, and the examinations are severe tests. Promotions, moreover, are based on efficiency ratings, in the preparation of which the department assists. The present administration, far from deviating from this policy, has strengthened the system of appointment and promotion on merit.

You cite one example of the "inaccurate reports" appearing in *Commerce Reports*—an item relative to restrictions on the importation of machine tools into England. This item, a telegram from the embassy at London, was as follows:

> A royal proclamation, published November 30, 1915, prohibits, after December 21, the importation into the United Kingdom of all machine tools and parts thereof, except small tools. A further exception is made in favor of machine tools and parts thereof imported under the license of the board of trade and subject to the provisions and conditions of such license.

It was stated specifically that machine tools and parts thereof imported under the license of the board of trade were exempted from the general embargo on machine tools, and it is not quite clear why MACHINERY was justified in drawing the "natural inference" that machine tools would be practically barred from Great Britain after December 21.

Upon receipt of a telegram addressed to Richard D. Micou, Mills Bldg., Washington, requesting further particulars in regard to the embargo, a cablegram was sent to Commercial Attaché Baldwin and Mr. Baldwin's reply was published in *Commerce Reports* for December 13, as follows:

> The British importer of machine tools must obtain a license from the board of trade, which, in cooperation with the war munitions board, restricts the disposition and exportation of such articles and regulates profits.

On January 3 Mr. Baldwin's complete report by mail was published in *Commerce Reports* as follows:

> The restriction on the importation of machine tools into Great Britain is a part of the general war control of manufactures, imports, and exports by the government, and the primary impulse in the matter comes from the war munitions board, which controls many factories and, in general, has the power to make such restrictions as may seem necessary for the proper conduct of the war. Machine tools are so important that the board of trade has been requested to take charge of the issuance of licenses for the importation of these products (instead of the war trade department, which furnishes the licenses for export). In order to secure the importation of these machine tools, British importing houses, or manufacturers (as purchasers), must first obtain permission from the board of trade and must make certain agreements with respect to their disposal. Importers who desire to resell machine tools are restricted as to profits in such tools, and definite permission must also be obtained before any such machine tools can be exported. It is apparently not the intention to prevent such importations, but merely to control them in such a fashion that the interests of the government may be served.
>
> I endeavored to secure any papers which might add further details with respect to this matter, but was advised that none was available. It is evident that each specific request for permission to import must be handled at the discretion of the board of trade and the war munitions board. It is probable, also, that the war munitions board will give first call to controlled factories for any incoming machine tools that they may desire to take. With the war munitions board also lies the authority to designate the classes of machine tools which shall be subject to restrictions; and, while I was unable to obtain a statement in regard to this detail, it is apparent that the disposal of those tools which can be used in the manufacture of war material of any kind will be subject to such restriction by the authorities as may be deemed necessary.

In justice to the members of the Consular Service and to the Bureau of Foreign and Domestic Commerce, I know you will be glad to present these facts to the readers of MACHINERY.

Washington, D. C. E. E. PRATT,
Chief of Bureau, Foreign and Domestic Commerce

[The fact is that the item published in *Commerce Reports*, December 6, 1915, quoted in the foregoing, created consternation in the machine tool trade. It is contradictory and absurd as first printed, stating that the importation in the United Kingdom of all machine tools and parts thereof, except small tools, would be prohibited after December 21, and in the next breath that "a further exception is made in favor of machine tools and parts thereof imported under the license of the board of trade and subject to supervision contained in such license." It is true that the department officials very quickly cleared up the matter for those who took the trouble to telegraph to Washington, and credit is due them for the full explanations subsequently published.—EDITOR.]

SHELL TURNING ATTACHMENT

The following describes a shell turning attachment for an engine lathe, which provides for turning the wall of the shell and forming the nose to exactly the required shape, the entire operation being completed at one traverse of the carriage. Referring to the accompanying illustrations, it will be seen that the frame *A* is attached to the saddle by removing the cross-slide and making use of the standard screw and nut. Radius arm *B* is pivoted to cross-slide *C* of the attachment, the pivot

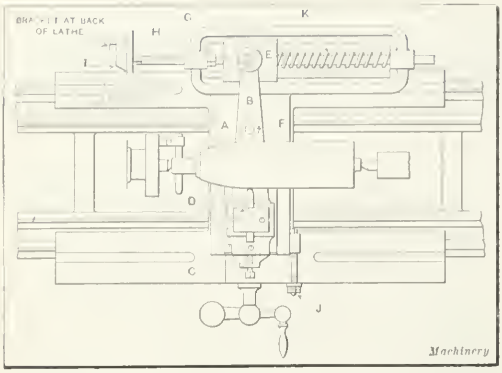


Fig. 1. Shell Turning Attachment with Tool working on Wall of Shell

being located at *D;* arm *B* is also pivoted to crosshead *E*. Carried on arm *B* there is an adjustable tool-block provided with a tool-setting gage which is pivoted at *F* to provide for setting the attachment to turn the nose of the shell to the required radius of curvature.

The cut is started at the base of the shell, and while turning the wall, lock-nuts *G*, carried on rod *H* which is secured to the crosshead, will rest against the end of the yoke, as shown in Fig. 1. With the crosshead in this position, pivot *D* is located on the center line of the cross-slide, and the entire attachment travels as a simple unit until the tool reaches the

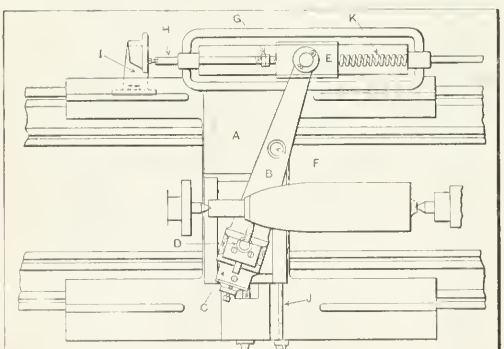


Fig. 2. Shell Turning Attachment with Tool turning Nose of Shell

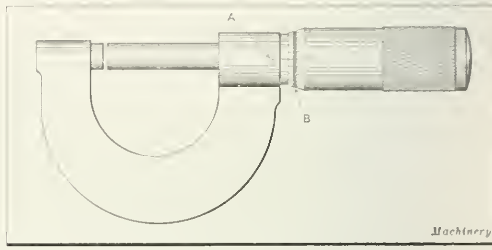
nose of the shell, at which position it is shown in Fig. 1. Rod *H* now comes into contact with stop *I*, which is mounted at the back of the lathe, and stops the movement of the crosshead. The lathe carriage continues to travel along the bed and carries the remainder of the attachment with it; this results in arm *B* swinging on its pivot *F*, as shown in Fig. 2, thus providing for turning the nose of the shell to the required form. In swinging the arm in this way, the required transverse movement is provided by cross-slide *C*.

The tool may be moved back from the work without changing the setting of the attachment, and attention is called to stop *J*, which is provided for the purpose of returning the tool to the working position ready to start a fresh cut. Spring *K* normally holds crosshead *E* so that lock-nuts *G* are held against the yoke; but when rod *H* engages stop *I*, continued movement of the lathe carriage results in the compression of this spring. When the carriage is returned to the starting position, it will be evident that spring *K* automatically returns crosshead *E* to the extreme left of its travel so that the tool is ready to start turning a new shell.

Hamilton, Ontario, Canada. George Armstrong

USE OF MICROMETERS TO SET DIVIDERS

The following describes an improvement which I have made on my Brown & Sharpe micrometer—although the same idea can be applied in the case of a micrometer of any other make—in order to adapt the instrument for setting a pair of dividers. Referring to the illustration, it will be seen that a small pin is mounted in the bearing at *A;* this pin is high enough so that it comes level with the sleeve, and there is a prick-punch mark at the center of the pin. On the cone of the revolving sleeve, a fine circle *B* is cut across the graduations, the location of this circle being such that it is level with the top of pin *A* and at a distance of 0.100 inch from the prick-punch mark on



Micrometer adapted for Use in setting Dividers

pin *A* when the micrometer is set at zero. Then if it is desired to set the dividers to, say, 0.756 inch, adjust the micrometer until the reading is 0.656 inch and then adjust the dividers to bring one point into the prick-punch mark on pin *A* and the other point into groove *B*. The dividers will then be accurately set to lay off the distance of 0.756 inch. I think this little kink will be found useful by draftsmen and mechanics who are called upon to do extremely accurate work.

Tottenville, Staten Island, N. Y. John H. Newstead

NECKING PARTS TO BE HARDENED

Sharp corners and the hardening processes are arch enemies, with the odds favoring hardening, it being universally realized that the way to avoid cracking is to avoid sharp corners and thin sections. A toolmaker will claim that he is taking advantage of these facts to the utmost; but is he? Fig. 1 is an example of the way this point in design is often neglected. The small drill spindles were hardened and ground for bearings at *A* and *B* and a gear at *C*. Quite a few of these parts were lost when hardening due to cracking at *D*. When precedent was discarded and the spindle turned as shown in the lower view, the work was seldom lost. The edges of the bores

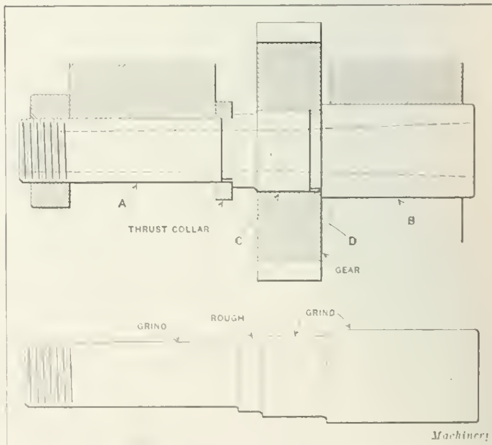


Fig. 1. Example of Changes made in Design of a Small Spindle to avoid Cracking

in the gear and thrust collar had to be rounded, but that costs nothing on a chucking job. Wouldn't it be worth trying to provide all necks on hardened and ground parts with a liberal radius?

When hardened rest-pins or jig feet are to be ground, the toolmaker is usually careful to neck them down, as shown at *A* in Fig. 2, and the sharp corners on this piece allow the development of water cracks. If cracks are detected before assembling, all it means is to try your luck on another piece, and charge up more time to the making of the jig. Why not omit the neck and turn a reasonably large radius under the head, as shown at *B*? This stud still can be ground and the chances of developing a crack are materially reduced. The hole that receives the rest-pin can easily be rounded, as shown

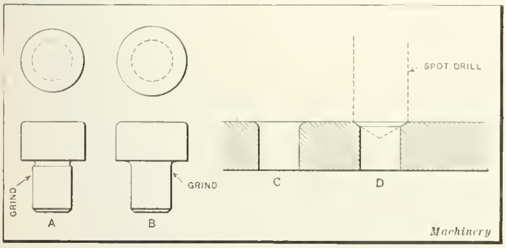


Fig. 2. Method of finishing Jig Feet and Holes to avoid Development of Crack while hardening

at *C*, or as the holes are usually produced by spotting, drilling and reaming, the spot-drill could be used to advantage, as shown at *D*. It is just a little point, but it will help prevent broken jig feet and rest-pins. LAWRENCE FAY

FLUSHING BEARINGS WITH KEROSENE

In the March number of MACHINERY "W. E. R." makes inquiry concerning the possibility of injuring bearings through the use of kerosene for flushing out residue left after the old lubricating oil has been drawn off. In reply, I wish to say that kerosene is undoubtedly a splendid medium for flushing out the bearings, but it is well to remove the kerosene entirely before adding a fresh supply of lubricating oil. This may be done by washing out the bearing with wood alcohol and allowing it to dry before the fresh lubricating oil is added. Alcohol will clean the metal better and more quickly than kerosene or benzine, and there is no possibility of a bad after effect.

New Britain, Conn. WILLIAM C. BETZ

TABLE FOR COUNTING SHELLS

The table presented herewith was developed for the purpose of rapidly determining the number of shells or billets in a pile without actually counting them. Where the billets from

TABLE FOR FINDING TOTAL NUMBER OF SHELLS OR BILLETS IN A PILE

Number on Top and Side / Number on Top	1	2	3	4	5	6	7	8	9
1	1	...	...	...	...	...	...	...	...
2	3	2	...	...	...	...	...	...	...
3	6	5	3	...	...	...	...	...	...
4	10	9	7	4	...	...	...	...	...
5	15	14	12	9	5	...	...	...	...
6	21	20	18	15	11	6	...	...	...
7	28	27	25	22	18	13	7	...	...
8	36	35	33	30	26	21	16	8	...
9	45	44	42	39	35	30	25	17	9
10	55	54	52	49	45	40	35	27	19
11	66	65	63	60	56	51	45	38	30
12	78	77	75	72	68	63	58	51	43
13	91	90	88	85	81	76	70	63	55
14	105	104	102	99	95	90	84	77	69
15	120	119	117	114	110	105	99	92	84
16	136	135	133	130	126	121	115	108	100
17	153	152	150	147	143	138	132	125	117
18	171	170	168	165	161	156	150	143	135
19	190	189	187	184	180	175	169	162	154
20	210	209	207	204	200	195	189	182	174

Machinery

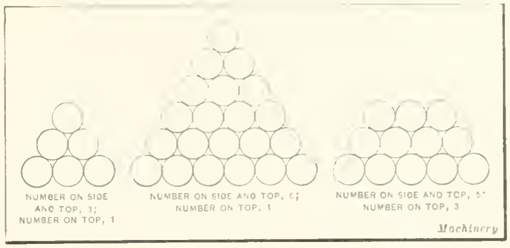


Diagram showing Method of Procedure in using Table

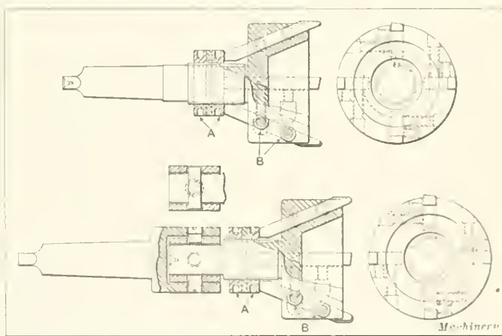
several heats have been placed side by side, so that it is only possible to count the number in the top row and the number in the side row, this table will enable the total number to be determined immediately.

To use the table, count the number of shells on the top row and the number on the side row, the corner shell being counted only once. Now add the number of shells on the top row and on the side row, and referring to the table locate this sum in the left-hand column; then locate the number of shells in the top row of the pile in the top column of the table. Following horizontal and vertical lines from the numbers determined in this way, the point of intersection will give the total number of shells or billets in the pile. The idea will be readily understood by following through one or two problems, making use of the diagram shown in the illustration for that purpose.

Brooklyn, N. Y. JAMES H. CRARY

ADJUSTABLE CYLINDER BORING-BAR

We had a number of cylinders to bore, the diameters of which varied between 6 and 7 inches. To avoid the expense of making a separate boring-bar for each cylinder, we designed



Adjustable Boring-bars for performing Rough- and Finish-boring Operations in Engine Cylinders

the adjustable tool shown in the accompanying illustration, which met all requirements. It will be evident that the cutters may be adjusted by regulating the position of collars *A* to adapt the bar for boring the various sizes of cylinders which come within its range. After the adjustment has been made by collars *A*, the cutters are rigidly held by tightening set-screws *B*, two of which are provided for securing each cutter. The cutters are made of 5/8-inch square stock and the boring-bar is used on a turret lathe. As extreme accuracy was required, two bars were made, one of which is a solid tool used for performing the roughing operation, while the other is a tool of the floating type used for finish-boring the cylinders.

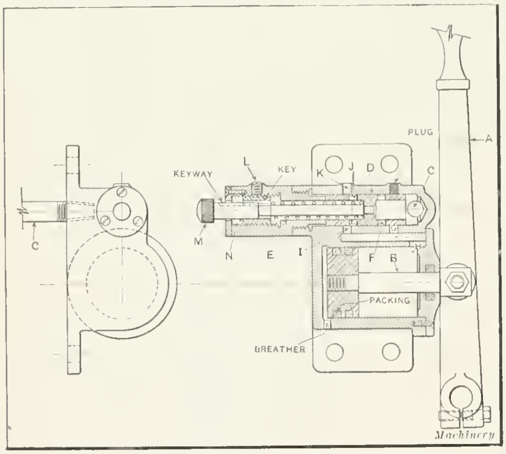
Milwaukee, Wis. MENDEL GLICKMAN

SAFETY VALVE FOR AIR CHUCKS

The automatic air valve here described was designed to prevent accidents on machines equipped with compressed air chucks. Simultaneous demand from a number of air tools or the breaking of an air line is likely to result in a sudden decrease of pressure, and this may cause the work to be

released from the chuck. It is to overcome trouble of this kind that the safety valve was designed.

Referring to the illustration, it will be seen that the lever *A* which is used to start or stop the machine is connected to piston rod *B*, but this does not interfere with the normal operation of the lever. Air pipe *C* is a branch from the main supply pipe of the air chuck, and furnishes pressure to operate hardened steel valve *D* which is held back by spring *E* as long as the air pressure in the line remains normal. If the pressure decreases to a point below the minimum required to operate the chuck, spring *E* throws valve *D* back and admits air to the cylinder through openings *F*, *G* and *H*. Any leakage of air past the valve will not accumulate in the cylinder and cause a shut-down of the machine because it escapes through the by-pass and openings *I*, *J* and *K*.

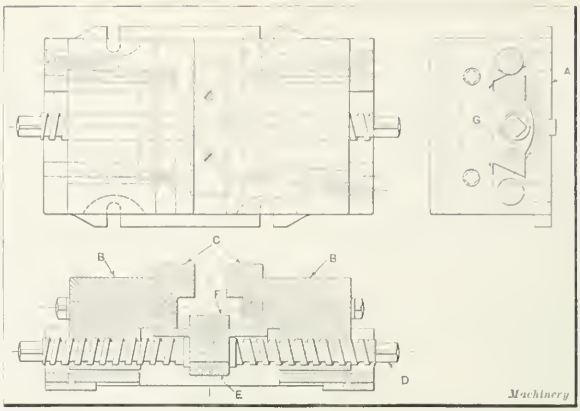


Safety Valve for Air Chuck which shuts down Machine if Air Pressure fails. The Illustration shows Machine shut down by Hand

The tension of spring *E* may be adjusted by loosening a setscrew *L* and revolving knurled rod *M* that is riveted to valve *D*, thus operating screw bushing *N*. As rod *M* moves with valve *D* the position of the valve can be easily estimated; and this is important because if the air pressure is low, it is impossible to start the machine without exerting sufficient force to overcome the total pressure against the piston. This device shuts down the machine if the air pressure falls below the minimum required to hold the work in the chuck; it is sensitive to a variation in pressure of five pounds per square inch and adjustable for any reasonable range. LAWRENCE FAY

SELF-CENTERING MILLING MACHINE VISE

The milling vise described in the following was designed to handle castings, drop-forgings and other parts likely to vary slightly in shape and size. With an ordinary vise any eccentricity of the work results in throwing all the error to one side, and in order to overcome this difficulty I designed the self-centering vise shown in the illustration. It will be seen that the main body *A* holds two sliding jaws *B* to which are secured interchangeable jaws *C* that may be formed to hold work of any desired shape. The movement of jaws *B* is controlled by a right- and left-hand screw *D* which can be operated from either end; this screw moves both jaws an equal distance toward or away from the center of the vise. Screw *D* is secured against end play by a steel bearing *E* which is tongued into the vise body and held by two screws. Cover *F* prevents chips from finding their way into the bearing.

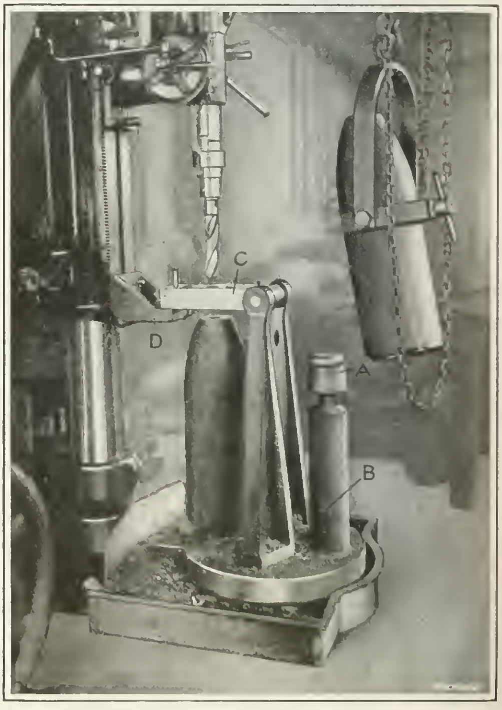


Design of Self-centering Milling Machine Vise

Three taper gibs *G* are employed to keep the sliding jaws *B* in accurate alignment and also to make it easier to fit the parts together. The side having one taper gib is easily scraped in, and as soon as any wear becomes apparent this gib is adjusted. On many small parts which call for a second machining operation—and particularly in cases where a form cutter is employed—it is important for the vise jaws to be held in absolute alignment. By adjusting the two taper gibs at the right-hand side of the vise, the alignment of the jaws can be maintained; and by easing up one gib and forcing in the other, the right-hand slide can be adjusted in either direction. Jaws *C* do not come into contact, and in this way the capacity of the vise is materially increased. AUTOMATIC

SELF-CENTERING JIG

A simple indexing jig for holding 8-inch high-explosive shells has been devised by one manufacturer who handles the various machining operations from a hole drilled through the nose



Self-centering Jig for 8-inch Shells

end of the shell in the first operation. A rotating fixture carries three vertical posts, two of which are bored for a 2-inch diameter piston; one of these pistons is visible at A. A heavy spring floats the pistons when not in use, but when a shell is placed over the end its weight causes this spring to be compressed. This expands three plungers B located around the posts so as to grip the forging just inside the lower end of the shell. The outer ends of the plungers are corrugated. The weight of the shell thus automatically centers it with the rough-forged hole, and the friction of the plungers is sufficient to prevent the shell turning while the nose is drilled and faced. The leaf C holding the locating bushing is hinged to the middle post and is supported by a bracket D on the face of the drilling machine column. While one shell is being drilled and faced, the operator removes a finished shell and chucks another to continue the cycle of operations as before. F. L. H.

AN UNUSUAL BORING OPERATION

There are few machining operations which present greater difficulties than boring around a corner, and this is particularly hard when the corner is a long one and extends through an angle of ninety degrees, as in the case of the work shown in Fig. 3. The writer recently saw such a boring operation accomplished in an ingenious manner and felt that, despite a somewhat general belief to the contrary, there really is something "under the sun" worth knowing about. The part to be machined was a right-angle elbow 4 inches in diameter, which was to be used for experimental work, and it was required to bore the holes in twelve pieces.

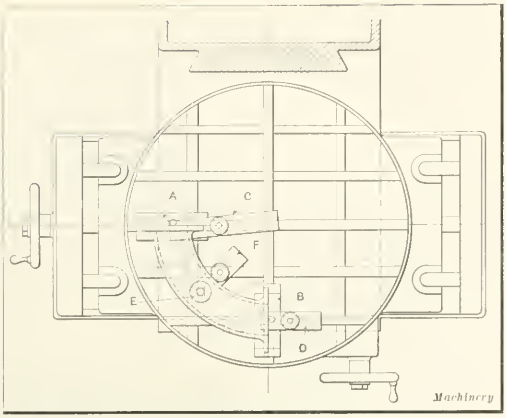


Fig. 2. Method of setting up Work on Circular Attachment of Milling Machine

In preparing for handling this job it was necessary to consider two points: first, the method of holding the work; and, second, the means for getting the tool to follow the hole. Fig. 2 shows the method which was adopted, and the results obtained were highly satisfactory. The work was set up on a horizontal milling machine provided with a circular milling attachment, and supported by two V-blocks A and B. The work was held down by two clamps C and D placed over the V-blocks, and an adjustable jack E was placed under the center of the elbow, with a third clamp F over it. The piece was located at the proper distance from the center of the circular milling attachment to obtain the required radius of curvature.

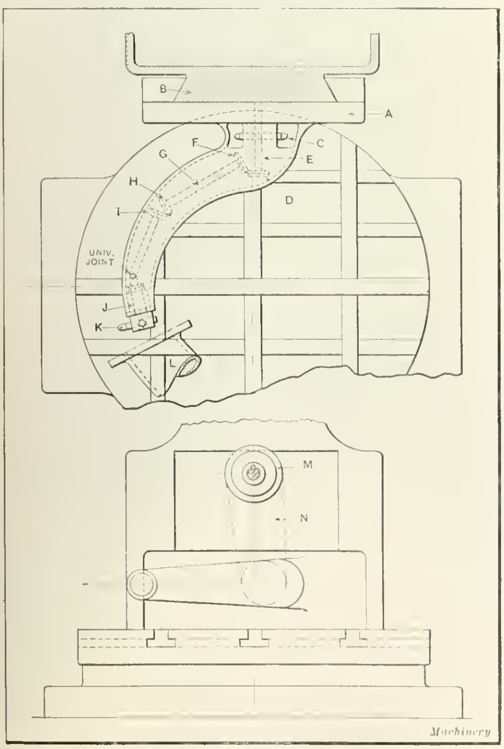


Fig. 1. Design of Special Boring-bar for machining Piece shown in Fig. 3

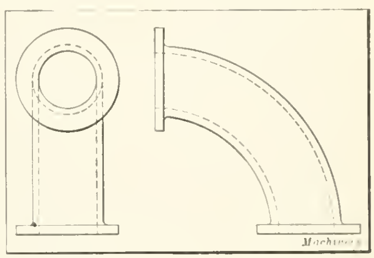


Fig. 3. Piece in which Hole is to be bored

The boring tool was really a unique part of the equipment, and the best idea of how this outfit operated will be obtained by referring to Fig. 1. It will be seen that bracket A is curved so that it will not obstruct the work as it is rotated by the table of the circular milling attachment. This bracket is mounted on the vertical slide B which carries the knee of the milling machine. A suitable bearing is provided in bracket A to support sprocket C and bevel gear D on shaft E. This drive transmits power to gear F on shaft G, and thence through gears H and I, and the universal joint to spindle J which carries fly-cutter K that bores the hole. In this illustration the work is shown at L, and referring to the lower view, it will be seen that power is taken from the milling machine spindle and transmitted through chain N and sprocket M.

When setting up this outfit, the circular milling attachment is mounted in such a way that the fly-cutter will occupy a radial position. The table of the machine is locked and the knee is also locked after bringing the cutter into a central position in the vertical plane. Then by starting at the position shown in Fig. 1 and rotating the circular milling attachment, the work is fed over the cutter so that the hole will be bored to the required shape. SERVER

TOOLS MOUNTED WITH CUTTING EDGE DOWN

The advantage of a spring tool or so-called "gooseneck" tool is known to most machinists, the smooth cutting action of this tool having been explained by many mechanical writers. But comparatively few machinists use an ordinary tool mounted with the cutting edge down to obtain a similar result, although this practice could often be advantageously employed; and still fewer men would be able to give a reasonable answer if asked to explain the benefit resulting from such a practice.

It is an established fact, however, that chatter and breakage of delicate tools are often materially reduced by mounting the tools with the cutting edge down, the principal reason being that the spring of the tool and support tends to relieve the pressure at the point, making the action similar to that of a gooseneck tool.

For instance, owing to the excessive overhang, boring tools are quite likely to chatter. A boring cut is usually a light facing cut, and the fine finish generally required makes it particularly important to avoid chattering and digging in of the tool. By mounting the tool with the cutting edge down, as shown at *A*, relief will be provided which will insure obtaining satisfactory results. At *B* the tool is shown mounted with the cutting edge up, and it will be evident that here the pressure of the cut will result in springing the tool point down and causing it to dig into the work. The lower the center about which the tool point swings, the greater will be the trouble from this cause, and consequently the more imperative becomes the need of mounting the tool with the cutting

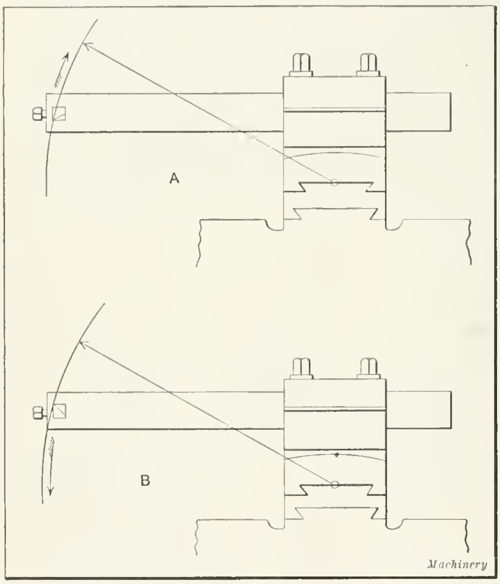


Diagram showing Conditions with Cutting Edge of Tool pointed down at A and up at B

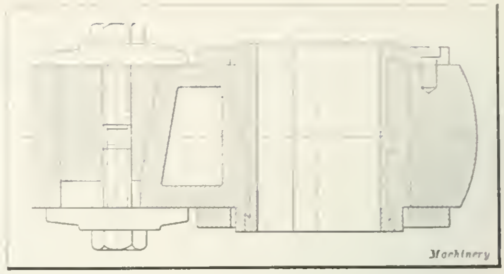
edge down. In the case of parting tools, another decided advantage is gained by the application of this principle, namely, the tool does not hinder the chips from dropping out of the cut.

Wilkinsburg, Pa. WILLIAM S. ROWELL

METHOD OF INDICATING SCREW THREADS

I wish to call the attention of readers of MACHINERY to a simple and yet perfectly explicit convention for delineating the threads of screws. While this may have come to notice before in the foreign prints, it has, so far as I know, never appeared in American drafting practice. Its simplicity and clearness should strongly recommend it to draftsmen generally. The accompanying illustration is reproduced from a portion of two cuts in a German work on connecting-rods and crossheads, which is one book of a number I have found using this convention. The illustration is self-explanatory. The outlines of the bolts are drawn in the usual way; the depth of thread and the upper and lower limits of threading are indicated by dotted lines parallel and perpendicular to the axis of the bolt, respectively.

This convention will save a great deal of time as compared with the usual method of drawing inclined lines to represent the inclination of the threads. Its use will result in greatly



Conventional Method of indicating Screw Threads

clarifying intricate and detailed views, as the distraction of the eye occasioned by the large number of lines required to represent a threaded member in the old way does not occur with the manner of representation proposed. This convention should have a strong appeal to designers and draftsmen; the time saved and clearness gained are of undoubted value, and if there are any serious objections to the practice outlined, they are not apparent to the writer.

Washington, D. C. F. J. SCHLINK

SELECTIVE OR LOCAL HARDENING

On page 512 of the February number of MACHINERY, Paul Cyr tells of his experience in developing a method for hardening a die around a cutting edge and leaving the rest of the steel soft. Mr. Cyr would have obtained better results and done his work more easily by using a compound known as "enamelite" which is made by the Shore Instrument Co. of New York City. This compound is applied to those surfaces of the work which are to be left soft, the degree of softness obtained depending on the thickness of the film of enamelite which is applied to the work. Where it is required to leave the metal very soft, the coat of enamelite should be about 3/16 inch thick.

The ability of this compound to keep the metal soft is due to the fact that when heated it liberates hydrogen gas which is held in a film around the heated steel and keeps the quenching fluid from coming into contact with it. Naturally this prevents the steel from hardening, while those portions of the work which are not coated with enamelite are reached by the quenching fluid and hardened in the usual way. Enamelite can be used in hardening steel by quenching in water or oil, and it can also be used where a lead bath is employed for heating; but it cannot be used in a salt bath, as the salt decomposes the enamelite and renders it useless. The best results are obtained by using enamelite in an open-fire furnace.

New Britain, Conn. W. C. BETZ

TURNING ECCENTRIC BUSHINGS

The writer is frequently called upon to turn eccentric bushings of the form shown in Fig. 1, and in handling work of this kind, he uses the special form of arbor illustrated in Fig. 2. It will be seen that this is made after the pattern of the "Champion" expanding arbor with the addition of adjustable centers to provide for obtaining the required eccentricity. These arbors were designed by a foreman in the machinery division department of the United States Navy at Boston, Mass., and enable extremely accurate work to be turned out in a relatively short time.

The operation of turning an eccentric bushing with this

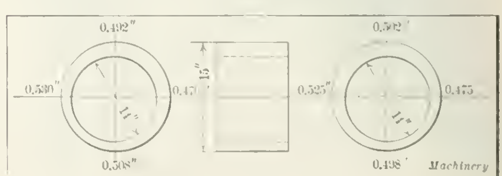


Fig. 1. Examples of Eccentric Bushings to be turned

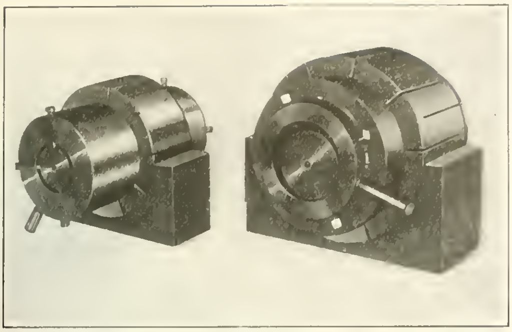


Fig. 2. Expanding Arbor with Adjustable Center for turning Eccentric Bushings

tool is as follows: In the case of one of the bushings shown in Fig. 1, the first step consists of boring the work out to an inside diameter of 14 inches, after which it is placed on the arbor and the centers adjusted to give approximately the desired eccentricity. After this setting has been made a trial cut is taken to see what amount of eccentricity has been obtained, and the centers are adjusted in a direction shown to be necessary. This method of taking a trial cut and resetting the centers is continued until exactly the desired eccentricity is obtained. It should be borne in mind that while these trial cuts are being taken the work is considerably over size, and after the centers have been adjusted to give the required eccentricity, the outside diameter of the bushing is turned down to the required size.

Boston, Mass. N. I. Mosher

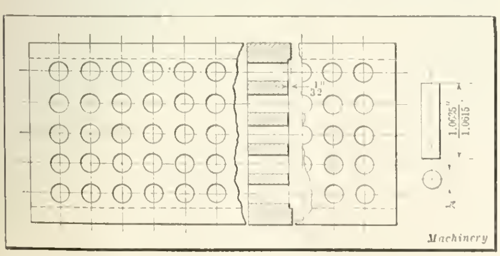
SETTING ONE PAIR OF CALIPERS TO ANOTHER

It is much easier and quicker to set a pair of calipers to the size indicated by a second pair of calipers by holding the tools at right angles to each other than by holding them end to end. The reason for this is that the points of the calipers are round and when the tools are held end to end it is difficult to keep the points from slipping over each other.

Milwaukee, Wis. W. E. Butler

PLUG GRINDING FIXTURE

For use in accurately grinding to length short cylindrical plugs of the size shown, we designed a fixture which has given very satisfactory results. It holds 100 plugs and is used in connection with a magnetic chuck on a No. 2 Brown & Sharpe surface grinder. The plugs are a free sliding fit in the holes in the fixture, and in grinding them a "clean-up" cut is first taken over one end of all of the plugs. The fixture is then removed from the chuck and turned over so that the plugs drop out; and they are then taken to a speed lathe on which the ground ends are burred up. The work is next returned to the grinder and placed in the fixture with the ground ends down, after which a second grinding operation reduces them to the required length. The work is gaged by placing a parallel on top of the plugs which is supported by master plugs, the lower ends of which engage the face of the magnetic chuck. The



Fixture used for grinding Ends of Short Plugs

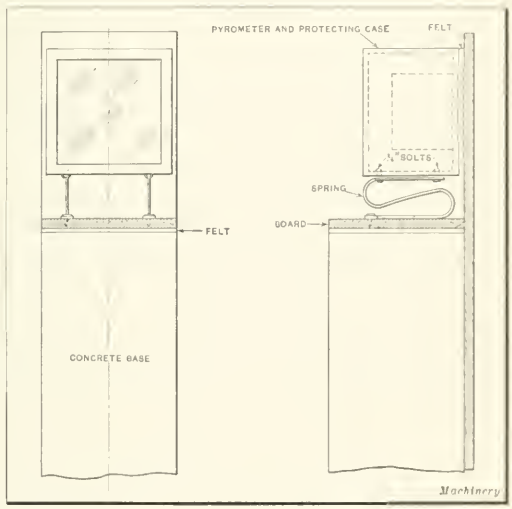
plugs project about 1/8 inch above the surface of the fixture, so that further tests may be performed by removing one or two plugs and measuring them with a micrometer. When the final grinding operation has been performed, the upper ends of the plugs are burred, after which they are ready for use.

Plainfield, N. J. J. B. Murphy

SPRING STAND FOR PYROMETERS

Trouble is often experienced with pyrometers used in forge shops due to the vibration caused by heavy power hammers, and this difficulty may be experienced in cases where a pyrometer is mounted at some distance from the hammer. The impact of the hammer interferes seriously with the reading of the instrument, as the vibration set up causes the indicator to quiver in such a way that it is practically impossible to secure an accurate reading.

We tried two or three methods of overcoming this trouble, but the one here illustrated gave the most satisfactory results. It consists of a concrete base, upon which is placed a layer of felt, a board, and a spring made of 3/16-inch round spring steel which is secured to the case of the instrument. A layer of



Spring Stand for Pyrometer to absorb Vibration from Power Hammers

felt is also put between the case and the board which forms the back of the stand. After the pyrometer was mounted on this stand, no trouble was experienced through quivering of the needle. L. K.

RING VS. LINE STRAIGHTENING OF RIFLE BARRELS

Referring to the editorial note regarding the concentric method of observation when straightening rifle barrels, which appeared with my article, "Drilling, Reaming and Straightening Rifle Barrels," in the April number, I wish to say that in Avis & Co.'s plant in West Haven, Conn., we have nearly thirty barrel straighteners, including beginners. We would not think for an instant of employing a ring straightener, because we know that method is far from being the best. When a barrel straightener uses the ring method, it is because he cannot use the line method, which is more difficult and gives far better results. The ring method simply means lining up one part of the interior surface of the barrel with another part; in other words, straightening barrels at different points but not from end to end. Line straightening, on the other hand, means straightening every inch of the bore of the barrel from end to end. None of the important sporting gun makers would tolerate the ring method of straightening for an instant.

Whitneyville, Conn. William H. Avis

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

NUMBER OF B. T. U. IN HORSEPOWER-HOUR

T. T. H.—A horsepower-hour is said to be equal to 2545 B. T. U.; how is this number determined?

A.—If a machine having a capacity of one horsepower were to run for one hour, it would perform 1,980,000 foot-pounds of work. Since one B. T. U. is equal to 778 foot-pounds of work,

$$\text{one horsepower-hour} = \frac{1,980,000}{778} = 2545 \text{ B. T. U., very nearly.}$$

It should be noted that a horsepower-hour is not a unit of power, but a unit of work, and is equal to 1,980,000 foot-pounds. Similarly, 200 horsepower-hours may mean the work done by a 200-horsepower machine in one hour, or by a 25-horsepower machine in eight hours, etc., but in any case, it would equal $1,980,000 \times 200 = 396,000,000$ foot-pounds $= 2545 \times 200 = 509,000$ B. T. U. J. J.

DURABILITY OF LIMIT GAGES

F. E. W.—How long will an outside limit gage last when used for gaging three-inch high-explosive shells? How many limit gages should be provided for a plant turning out 1000 shells per day of ten hours?

A.—No reliable data on the durability of limit gages are available. Records of the life of gages are imperfect, and even if perfect records were available they would not serve directly as the basis for estimating what might be required in a plant producing a totally different product under different conditions, except in a very general way. Small limit gages have been used to measure as high as 150,000 pieces, which were required to be kept within limits of $\pm$ 0.00025 inch. A great deal depends upon the condition of the work gaged, the character of the labor using the gages, and the limits imposed. Two sets of gages should be provided in a plant turning out high-explosive shells, one set being used in the shop while the other is being repaired and adjusted in the tool-room.

COLORED DRAFTSMEN

A. T. C.—Why is it we see so few colored men employed in drafting-rooms of manufacturing establishments? It seems to me that drafting offers inducements to colored men having some technical education.

A.—There are two principal reasons why colored men are not more often employed as draftsmen, the first being the race prejudice which bars them from many other occupations, and the second that very few colored men have acquired the knowledge of drawing and machinery required to fit them to be draftsmen. A letter addressed to the Tuskegee Normal and Industrial Institute elicited the information that very few colored men are employed as draftsmen, there being only one or two in Philadelphia and about the same number in Cleveland, Chicago, Boston, Milwaukee and Quincy, Mass. A few colored men have gone to architectural schools and are practicing as architects in the South, but comparatively few have taken up mechanical drawing, as they realize how difficult it would be for them to obtain positions.

LENGTH OF A METER

H. R. L.—In the March number of MACHINERY, page 585, it is stated that Congress legalized the meter and decided that it is equal to 39.37 inches. It is also stated that, according to the *Encyclopaedia Britannica*, a meter is equal to 39.370113 inches. Does this mean that a meter has two different lengths?

A.—It does not; the lengths of all meters are alike, theoretically. The standard meter is the distance between two marks on a certain metal bar, which is preserved in the International Bureau of Weights and Measures at Paris. Copies of this were constructed and delivered to various governments in the year 1889, and the U. S. government got meters Numbers 21 and 27. These copies are as exact reproductions as it is possible to make. The effect of making a meter contain exactly 39.37 inches was to change the length of the inch, which previous to the Act of Congress referred to was 1/36 of a standard yard. The standard yard is defined in two ways: In Great Britain an Act of Parliament (18 and 19 Vict. cap. 72) defines the yard as the distance at 62 degrees F. between the centers of the transverse lines in two gold plugs in the bronze bar deposited in the office of the Exchequer. By a former Act of Parliament, the foot is $1 \div 3.26159$ of the length of a simple pendulum, beating seconds at the Tower of London, the yard being three such feet. Both of these yards are supposed to be identical, and the U. S. standard yard has the same value. Consequently, what we may call the metric inch is a trifle longer than the yard inch. In England, the value most commonly used for the meter is 39.37079 inches, while in this country, the value is usually stated as 39.370432 inches. The value quoted above is a more recent determination and is more accurate. The different values were arrived at by different persons, and they illustrate strikingly the difficulties of measuring distances correctly to more than five or six significant figures. J. J.

NUMBER OF WATTS IN A HORSEPOWER

O. J. D.—A horsepower is said to be equal to 746 watts; please explain how the number 746 is arrived at.

A.—The fundamental equation of dynamics is $F = ma$, in which F is the force that will produce an acceleration a in a body having a mass m. Since $m = \frac{W}{g}$, $F = \frac{W}{g}a$, in which W is the weight of the body and g is the acceleration due to gravity attained by a freely falling body at the point where the body is weighed. In the English system of measures, F and W are measured in pounds and a and g in feet per second per second, or as some writers put it, in feet per second². In the C. G. S. system, the unit of force is the dyne, the unit of mass is the gram (0.00220462 pound), the unit of acceleration is one centimeter ($= 0.0328087$ foot) per second², and the acceleration due to gravity is taken as 981 centimeters per second². Letting D represent the force in dynes, and substituting in the above equation the English equivalents for the weight and accelerations:

$$1D = \frac{0.00220462 \times 0.0328087}{981 \times 0.0328087} = 0.00000224732 \text{ pound.}$$

The C. G. S. unit of work is the erg, which is one dyne-centimeter ($= 1D \times 1$ centimeter); this unit is too small for most purposes, and, hence, the practical unit is the joule, which is 10,000,000 ($= 10^7$) ergs. Consequently, 1 joule $= 10^7 \times 0.00000224732 \times 0.0328087 = 0.737317$ foot-pound, and

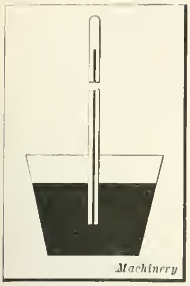
$$1 \text{ foot-pound} = \frac{1}{0.737317} = 1.32346 \text{ joule.}$$

The C. G. S. unit of power is the watt, which is 1 joule per second; hence, 1 horsepower $= 550$ foot-pounds per second $= 550 \times 1.32346 = 745.9485$ joules per second $= 746$ watts, very nearly. According to the U. S. Bureau of Standards, the horsepower is exactly equal to 746 watts when that value of g is used which corresponds to sea level and latitude 50 degrees, which is very nearly the latitude of London. J. J.

ATMOSPHERIC PRESSURE ON MERCURY COLUMN

B. L. R.—Please explain why the pressure of the atmosphere makes the mercury stand in a barometer tube.

A.—In order for any liquid to be at rest, it is necessary that the pressure on any particle of it be the same in all directions—upward, downward, or sideways. Otherwise, if there is less pressure in some particular direction, the liquid will



Atmospheric Pressure on Mercury Column

flow in that direction. Referring to the illustration, take a glass tube about three feet long, fill it with mercury, close one end, and with the finger over the other end, stand the tube in a cup of mercury, as shown. On removing the finger, the column of mercury will be found to be about 30 inches in length between its top and the top of the mercury in the cup. The pressure is exerted all over the top of the mercury in the cup, except on the area occupied by the hole in the tube. This pressure is transmitted in all directions, and presses upward on the bottom of the tube; as the space above the column of mercury is a vacuum, the weight of the mercury in the tube must exert a downward pressure exactly equal to the upward pressure on the mercury column due to the atmosphere. This should answer your question, since the essential features of a mercurial barometer are a cup of mercury and a glass tube having a vacuous space above the mercury column. J. J.

TO DIVIDE A STRAIGHT LINE INTO ANY NUMBER OF EQUAL PARTS

A. C.—How can I divide a straight line (graphically) into any number of equal parts?

A.—Assuming that the line can be placed at will, draw a horizontal line AB, Fig. 1, using a T-square, and make it equal in length to the given line. At one end, say B, erect a perpendicular BC with the T-square and a triangle. Let n represent the number of parts into which the line is to be divided. Take n divisions on the scale, of such length that when the 0 mark of the scale is placed at A, the end of the nth division will fall on the line BC at a point D. Draw AD, and with a sharp pencil prick the division points 1, 2, 3, etc. Through these points, using the T-square and triangle, draw the vertical lines 1-1′, 2-2′, etc. Then $A1' = 1'2' = 2'3'$, etc. $= AB \div n$. This construction is very accurate and rapid. When the line is on a drawing and is not horizontal, use the method shown in Fig. 2. AB is the given line. Draw a line AC of indefinite length, and lay off with a scale or space off with dividers $n + 1$ equal spaces from A, the end of the $n + 1$ division being the point D. Draw DBE, and make $BE = BD$. Through E and the point marking the second division from D, draw $E6$, intersecting AB at 6′. Then $6'B$ is $\frac{1}{n} \times AB$. The other divisions are found by drawing lines through the points 5, 4, etc., parallel to $E6$. In both figures,

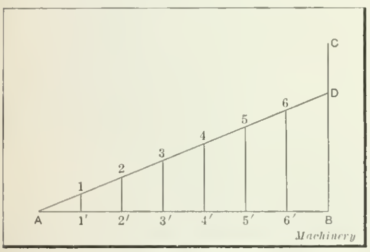


Fig. 1. Graphical Method of dividing a Given Line into any Number of Equal Parts

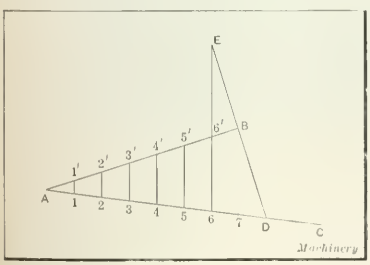


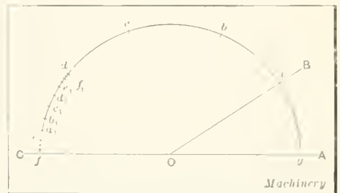
Fig. 2. Another Method of dividing a Line into a Number of Equal Parts

the line AB has been divided into seven equal parts; *i. e.*, $n = 7$. This construction is also rapid and gives very accurate results. It should be understood that a graphical construction, particularly when the result depends upon the location of points of intersection, may be mathematically correct, while the construction itself may not give accurate results in practice. J. J.

GRAPHICAL METHOD OF MEASURING ANGLES

F. A. M.—Is there any reliable method of measuring an angle without using a protractor?

A.—The following method is due to de Lagny, who made it public about 1724; it is very exact and is readily applied. Referring to the illustration, let AOB be the angle to be measured. Produce one side, say, OA to C, and with O as a center and any convenient radius (the larger the better) describe a semicircle whose diameter shall coincide with AC. Now place one leg of the spacing dividers at g and the other at a and space off the arc ag along the semicircle, stopping at e. Then space off the arc ef from e toward d, stopping at the point f_1, f_1d being less than ef. Then space off f_1d from f_1 to e_1, and note that the stopping point practically coincides with the point e_1. The semicircle is equal to $5 \times$ arc ag + arc ef. Arc $ed = 6 \times$ arc $ef + f_1d$. Arc $e_1f_1 = 3 \times$ arc f_1d, very nearly. These numbers 5, 6, and 3 are the denominators of the continued fraction $\cfrac{1}{5+\cfrac{1}{6+\cfrac{1}{3}}}$ which, as is readily seen, is equal to $\frac{19}{98}$. In other words, the angle AOB is very nearly $\frac{19}{98}$ of a semicircle, and $AOB = 180 \text{ deg.} \times \frac{19}{98} = 34.9$ deg. = 34 deg. 54 min. The accuracy of the result depends on the care exercised in spacing; if great pains are taken, it is claimed the error will not be more than one or two minutes. J. J.



Graphical Method of Measuring Angles

FORMULA FOR FINDING AREA OF SEGMENT OF CIRCLE

L. N. P.—Please give a formula for finding the area of a segment of a circle in terms of the chord and height or radius.

A.—Referring to the illustration, let

r = radius = OA = OC = $\dfrac{c^2 + 4h^2}{8h}$;

c = chord of arc AC;

h = height of segment DB;

V = central angle AOC;

A = area of segment $ABCDA$.

Then

$$A = \frac{r^2}{2}(V - \sin V), \text{ when } V \text{ is in radians}$$

$$A = \frac{r^2}{2}\left(\frac{\pi}{180}V - \sin V\right) = \frac{r^2}{2}(0.0174533\,V - \sin V), \text{ when}$$

V is in degrees.

This formula may be readily solved with the aid of a table of trigonometric functions, provided the central angle is known. In practice, mechanics usually measure the chord and the height, in which case, $\tan BAC = \tan \dfrac{AOC}{4} = \dfrac{2h}{c}$, from which angle AOC is easily found. Mathematicians have failed

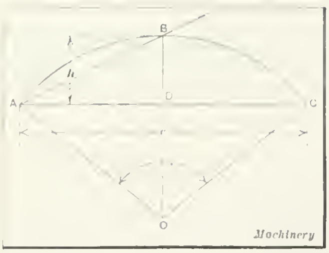


Diagram for finding Area of Segment of Circle

to furnish a convenient formula for calculating the area without employing trigonometric functions and which will give accurate results for both large and small angles. If the central angle does not exceed 160 degrees, the following formula can be used:

$$A = \frac{2}{3} h \sqrt{c^2 + 1.568\,h^2}.$$

If accurate results are desired and the central angle is greater than 160 degrees, that is, if $\frac{h}{c}$ is greater than, say, 0.4, the following formula may be used, which gives very good results for all angles from 0 to 180 degrees; it is, however, far more difficult of application:

$$A = \frac{12\,r^2h\left[1 + 0.01824\left(\frac{h}{c}\right)^3\right]}{c + \sqrt{32\,rh}} - \frac{c}{2}\,(r - h).$$

J. J.

TO FIND THE CENTER OF GRAVITY OF A SECTION

A. O. B.—Referring to the accompanying illustration, please show me how to calculate the center of gravity of the section.

A.—We note first that the figure is symmetrical about the axis AA', which passes through the center o of the circle in the upper part and is perpendicular to the base bc; in other words, if the paper were folded on the line AA', every point and line on one side would fall on corresponding points and lines on the other side; consequently, the center of gravity of the figure must lie on the line AA'. Now draw a line perpendicular to AA', the most convenient line in this case being BB', which coincides with the base line bc; this is an axis of reference. Divide the figure into elementary areas (rectangles, triangles, circles, etc.), whose areas and centers of gravity are easily found, and calculate the area of the entire figure, which we will call A. Denote the various elementary areas by A_1, A_2, A_3, etc., and the distances of their centers of gravity from BB' by y_1, y_2, y_3, etc.; also, let y = the distance of the point C, the center of gravity of the entire figure, from BB'. The distance y can then be readily found from the equation:

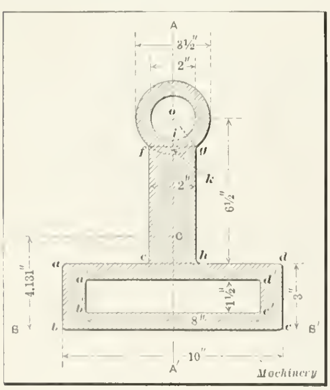


Figure whose Center of Gravity is to be determined

$$Ay = A_1y_1 + A_2y_2 + A_3y_3 + \text{etc.}$$

The different terms in this equation are the moments of the areas about the axis BB'. Referring now to the figure, the area A may be regarded as being made up of the hollow circular area minus the area of the segment fg plus the area of the rectangle $efgh$ plus the area of the hollow rectangle $abcd$, and these are now calculated as follows: Area of circular ring $= \frac{\pi}{4}\left[\left(3\frac{1}{2}\right)^2 - 2^2\right] = 6.4795$ square inches. Sin foi $= \frac{fi}{of} = \frac{1}{1.75} = 0.57143$; hence, $foi = 34$ degrees 51 minutes, and $fog = 69$ degrees 42 minutes $= 1.2165$ radian. Area of segment $= \frac{1.75^2}{2}(1.2165 - 0.9379) = 0.4266$ square inch, since sin 69 degrees 42 minutes = 0.9379. Distance $oi = \sqrt{1.75^2 - 1^2}$ $= 1.4361$ inch. Whence, $gh = 6.5 - 1.4361 = 5.0639$ inches, and area $efgh = 5.0639 \times 2 = 10.1278$ square inches. Area of hollow rectangle $= 10 \times 3 - 8 \times 1\frac{1}{2} = 18$ square inches. Consequently, $A = 6.4795 + 10.1278 + 18 - 0.4266 = 34.1807$ square inches. Distance of center of gravity of circular ring from $BB' = 6.5 + 3 = 9.5$ inches. Distance of center of gravity of segment from o is equal to the cube of the chord fg divided by twelve times the area of the segment $= \frac{2^3}{12 \times 0.4266} = 1.5627$ inch $= ok$, and distance of k from $BB' = 6.5 - 1.5627 + 3 =$ 7.9373 inches. Distance of center of gravity of $efgh$ from BB' $= 5.0639 \div 2 + 3 = 5.5319$ inches. Distance of center of gravity of $abcd$ from $BB' = 3 \div 2 = 1.5$ inch. Substituting these values in the formula, $34.1807y = 6.4795 \times 9.5 + 10.1278 \times 5.5319 + 18 \times 1.5 - 0.4266 \times 7.9373 = 141.1946$, and $y = 141.1946 \div 34.1807 = 4.131$ inches. Since the area of the segment was subtracted, its moment must be subtracted. J. J.

WEDGE REACTIONS

P. G. F.—What is the formula giving the relationship between the force P and the resistance Q in a wedge of the shape shown in the accompanying illustration (Fig. 1), friction being considered?

A.—A formula giving the relationship between the force P and resistance Q in Fig. 1 may be derived as follows: The force P may be divided into two components Q and Q_1, one acting normal to the inclined surface and one normal to the vertical surface of the wedge. If the parallelogram of forces is drawn, it is evident that, neglecting friction:

$$P = Q \sin \alpha$$
$$Q_1 = Q \cos \alpha$$

Now, if friction is considered, the forces resisting a downward movement of the wedge are composed of the vertical component of force Q, the vertical component of the frictional resistance due to the normal pressure of Q against the inclined side of the wedge, and the frictional resistance due to the pressure of force Q_1 against the vertical side of the wedge, or, expressed as a formula (the coefficient of friction being μ):

$$P = Q \sin \alpha + Q\mu \cos \alpha + Q_1\mu$$

But it has already been shown that:

$$Q_1 = Q \cos \alpha$$

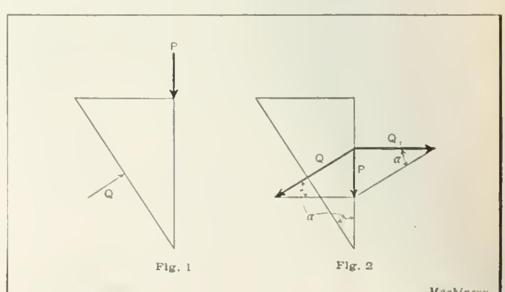
Hence, by inserting this value of Q_1 in the above formula:

$$P = Q \sin \alpha + Q\mu \cos \alpha + Q\mu \cos \alpha$$

This formula may be reduced to the simple form:

$$P = Q\,(2\mu \cos \alpha + \sin \alpha)$$

which may be considered the fundamental formula for a wedge of the type shown.



Wedge Reactions

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

HART-PARR SHELL BORING AND TURNING LATHE

The Hart-Parr lathe for turning and boring shells from 6- to 12-inch sizes is the result of an investigation conducted by the Hart-Parr Co., Charles City, Iowa, in preparing to start work on a shell contract. This is a single-purpose machine and its design combines several noteworthy features. Chief among these are the application of carefully fitted ball bearings in the head, and the extension of the spindle to form a boring-bar for the performance of internal operations, or a mandrel to support the shell for turning operations. The spindle bearings are fitted with great care so that alignment is obtained without the use of a tailstock, except where the shells are of exceptional length.

In taking up the manufacture of shells from 6- to 12-inch sizes, a preliminary study of the work made by the Hart-Parr Co., Charles City, Iowa, convinced its engineers that the boring and turning operations could be most advantageously handled on special machines designed with particular reference to the peculiar requirements of these operations. The machines shown in the illustrations which accompany this description represent the outcome of this investigation; they have a capacity for handling various types and sizes of shells from 6 to 12 inches in diameter, and the design has been worked out along lines which would make it easily modified to adapt the machine for various manufacturing operations in addition to the special class of work referred to. To meet the severe service conditions which exist in munition factories, these lathes have been heavily built to adapt them for continuous operation during a 24-hour working day. All lathe features not actually required for shell turning and boring have been eliminated to make the machines suitable for operation by relatively unskilled labor.

It will be seen that the headstock and bed are cast integral; and the headstock is of the box type with side walls that connect the front and rear bearings. The bed is provided with ribs of I-section which run crosswise to stiffen the construction as far as possible. The spindle is forged from high-carbon steel and extends out over the ways and carriage to form a boring-bar for the performance of interior operations on the shells, or an expanding arbor for supporting the work while turning operations are performed. The spindle is 6¾ inches in diameter, and for all ordinary shell work it is depended upon to provide a sufficiently rigid support for the boring tools and formers; the same is true when the spindle is used as an expanding arbor to carry the shell, so that no tailstock is ordinarily required on the lathe. In the case of very long work, however, the use of a tailstock is required to provide outboard support.

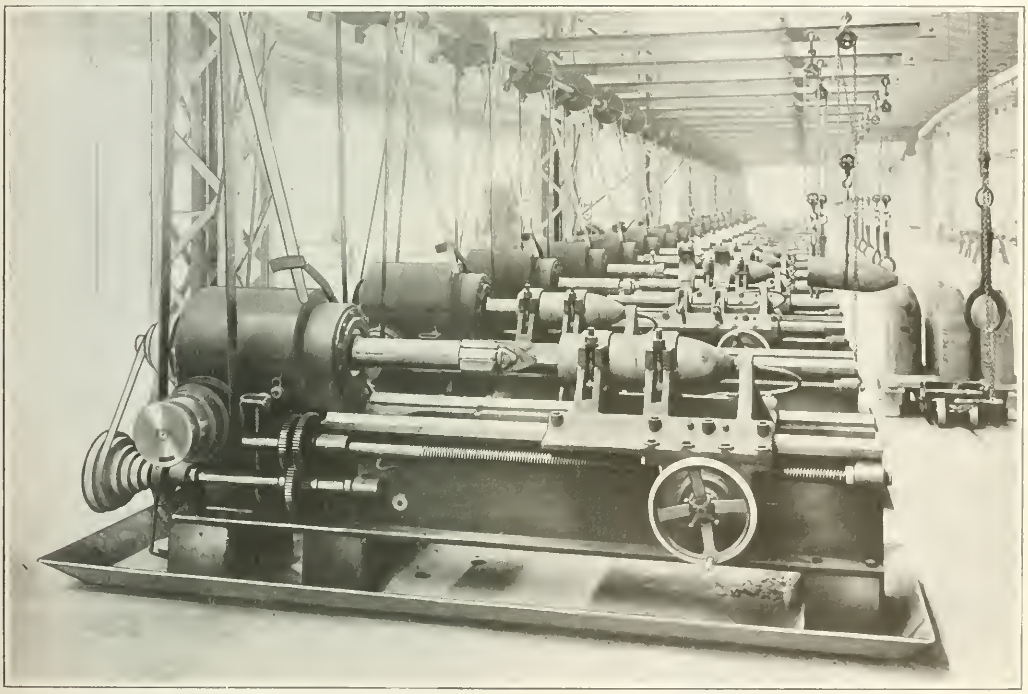


Fig. 1. Group of Hart-Parr Lathes for Shell Boring Operations; note Extension of Spindle and Method of holding Work

The spindle is mounted in combination radial and thrust ball bearings which are very accurately fitted; and owing to the liberal size and great durability of these bearings, permanence of spindle alignment is practically assured. Mounted upon the spindle there is a worm-wheel with a phosphor-bronze ring; and the worm which meshes with this wheel is mounted on the cone shaft, provision being made for clutching the worm directly to the shaft or driving through back-gears. With the four-step cone pulley on the machine, provision is made for eight changes of speed. With the high reduction obtained in this way the belt cone runs at high speed, enabling a 3-inch belt to provide ample power. Previous ex-

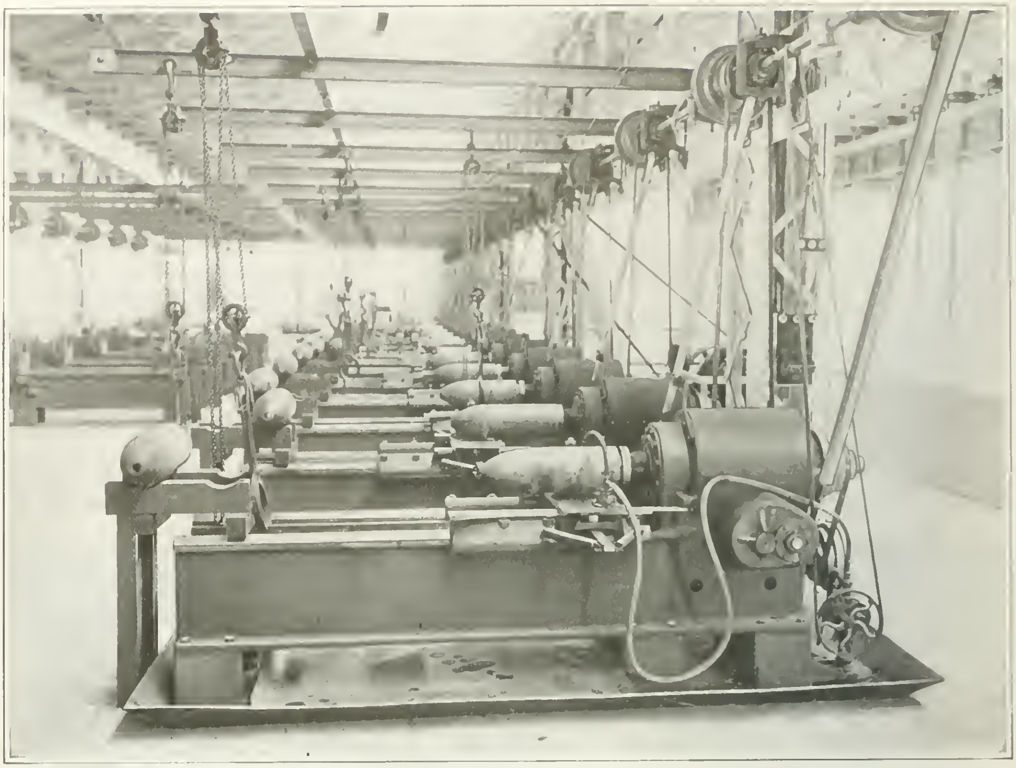


Fig. 2. Group of Hart-Parr Lathes tooled up for performance of Shell Turning Operation; note Arrangement of Forming Plate

perience with heavy machining operations led to the selection of this type of worm drive because of its steady action and freedom from chatter. The worm is quadruple threaded and mounted below the wheel; and the worm and wheel run in a liberal sized oil pocket which provides adequate protection against heating.

The feed mechanism is operated through spindle cone pulleys and provides six changes of feed. Both power feed and hand traverse are available and the mechanism is simply constructed. For the performance of outside turning operations, the tool and cross-slide are under control of a simple profiling cam which governs the turning operation over the entire length of the shell. For boring, the lathe is fitted with a heavy saddle carriage upon which the shell is clamped, and the carriage is fed up to the cutters secured in the end of the spindle. The stiffness of the machine and secure method of mounting provided for the work enables heavy boring and turning operations to be readily performed, including long forming cuts for finishing the outside of the nose and the taper on the inside of the shell. A quick return is provided for the carriage. For turning operations, a four-tool turret post is usually employed; or the lathe may be equipped with a turret tool-holder. The tools are made of ordinary square high-speed steel or steel shaped for round point cutters. The tools are held and clamped in this turret tool-holder in such a way that they are supported close to the work. The method of supporting is such that the heat generated by the cut is quickly conducted back from the tool point and dissipated.

In machining shells on this lathe the internal operations are performed first. The shell is clamped to the carriage and the first tool-head is mounted on the end of the spindle; this head carries a single-point tool which takes the roughing cut. By means of a special drift, this head is quickly removed from the spindle and a second head substituted which carries a

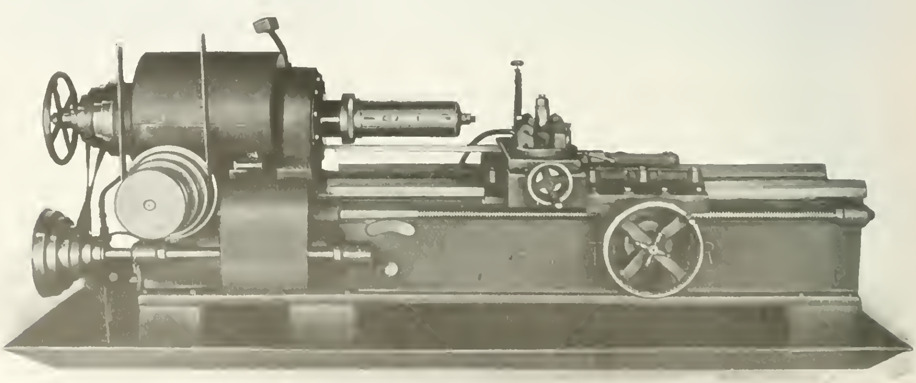


Fig. 3. Front View of Hart-Parr Shell Turning Lathe; note Mandrel carried by Spindle

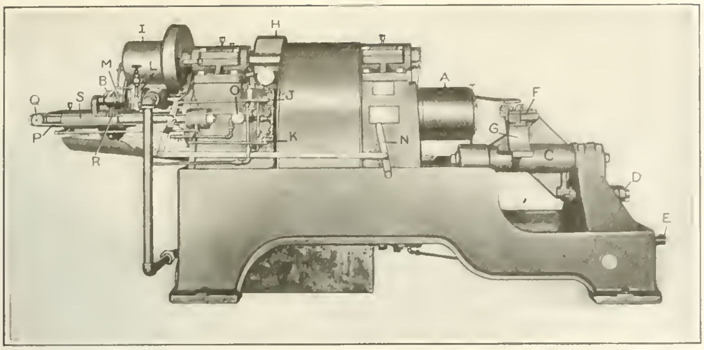


Fig. 1. Front View of Warren Lathe for rough-turning Nose of 5-inch Shell Forgings

rough-sizing reamer and rough arch-forming tool. The cut taken with this head finishes the inside diameter of the shell to size and rough-forms the arch. The next cutter-head carries finish-reaming and forming tools which complete the work on the arch. These three cuts complete the interior machining, and the same operations might provide for recessing and facing; but in case the forgings are very rough, one or two additional cuts are sometimes necessary. The shell is then removed and mounted on another Hart-Parr lathe equipped with an expanding mandrel on the spindle, on which the turning operation is performed. Turning, waving, and undercutting the band groove and boring, tapping and beveling the fuse opening could also be done on this machine if it were fitted with suitable attachments, but it will be found that this part of the work can be done more efficiently on a standard engine lathe.

The principal dimensions of the machine are as follows: length of bed, 10 feet, $6\frac{5}{8}$ inches; depth of bed, $20\frac{7}{8}$ inches; width of bed across vees, 24 inches; swing over bed, 26 inches; swing over carriage, $13\frac{3}{4}$ inches; width of vee, $2\frac{3}{4}$ inches; diameter of the front spindle bearing, 6.69 inches; diameter of the rear spindle bearing, 4.33 inches; width of the tool-slide, 12 inches; length of the carriage on the ways, 36 inches; available feed changes, 1/128, 1/64, 1/32, 3/64, 1/16 and 3/32 inch per revolution; available speeds for lineshaft speed of 682 R. P. M. wheu driving through back-gears, $8\frac{1}{4}$, $11\frac{1}{4}$, $15\frac{1}{4}$ and $20\frac{3}{4}$ revolutions per minute; available speeds when driving direct, 33, 45, 61 and 83 revolutions per minute; dimensions of lead-screw, 2 inches diameter by 1 inch lead; floor space occupied, 5 by 12 feet; and weight of machine, 10,000 pounds.

WARREN SHELL NOSE-TURNING MACHINE

In the February number of MACHINERY a description was published of the Warren lathe. Since that machine was placed on the market the Lombard Governor Co., Ashland, Mass., which is the builder of the Warren lathe, has developed a single-purpose machine for use in rough-turning the nose of 5-inch shell forgings. It will be seen that this machine has a heavy swinging tool-holder substituted in place of the turret; this tool-holder has two stations, one of which holds the cutting tools and the other a saddle that assists in putting the work into the chuck and removing it when finished. The turning is done by a series of tools which are stepped in to produce a form which roughly approximates the required shape of the shell nose; and the forging, that is carried in a collet, is fed up to these tools by oil under pressure, acting directly behind the end of the revolving spindle, thus eliminating all thrust friction.

The operation of the machine will be best understood by referring to the front view shown in Fig. 1. It will be seen that the end of the spindle is enlarged at *A* to provide for carrying a collet, the action of which is controlled by diaphragm *B*. Tool-holder *C* is provided with a locking pin *D*, operated by treadle *E* to provide for securing the tool-holder in either of its two positions. The turning tools are shown at *F*; and while loading a new forging into the collet, saddle *G* is swung up to provide a support for the forging from which it may easily be transferred to the collet. The machine is driven by pulley *H*, from which power is transmitted through double back-gears. Inside case *I* is a hydraulic clutch operated by valve *J*; and the chuck is controlled by valve *K*. An automatic reversing valve is shown at *L* which provides for

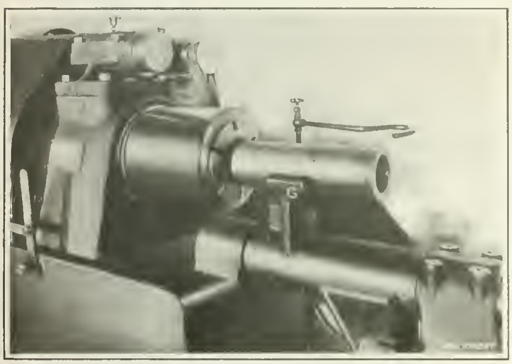


Fig. 2. Bracket G in Position to load Shell Forging into Collet

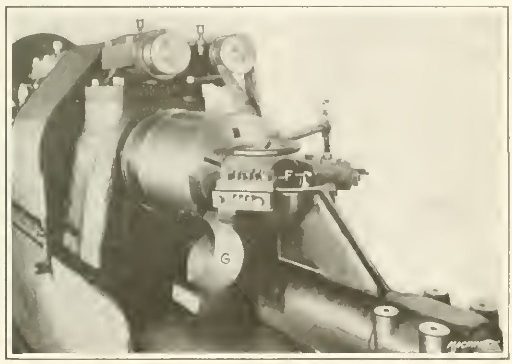


Fig. 3. Tools F at work roughing out Nose of Shell Forging

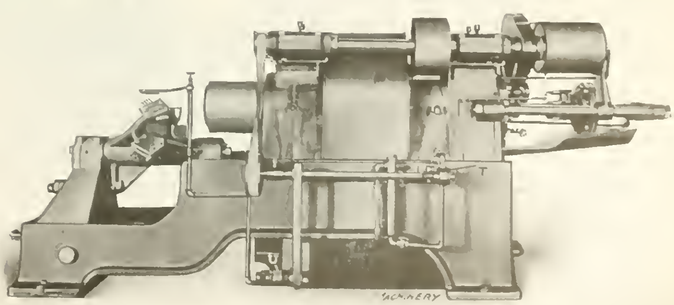


Fig. 4. Rear View of Warren Lathe showing Pumps for delivering Lubricant to Bearings and Tools

governing the forward and backward movements of the spindle, the forward movement being limited by thread stop *M*. The reversing valve *L* is controlled by handle *N*.

The speed at which the spindle moves forward, *i. e.*, the rate of feed, is controlled by an automatic needle valve *O* in such a way that it reduces the time required to complete the nose-turning operation by about 50 per cent. This is accomplished by placing a spiral grooved sheave upon the stem of this needle valve and mounting a small flexible steel cable *P* in the grooves of this sheave, the cable running back over idler pulley *Q*. At point *R* the cable is fastened to traveler *S* by an adjustable turnbuckle. This traveler moves back and forth with the spindle, and as the spindle is fed forward sheave *O* is rotated by the cable in such a manner that it gradually reduces the opening of the needle valve. Since this valve controls the rate at which the spindle is fed forward, it is obvious that the spindle starts to move at its maximum speed and this speed is gradually reduced until a minimum is reached at the forward limit of its travel.

The importance of this action will be appreciated when it is considered in connection with the arrangement of the turning tools *F*. There are eight of these tools, which are arranged in two rows and stepped in such a way that they roughly outline the nose of the shell. It will be evident that the holding power of the chuck is not unlimited, and the same applies to the driving power of the lathe. When only two tools are cutting, the rate at which the work is fed to the tools may properly be much greater than at later periods, when four, six or eight tools are at work; and it will be evident that the rate of feed must be decreased in direct proportion to the number of tools that are cutting in order to run at approximately the maximum driving capacity of the machine and holding capacity of the chuck at all times. This is the condition which is controlled automatically by needle valve *O*. If the rate of feed were constant it would be necessary to limit it to a value which would be permissible when all eight tools were cutting.

In the back view of the machine shown in Fig. 4, *T* is a pump which furnishes pressure for the hydraulic feed and supplies oil to all bearings, and *U* is a pump for delivering cutting compound to the tools. The oil is contained in a tank located in the base of the machine. It is stated that the first of these machines put in operation performed the rough nose-turning operation on 460 5-inch shell forgings in twenty-four hours.

GORTON FUSE RING MILLING MACHINE

The most noteworthy feature of the No. 8-C universal horizontal routing machine developed by the George Gorton Machine Co., Racine, Wis., for milling the vent and powder

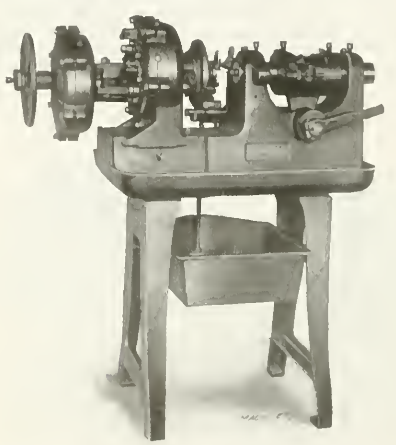


Fig. 1. Gorton No. 8-C Universal Fuse Ring Milling Machine

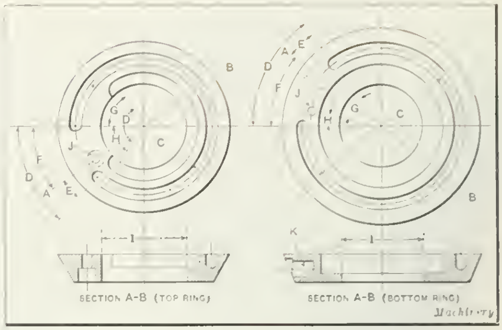
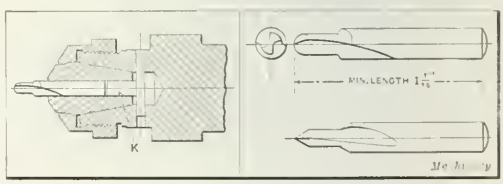


Fig. 2. Fuse Rings, showing Variations in Dimensions of Work which can be handled

grooves in fuse rings is that sufficient adjustment is provided to adapt the machine for working on rings for different types of fuses. The machine is shown in Fig. 1, and the amount of adjustment provided will be most readily understood by reference to Fig. 2. With fuse rings milled on the No. 8-C machine, *C* may be any dimension up to 4 inches; angle *D* may range from zero to 360 degrees; the gage holes may be located in any position on the top, bottom or side of the ring; and dimensions *E*, *F*, *G* and *H* may be of any magnitude called for by the drawings. Varying the diameter of the center hole *I* simply necessitates the use of a suitable faceplate.

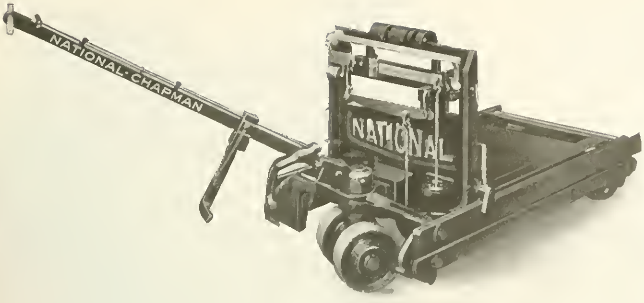
The spindle of the machine is made of tool steel; it is hardened and ground and mounted in combination radial and thrust bearings. These bearings are housed in a sliding sleeve which is closed at the ends by felt washers and packed in grease. End play is taken up by a nut at the rear end of the spindle. The loose pulley is mounted independently of the spindle and carried by ball bearings. The spindle sleeve and



Figs. 3 and 4. Cross-section through Spindle Nose: and Type of Cutter used

the sleeve which supports the loose pulley are clamped together by a yoke bored to fit the sleeves. This construction brings the belt pull between the front and rear bearings and avoids all tendency to throw the spindle out of line. Fig. 3 shows the spindle collet which holds the cutter in such a way that a fresh one may be easily substituted. The shank of the cutter bears against a spacing pin *K*, making it impossible for the tool to slip back from the work. If cutters with shanks of different diameters are required, it is merely necessary to use suitable collets, all of which are carried by the same spindle. The spindle should run at approximately 3200 revolutions per minute, the speed being varied slightly according to the nature of the work.

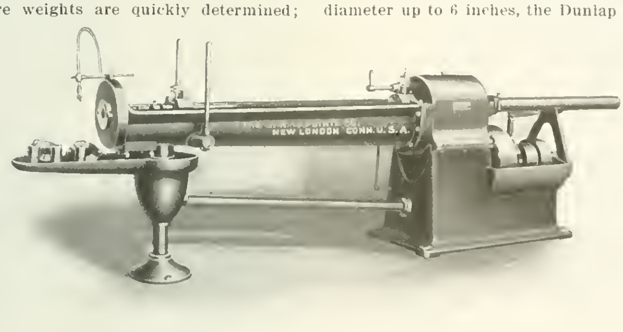
The groove in the fuse ring may be smoothly and accurately finished at a single cut, and the rate of production is from 25 to 30 rings per hour. The ring is held on a hardened and ground steel plate by a cam-actuated clamp; and the milling operation is controlled by hardened steel stops. A cutter lubricating system is furnished with the machine which consists of a pump, tank, strainer, relief valve, piping, and flexible nozzle. The machine may be mounted on legs, as shown in Fig. 1, or set directly upon a work bench; but where the latter method of mounting is employed a pump is not furnished. It is recommended that the cutter be run right-hand and the work left-hand, or *vice versa*, as this has been found to give the best finish at a single cut.



National-Chapman Combination Weighing Scale and Elevating Truck

NATIONAL-CHAPMAN SCALE ELEVATING TRUCK

One of the recent additions to the line of elevating trucks manufactured by the National Scale Co., 6 Mechanic St., Chicopee Falls, Mass., is a combination weighing scale and elevating truck, which is illustrated and described herewith. This truck is particularly useful in shipping and receiving departments or for taking inventories, where it is not only required to transfer material from one point to another but also to obtain accurate information as to its weight. Material loaded on wooden platforms can be weighed to obtain the gross weight, after which net and tare weights are quickly determined; and it will be evident that this does not in any way affect the advantages obtained from using the elevating truck. A so-called "Giant lift" is provided for raising heavy loads, and a safety handle release is furnished in addition to the foot-lever; a hydraulic check enables the heaviest loads to be lowered without the least jar. The axles are made of heat-treated steel and supported in Hyatt roller bearings. When transporting material on this truck, the loaded platform is supported by side bars so that no strain comes on the scale mechanism. This truck is made in four sizes having capacities for loads of 2500, 3500, 4000 and 4000 pounds.



No. 3-B Broaching Machine built by J. N. Lapointe Co.

J. N. LAPOINTE BROACHING MACHINE

The No. 3-B broaching machine which forms the subject of this description is a recent product of the J. N. Lapointe Co., New London, Conn., and supersedes the No. 3 machine formerly manufactured by this company. Two speed changes are provided which are fast and slow, and suitable for handling light and heavy work. Changes of speed can be made while the machine is either running or stopped; and all gears are enclosed and run in oil. A roller thrust bearing is mounted inside the gear-case and takes the pressure of the cut so that friction losses are reduced to a minimum and danger of heating the screw and nut is avoided. The driving screw is protected by a tube at the rear of the machine.

This broaching machine can be operated from the front or back, two operating levers being provided for the purpose. The oil pump has a capacity for delivering a copious flow of lubricant to the work at low pressure, a $\frac{1}{2}$-inch flexible tube being provided to deliver the lubricant to the work. The machine is fitted with a duplex self-oiling clutch which is provided with a "non-burn" indestructible lagging. A reservoir is provided for lubricating the clutch, which has sufficient capacity so that it need only be filled once a month. Automatic stops control the length of stroke; these stops are of the spring and plunger type and may be adjusted without the use of wrenches. Means are provided for easily replacing any parts which are subject to wear.

The principal dimensions of this broaching machine are as follows: capacity to cut a $1\frac{1}{2}$-inch keyway 10 inches long or to broach a 3-inch square hole 6 inches long; size of driving pulley, 18 inches in diameter by $5\frac{1}{4}$ inches face width; speed of screw on low gear, 3 feet per minute; speed of screw on high gear, $5\frac{1}{2}$ feet per minute; dimensions of driving screw, $2\frac{3}{4}$ inches diameter by 54 inches maximum stroke, 2 pitch; floor space occupied, $16\frac{1}{2}$ by $2\frac{1}{2}$ feet; and net weight of machine, 3400 pounds.

DUNLAP SHELL LATHE

To meet the requirements of turning shell forgings up to 10 inches in diameter and for boring shells having an inside diameter up to 6 inches, the Dunlap Mfg. Co., Columbus, Ohio, has recently placed on the market the "Columbus" 21-inch back-geared engine lathe which is illustrated and described herewith. This is a heavy-duty single-purpose machine, and in addition to its application on shell work it is suitable for any class of general manufacturing where there are a large number of duplicate parts to be turned and bored. As the machine is intended for manufacturing, it is only provided with a sufficient range of speeds to cover working diameters from 2 to 10 inches; and changes of feed are provided ranging from 0.012 to 0.112 inch per revolution.

The bed is made of semi-steel and provided with five cross-girders to give the required stiffness. The vees have an included angle of 90 degrees, and the rear end of the bed is cut away to allow overhang or quick removal of the tailstock. At the back of the bed there is a pad to which a forming attachment or taper turning attachment may be secured. The headstock has ring-oiled bearings and is driven by a 6-inch belt

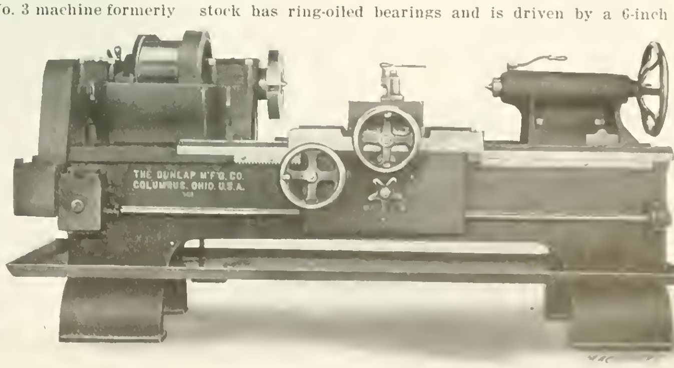


Fig. 1. Dunlap 21-inch Shell Turning and Boring Lathe

which provides sufficient power for driving high-speed steel tools to the limit of their cutting capacity. The ratio of the back-gears is 11 to 1. The spindle is machined from a steel forging and has a hole 1½ inch in diameter bored through it. The spindle thrust is taken by a bearing composed of steel and bronze collars.

The carriage is constructed of semi-steel and has a bearing on the bed 30 inches in length; the over-all width of the carriage is 26 inches and the tool-rest is 12 inches wide. The apron is of the double-wall box type; all shafts are supported at both ends and the gears are made of steel. Positive geared power longitudinal feed is provided, with automatic stops for governing the dimensions of duplicate work. Power is transmitted from the spindle to the gear-box by a roller chain. The seven rates of feed provided are 0.012, 0.018, 0.027, 0.037, 0.052, 0.074 and 0.112 inch per revolution.

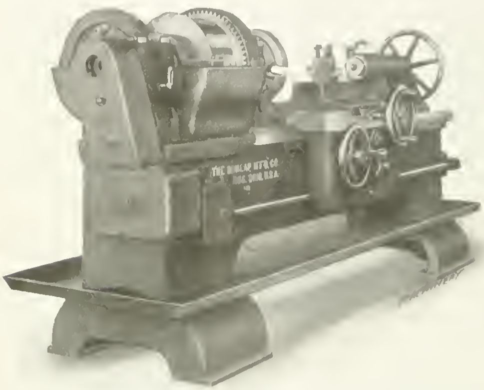


Fig. 2. Partial End View of Dunlap Lathe shown in Fig. 1

The principal dimensions of the machine are as follows: swing over bed, 21 inches; swing over carriage, 14 inches; swing over tool-rest, 13 inches; height of centers from floor, 40 inches; maximum capacity between centers, 37 inches; maximum distance between centers with tailstock overhanging, 44 inches; and approximate weight, 6000 pounds. The standard equipment furnished includes a toolpost, plain toolrest, two No. 5 Morse taper centers, a 12-inch faceplate, and the necessary wrenches for making all adjustments.

WILL-BURT ADJUSTABLE VISE

The "Carpenter" vise, which is a recent product of the Will-Burt Co., Orrville, Ohio, is so constructed that it may be used in either a horizontal or vertical position; and the vise swings freely on the base so that it may be used in any position which is most convenient for the workman. When the jaws are tightened by the screw, this also clamps the vise in place on its base. The construction of this tool will be readily understood by reference to Figs. 1 and 2, which show it in the vertical and horizontal positions, respectively.

Fig. 1. Will-Burt Vise in Vertical Position

The vise may be equipped with a pair of auxiliary jaws for holding a carpenter's saw in position for filing. These jaws slip over the vise jaws and are ready for instant use without adjustment. They have a wide contact bearing on the saw blade so that all chatter is eliminated.

Fig. 2. Will-Burt Vise holding Work in Horizontal Position

BEIGHLEE ELECTRIC RECORDING PYROMETER

The two most important features of the instrument made by the Beighlee Electric Co., Cleveland, Ohio, for recording the temperatures of one, three, six, nine or twelve thermo-couples on one chart, are the elimination of ink as the recording medium and the maintenance of accuracy of indications independent of temperature fluctuations at the cold junction, by means of a self-contained, automatic Wheatstone bridge system. The records are produced by an electric spark and are entirely separate for each thermocouple. The adjustment of the Wheatstone bridge system is always under full control of the operator and can be easily regulated by "test points," calibrated for each instrument. The recorder contains a self-winding electric clock, so that no winding by the operator is necessary. The internal resistance of

Fig. 1. Electric Recording Instrument which burns Record on Chart

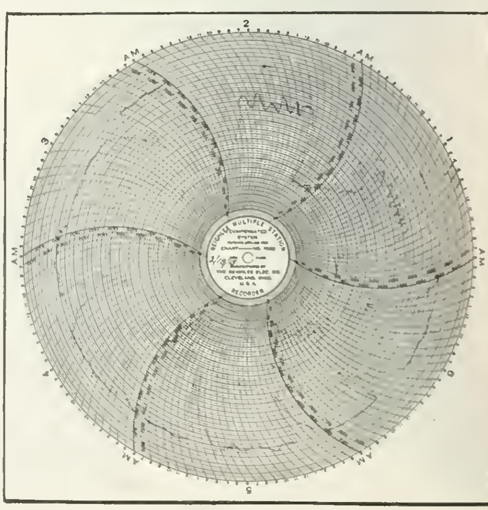


Fig. 2. Chart made on Beighlee Recording Instrument shown in Fig. 1

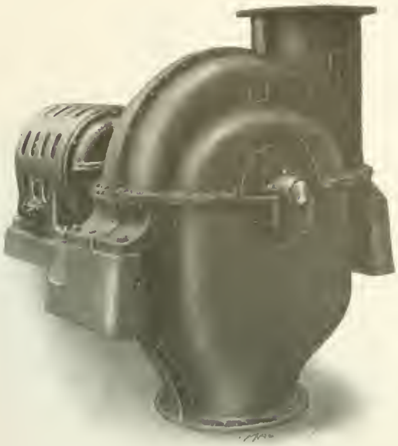


Fig. 1. Ingersoll-Rand Low-pressure Turbo-blower

these recorders is about 750 ohms, so that the accuracy of indications is not influenced by the difference in length of connecting wires of the various thermo-couples applied. These recorders are being manufactured by the Beighlee Electric Co., Cleveland, Ohio, and Herman A. Holz, 50 Church St., New York City, has the sales agency.

INGERSOLL-RAND TURBO-BLOWER

The Ingersoll-Rand Co., 11 Broadway, New York City, has added to its line of turbo-compressors and blowers a low-

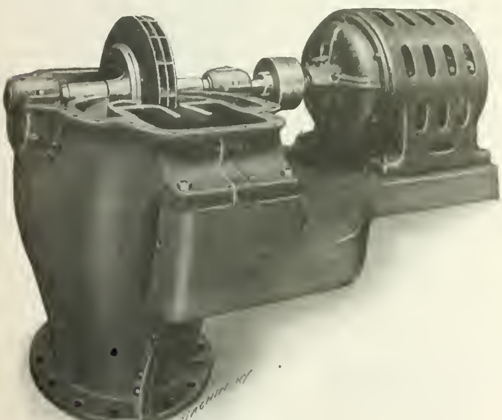


Fig. 2. Turbo-blower shown in Fig. 1 with Casing removed

pressure unit capable of handling volumes of air ranging from 3000 to 35,000 cubic feet per minute at a pressure of from 1 to 2½ pounds per square inch. These blowers are suitable for a variety of purposes, among which may be mentioned atomizing oil for oil burners, supplying the air blast to heating and annealing furnaces of various kinds, operating ventilating and pneumatic conveying systems, and supplying the blast for foundry cupolas. They are of the single-stage, double-flow type and may be driven by electric motor, steam turbine, or water wheel, electric drive being generally employed for the classes of service referred to. Operating at high speed makes it possible to connect the blower direct to the driving motor, and it is stated that constant pressure is maintained while delivering any volume from zero to the maximum capacity.

The four-bearing type of construction employed in all turbo-machines built by the Ingersoll-Rand Co. is employed on the present turbo-blower. The casing is split horizontally to facilitate installation and subsequent inspection, the assembled casing being doweled and bolted to a heavy sub-base which ordinarily serves as a support for both the blower and driving member. The whole unit is compactly built so that the floor space occupied is relatively small. The impeller is of the enclosed double-flow type, and the wheel is machined from a steel forging. The vanes and covers are made of pressed steel and are riveted in place, all rivet heads being driven flush. In testing the machine, the impellers are over-speeded, so that correct balance, strength and freedom from vibration are insured when running under normal conditions. The impellers are keyed to a heat-treated forged steel shaft, and a labyrinth packing is employed to prevent leakage. The use of flexible couplings between the blower and driving unit is standard Ingersoll-Rand practice. The intake opening is at the bottom and the discharge opening at the top. The flow of air from this type of blower is said to be absolutely uniform, without any tendency to develop "pulsation." There are no rubbing surfaces in the machine, and this precludes the necessity of making adjustment to take up wear.

WILLIAMS-WHITE RIFLE BARREL MILL

For use in rolling rifle barrels to approximately the required shape, Williams, White & Co., Moline, Ill., are building rolling mills of the types shown in the accompanying illustrations.

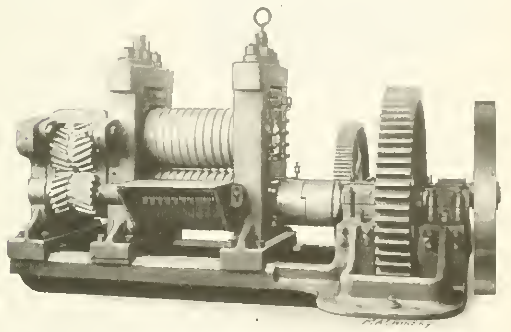


Fig. 1. Single-end Rifle Barrel Rolling Mill built by Williams, White & Co.

These are constructed along somewhat different lines from ordinary machines, as it is necessary for the rolls to match each other absolutely. It is quite a difficult operation to turn the grooves in the rolls on account of the irregular taper of the rifle barrels which they are required to produce. To meet the requirements of this work the builders of these rolling mills have designed a special machine for this purpose.

The machines shown are of essentially the same type except that one is a double-ended machine in which the rolling units are provided at each side of the driving unit, while the other is a single machine. In both cases, herringbone gears transmit the drive to the rolls in order to eliminate vibration. This type of machine is used in the factories of the Remington Arms Co. at Eddystone, Pa., Bridgeport, Conn., and Ilion, N. Y.

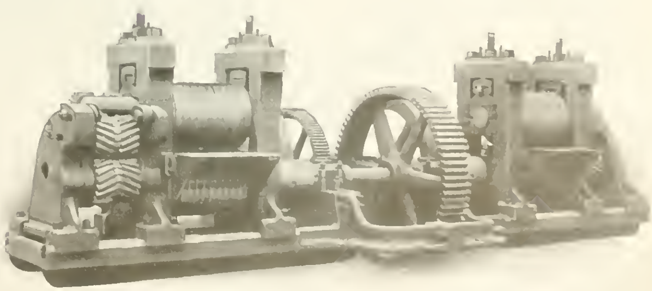
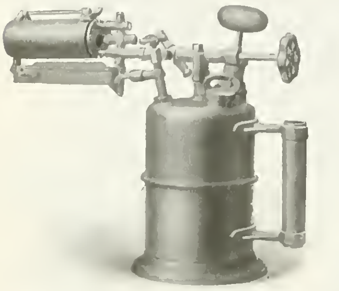


Fig. 2. Double-end Williams-White Rifle Barrel Rolling Mill

VOLCANO KEROSENE AND GASOLINE TORCH

The latest addition to the line of "Volcano" blow-torches made by the Volcano Torch & Mfg. Co., Erie, Pa., is a combination kerosene and gasoline torch shown in the accompanying illustration. As its name implies, either kerosene or gasoline may be burned in this torch, and it has the capacity for raising the temperature of a solid 2-inch shaft to a red heat in from eight to ten minutes. It will produce a flame from 12 to 14 inches in length. One of the features of this torch is that it enables kerosene to be used in places where insurance regulations prohibit the use of gasoline. The position of the burner can be adjusted to any angle that is most suitable for the work, and this adjustment is easily made while the torch is in use.

The pre-heating cup has a circular adjustment in a horizontal plane, so that it can be swung a sufficient distance toward the tank or main body of the torch to receive its fuel supply from a small valve situated at the top of the tank. A snuffer or extinguishing blade is located immediately above the starting cup for the purpose of extinguishing the flame when the main burner is hot enough to be ready for work, thereby eliminating interference of the combustion in the starting cup with combustion of the main burner. One-half the casing around the main burner can be swung open to permit the flame from the starting cup to have direct contact with the main burner, thus reducing the length of time required for pre-heating. These torches are made in two types, known as Nos. 10-A and 10-B. They have a capacity for holding ½ gallon of fuel oil.



Volcano Blow-torch in which either Gasoline or Kerosene can be burned

NEWMAN TURRET HEADS

The Newman Mfg. Co., 717 Sycamore St., Cincinnati, Ohio, is now making turret heads for use on lathes and drill presses, which provide for rapidly bringing into action any sequence of tools which may be required. Fig. 1 shows the drill head which holds four tools. This head is held in place by a locking mechanism, and may be quickly changed to bring successive tools into the operating position. The sleeve on the head is attached to the quill surrounding the drill press spindle, and provides for locating the head at the proper height. The only part of the mechanism which revolves is the tool in the operating position. These drill press turret heads are made in two sizes for No. 2 and No. 4 taper shanks, or they may be made to hold straight shanks if required.

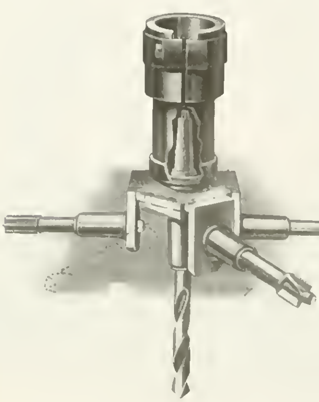


Fig. 1. Newman Turret Head for Use on Drilling Machines

Fig. 2 shows the lathe turret toolpost which is attached to the outside of the tailstock spindle and provides for using a sequence of five tools. This is obviously a great convenience where the work is of such character that it is necessary to perform turning, facing, boring, reaming and tapping operations or any similar sequence of five operations. Only a few moments are required to attach or detach this toolpost. It is made in three sizes which are 6, 7 and 8 inches in diameter, and suitable for use on a great variety of sizes and types of lathes. A similar turret toolpost is made to clamp to the carriage T-slot.

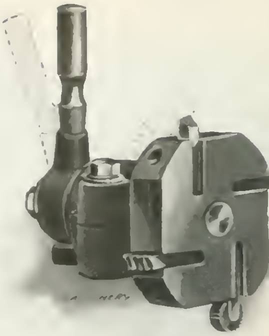


Fig. 2. Newman Lathe Tailstock Turret

PITTSBURG HARDNESS TESTING MACHINE

The Brinell method of testing the hardness of metals is too well known to require explanation here, but readers of MACHINERY will be interested in two types of machines built by the Pittsburg Instrument & Machine Co., 236 Third Ave., Pittsburg, Pa., for conducting the Brinell hardness test. Two types of machines are built, one of which is so heavy that it is only adapted for use where it is practicable to bring the test bars to the machine. To meet the requirements of those who want an instrument which may be carried about the factory so that tests may be conducted at the point where materials are used, a lighter form of machine has been developed which can readily be carried by one man. This machine is shown in the accompanying illustration; it is operated by hydraulic pressure and is suitable for testing structural steel, rails, automobile parts and similar products on which it is desired to ascertain the effect of hardening and annealing operations.

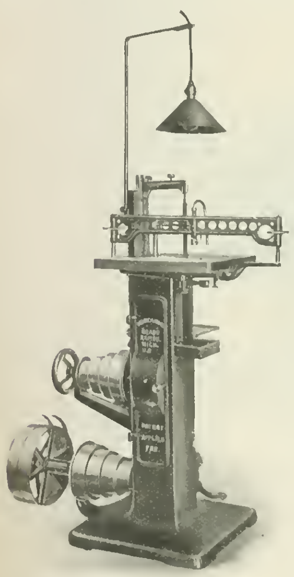
Pittsburg Hardness Testing Machine which operates on the Brinell Principle

LEWIS-SHEPARD ELEVATING TRUCK

The most important features of design of the "Hi-lift" elevating truck recently placed on the market by the Lewis-Shepard Co., 262-280 Dover St., Boston, Mass., are the provision for elevating the load 2½ or 3 inches (according to the size of the truck) by purely mechanical means, and the fact that all parts of the truck are made of cast steel with the exception of the wheels which are of gray iron. The system of levers by which the truck is elevated is so arranged that imparting a force of 85 pounds to the lifting lever and giving it four strokes provides for raising a load of 3000 pounds to the full

"Hi-lift" Elevating Truck made by Lewis-Shepard Co.

height; and by imparting six strokes with a force of 110 pounds, a load of 5500 pounds may be raised to the full height. The high-lift feature is important because it assures the wooden skid clearing all ordinary inequalities of floor level which are likely to be met with in transferring material through a factory. Another feature of the truck is that the handle by which it is drawn is placed at a sufficient height from the floor so that very little of the force exerted by the trucker is wasted. The truck is provided with a release check so that heavy loads may be lowered without the least shock or vibration. These elevating trucks are made in eight different sizes; they weigh from 305 pounds up (according to size) and have capacities for loads ranging from 2500 to 5500 pounds.



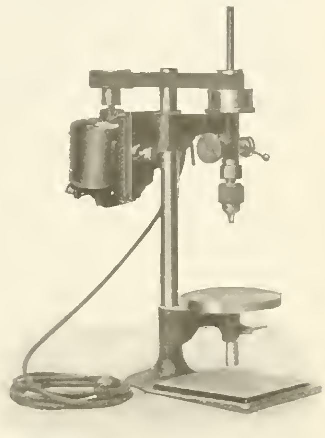
Improved Rearwin Die Filing Machine

REARWIN DIE FILING MACHINE

In the January, 1916, number of MACHINERY mention was made of a die filing machine which W. D. Rearwin, 341 Mill Ave., N. W., Grand Rapids, Mich., had just placed upon the market at that time. The accompanying illustration shows a die filing machine which is of essentially the same design, except that it is provided with a work-holding clamp, while it was necessary for the operator to hold the die block by hand while filing it on the original machine. Reference to the illustration will make it evident that the clamp arm is provided with adjusting screws at each end so that its height from the table may be quickly adjusted to accommodate the work, after which it is an easy matter to clamp the work by means of the screw located at the center of the arm. It will be seen that the provision of this clamping arm makes the operation of the machine much more convenient.

CRANE BENCH DRILL

The motor-driven ball bearing bench drill shown in the accompanying illustration is manufactured by H. G. Crane, 226 Cypress St., Brookline, Mass. The spindle of this tool is mounted in such a way that it is relieved of all belt strain, and the spindle runs in double annular ball bearings. A thumbscrew adjustment provides for regulating the belt tension. The motor is of the Holtzer-Cabot vertical type; it runs at 1750 R. P. M. and may be furnished for operation on 110 or 220 volt circuits, either alternating or direct current. It will be seen that a control switch is located at the side of the motor, and a 10-foot cord and connection plug form part of the regular equipment. The head and motor may be lowered and swung through an angle of 180 degrees to allow the drill to clear the base.



H. G. Crane Motor-driven Ball-bearing Bench Drill

The principal dimensions are as follows: capacity for driving drills up to ¼ inch in diameter; maximum feed of spindle, 2⅝ inches; maximum distance from chuck to round table, 8 inches; maximum distance from chuck to base, 13½ inches; size of round table, 6⅝ inches in diameter; size of base, 6¾ inches by 7½ inches; distance from column to spindle, 1¾ inches; total height, 22 inches; range of spindle speeds, from 900 to 3000 R. P. M.; and weight of tool, 60 pounds.

MULTI-METAL DUST HOOD AND BABBITTING MASK

The Multi-Metal Separating Screen Co., 68-72 E. 131st St., New York City, is now manufacturing the babbitting mask and dust hood, shown in Figs. 1 and 2, respectively. The dust hood is made of light fabric which is fitted over a frame that keeps the hood away from the face of the wearer. The hood drops down to the neck and can be tightened by means of a draw string. To give the wearer a clear view while wearing the hood, a window is provided which may be made of trans-

Fig. 1. Multi-metal Babbitting Mask

Fig. 2. Multi-metal Dust Hood for Sandblast Operator

parent celluloid, mica or glass; and ventilation is provided by six screened openings in the top of the hood and four in the skirt. There is always a free circulation of air through these openings, so that the hood is cool and comfortable to wear. An arrangement of multiple screens provides for excluding dust, so that the hood may be used in place of a respirator and goggles. It is intended for the use of sandblast operators, and for men whose employment takes them into places filled with lamp-black dust, lead dust, and other poisonous materials. The weight of the hood is 13 ounces.

The babbitting mask shown in Fig. 1 is built over the same form of head frame that is used to support the dust hood. The mask is made in three pieces of wire gauze, two of which are hemispherical in shape and form the cap, these two members being joined together by a web which serves to stiffen this part of the mask. The third part consists of an "apron" which drops to a point considerably below the chin of the wearer and extends around almost from ear to ear, so that ample protection is provided against injury from metal which may be splashed out of the molds. Additional protection for the eyes is afforded by two square pieces of heat-treated glass carried inside the screen. The weight of the mask is 14 ounces.

SHELL TURNING LATHE

For use in turning and facing the back end of 12-inch shells, the American Machine Tool Co., Hackettstown, N. J., has recently placed on the market a heavy-duty 24-inch single-purpose lathe. While the machine was built to meet the requirements of this particular class of work, changes could easily be made to adapt it for a variety of other special manufacturing operations or for general lathe work. It will be noticed that the headstock is of the English type with the gears placed at the front. The lever at the top of the head operates a pair of sliding gears carried on the feathered sleeve attached to the cone pulley, two changes of speed being provided in this way. The spindle is made from a high-carbon steel forging; it is 5½ inches in diameter and has a 2⅛-inch hole bored through it. The nose of the spindle is bored No. 6 Morse taper. The spindle bearings are bronze-bushed, and the end thrust is taken by a standard ball bearing. The cone pulley is turned both inside and outside to insure obtaining perfect running balance; and a hand-operated plunger provides for locking the large gear to the cone pulley.

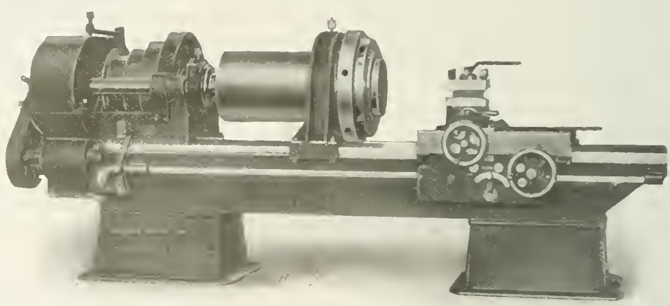


Fig. 1. American Machine Tool Co.'s 24-inch Shell Lathe equipped with Steadyrest and Chuck

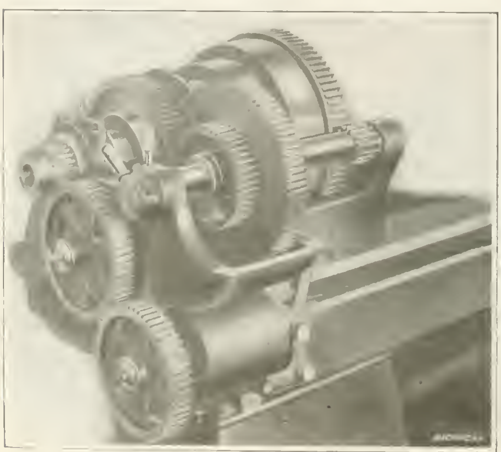


Fig. 2. Close View of Head and Gear-box with Gear Guards removed

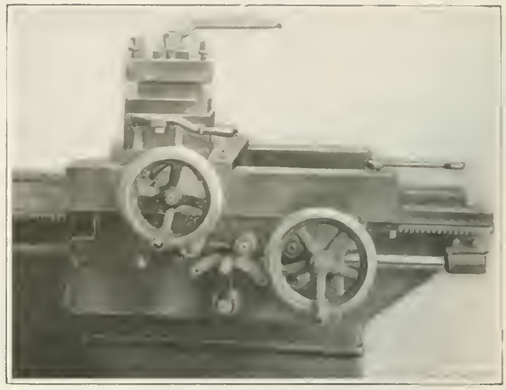


Fig. 3. Close View of Apron, showing Arrangement of Feed Reverse Lever

The gear-box is of simple construction, a feature of the design being that no clutch is employed. All gears run in oil. The hand-lever is easily moved to any of the four positions on the quadrant; this lever moves a key which provides for engaging the required gear. Hardened steel rings placed between the gears cause the key to be depressed below the surface of the shaft to pass from one set of gears to another and a spring under the key forces it back into place in the keyway as soon as it has passed from under the ring. Four changes of feed are provided, *viz.*, 0.015, 0.023, 0.033 and 0.063 inch per revolution of the spindle.

The bed is of the English type with a flat bearing at the back and a small supplementary vee for lathes where a tailstock is required. The vee at the front of the bed is planed to angles of 22 and 68 degrees. The carriage has its bearing on the inner side of the vee directly in line with the thrust of the tools. The apron is constructed with a back plate so that provision is made for supporting the gear shafts at both ends. Throwing the lever from the position marked "neutral" to the position marked "right" moves the carriage to the right; and the carriage can be moved in the opposite direction by throwing the lever to the position marked "left." The power cross-feed is operated by throwing the same lever to the neutral position and then pushing in the knob on the cross-feed shaft as far as possible, which engages the cross-feed gears and disengages the rack and pinion. The lever on the apron is then thrown one way or the other from the neutral position according to the direction in which the feed movement is required. Pulling out the knob on the cross-feed shaft disengages the gears.

The principal dimensions of the machine are as follows: diameter of spindle, 5½ inches; length of spindle, 3 feet, 7⅝ inches; diameter of hole through spindle, 2⅛ inches; size of front spindle bearing, 5 inches in diameter by 5 13/16 inches long; size of rear spindle bearing, 3⅝ inches in diameter by 4¼ inches long; length of bed, 11 feet; width of carriage bearing on ways, 31 inches; size of turret, 8 inches square; floor space occupied, 3 feet by 11 feet, 6 inches; and net weight of machine complete with steadyrest, chuck and countershaft,

7570 pounds. The factory of the American Machine Tool Co. is at Hackettstown, N. J., and sales offices are maintained at 50 Church St., New York City.

HIMOFF SINGLE-PURPOSE LATHES

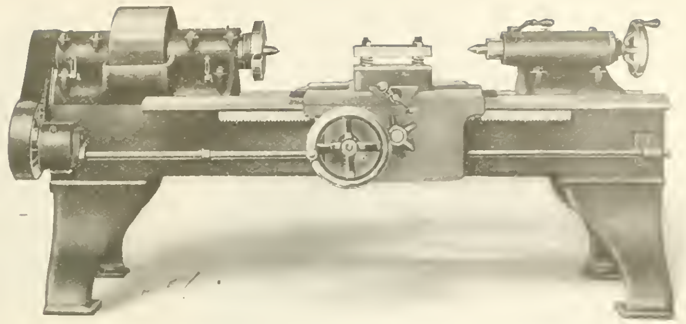


Fig. 2. Himoff Lathe equipped with a Single Pulley on the Spindle

The single-purpose manufacturing lathes illustrated and described herewith are built in 16- and 20-inch sizes by the Himoff Machine Co., Inc., 128 Mott St., New York City. It will be seen that the machine shown in Fig. 1 is equipped with a two-step cone pulley, and this machine is furnished with a back-geared drive. The machine shown in Fig. 2 has a single pulley mounted direct on the spindle, and this machine is arranged to be driven at a speed which is suitable for the class of work for which the lathe is used. With the exception of the drive, both machines are of the same design.

The principal dimensions of the 16-inch machines are as follows: length of bed, 8 feet; height from floor to centers, 40 inches; swing over ways, 17½ inches; swing over slide, 10 inches; maximum distance between centers, 40 inches; diameters of cone pulley steps, 10 and 12 inches; ratio of back-gears, 6½ to 1; travel of tail-spindle, 6 inches; available rates of feed, 0.020, 0.040 and 0.060 inch per revolution; and net weight of machine, 4500 pounds.

The principal dimensions of the 20-inch machines are as follows: length of bed, 8 feet; height from floor to centers, 40 inches; swing over ways, 21 inches; swing over slide, 10 inches; maximum distance between centers, 40 inches; diameters of cone pulley steps, 10 and 12 inches; ratio of back-gears, 6½ to 1; travel of tail-spindle, 6 inches; available rates of feed, 0.080 and 0.100 inch per revolution; and net weight of machine, 4750 pounds. The standard equipment furnished with both lathes includes two No. 5 Morse taper centers, a two-speed heavy countershaft, a toolpost and the necessary wrenches.

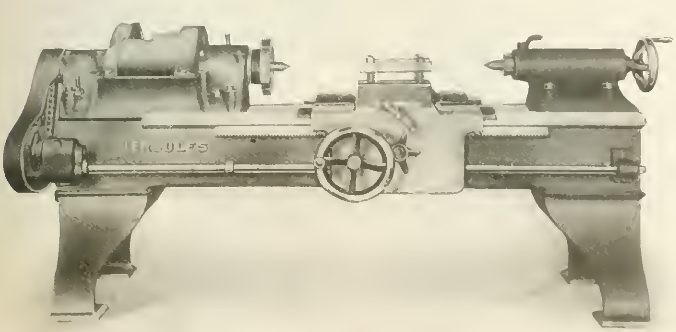
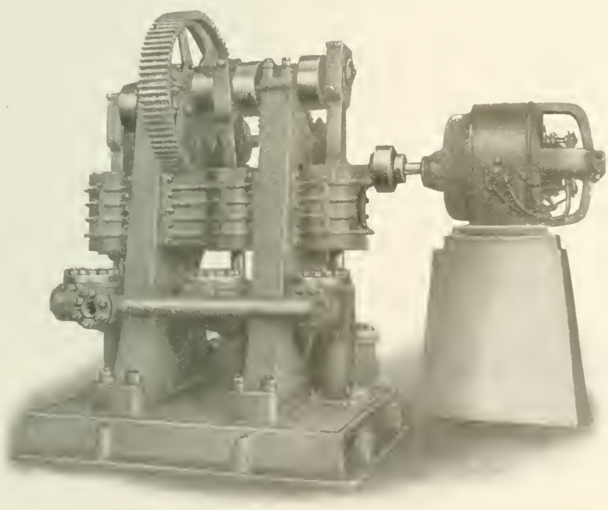


Fig. 1. Himoff Single-purpose Lathe equipped with Cone Pulley and Back-gears

HYDRAULIC TRIPLEX PUMP

For use in connection with hydraulic presses which require a large volume of water to be delivered to them at high pressure, the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, has developed a vertical triplex pump of the pot valve type. The volume of water and pressure developed by a pump is dependent upon the diameter of the plungers with which it may be equipped, and the pot valves on this pump allow the plungers to be from 4 to 5¾ inches in diameter. With each plunger running at 45 strokes per minute, the 4-inch plungers have a capacity for delivering 88 gallons of water against a pressure of 1700 pounds per square inch. Under the same conditions, the 5¾-inch plungers will deliver 183 gallons against a pressure of 800 pounds per square inch. The capacity of the pump varies proportionately for the intervening sizes of plungers.



Hydraulic Triplex Pump equipped with Pot Valves on Suction and Delivery Chambers

The pump plungers of all sizes have a stroke of 12 inches and a normal running speed of 45 strokes per minute, so that the pump has a normal capacity for delivering 135 feet of water per minute against high pressure. The volume of water will, of course, vary according to the diameter of the pump plungers. On account of the large volume of water which this pump is capable of handling in a given time, each plunger is equipped with pot valves for both the suction and delivery chambers. The total area of these valves is no greater proportionally than the single-valve type; but they permit of using lighter checks which have greater freedom of movement than would be possible with a large single check. The lift of the checks is also reduced, thereby cutting down the slippage which occurs in single-suction and discharge valves when used on pumps of large water capacity. This hydraulic pump is designed for direct-connected motor drive, and a 100-horsepower motor is required. It has double-reduction gears which have ratios of 5 to 1, and 3 to 1.

The principal dimensions are as follows: height, 10 feet; and floor space occupied by pump without motor, 8 feet by 5 feet, 9 inches.

WEST HAVEN SCRIBERS, CENTER PUNCHES AND DRIVE-PIN PUNCHES

The West Haven Mfg. Co., New Haven, Conn., is now manufacturing scribers, center punches and drive-pin punches of the form shown in the accompanying illustrations. These are

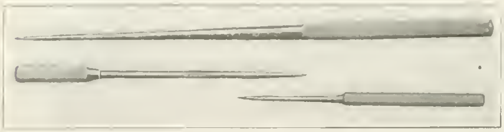


Fig. 1. Set of West Haven Scribers

known as the "O. K." brand, and each type of tool is made in three different sizes. The drive-pin punches, which are used for removing driving pins and rivets, have approximate diameters of 1/16, 5/64 and 3/32 inch. The center punches are 2¼, 2¾ and 4 inches long; and the scribers are 3½, 4¼ and 7 inches in length. The general features of all these tools are those with which experienced mechanics have become familiar.

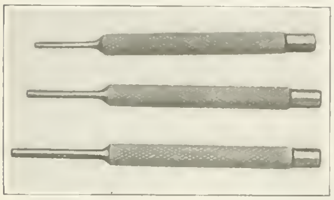


Fig. 2. Set of West Haven Drive-pin Punches

WATSON OPEN-TYPE BOX-TOOL

The open-type box-tool for screw machines, which is illustrated and described herewith, has a cast-steel body; the bars which support the cutters are made of machine steel, and the

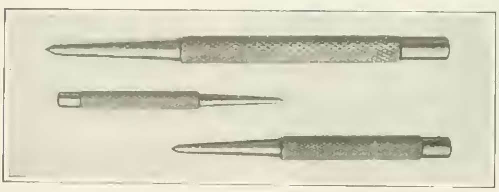
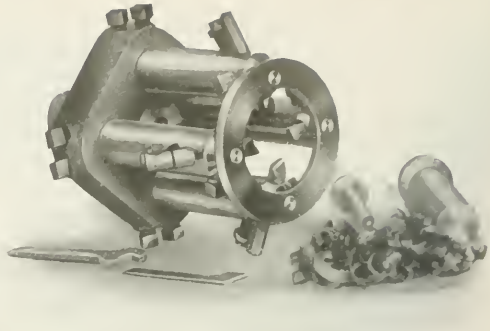


Fig. 3. Set of West Haven Center Punches

cutters are of high-speed steel. Adjustment of the cutters to provide for handling work of various diameters is effected by manipulating the small collar and set-screw located behind each cutter, which provides for adjusting the position of the cutters relative to the axis of the box-tool. The rake of each tool can be changed by releasing one of the cap-screws in the shank of the cutter holder and tightening the other screw. The open type of construction provides for free lubrication and chip clearance; and this tool also has the advantage of providing four cutting tools. It is unnecessary to use a roller block rest,

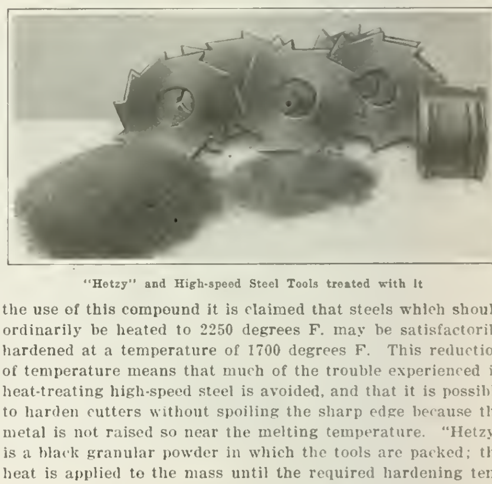


Watson Open-type Box-tool for Screw Machines

as the four tools cutting have the same effect as a rest. The Watson Mfg Co., Toledo, Ohio, manufactures these box-tools, and they are sold by the P. H. Biggs Machinery Co., 809 Hippodrome Bldg., Cleveland, Ohio.

STEEL HEAT-TREATING COMPOUND

The Bennett Metal Treating Co., Elmwood, Hartford, Conn., has recently placed on the market a compound known as "Hetzy" which is used for heat-treating high-speed steel. With

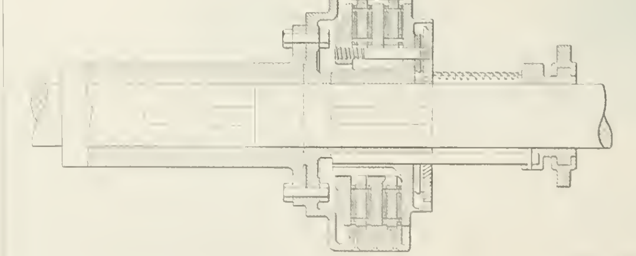


"Hetzy" and High-speed Steel Tools treated with It

the use of this compound it is claimed that steels which should ordinarily be heated to 2250 degrees F. may be satisfactorily hardened at a temperature of 1700 degrees F. This reduction of temperature means that much of the trouble experienced in heat-treating high-speed steel is avoided, and that it is possible to harden cutters without spoiling the sharp edge because the metal is not raised so near the melting temperature. "Hetzy" is a black granular powder in which the tools are packed; the heat is applied to the mass until the required hardening temperature is reached, when the tools are removed and quenched.

HILLIARD DOUBLE-DISK CLUTCH

In the February and November, 1915, numbers of MACHINERY, descriptions were published of two types of single-disk friction clutches manufactured by the Hilliard Clutch & Machinery Co., Elmira, N. Y. Recently this company has added double-disk friction clutches to its line for use in connection with drives where the amount of power is too great to be carried by a single disk. These double-disk clutches are made in three sizes known as Nos. 21, 22 and 23, and have capacities for trans-



Hilliard Double-disk Friction Clutch made in Three Sizes for transmitting Loads of 90, 150 and 200 Horsepower

mitting up to 90, 150 and 200 horsepower, respectively, when running at 100 revolutions per minute.

The operating mechanism is similar to that of the single-disk clutches previously described in MACHINERY, the movement of the friction disks being actuated by spiral racks and pinions. The multiplication of pressure provided ranges from 132 to 1 to 168 to 1 in the different sizes of clutches. The friction material used is a wire asbestos woven brake lining ¼ inch thick which is riveted to ¾-inch cast-iron plates, driving to alternate plain plates. They drive through hardened tool steel keys 1 inch square which are inserted and riveted to the housing.

Particular attention is called to the compact construction of the clutch. In the case of the 90-horsepower clutches, the maximum diameter is only 18¼ inches, and the maximum diameter of the 200-horsepower clutches is but 24¾ inches. This small diameter enables these clutches to be used for higher speeds than would usually be permissible where such a large amount of power is being carried.

CONVEYOR FOR REMOVING PRESS WORK

The application of mechanical methods of handling raw materials and product in industrial plants offers one of the great-

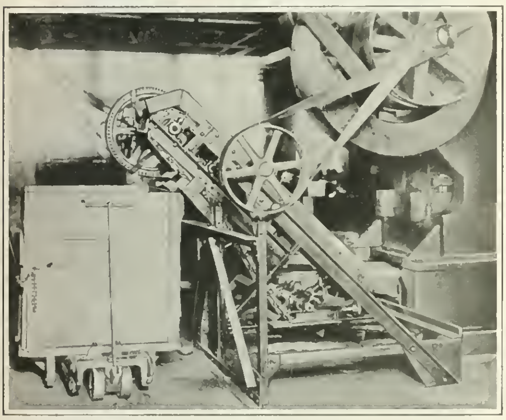


Fig. 1. Chain Belt Conveyor for transferring Product of Power Press to a Truck

est possibilities of increasing efficiency and reducing manufacturing costs. The accompanying illustrations show a conveyor

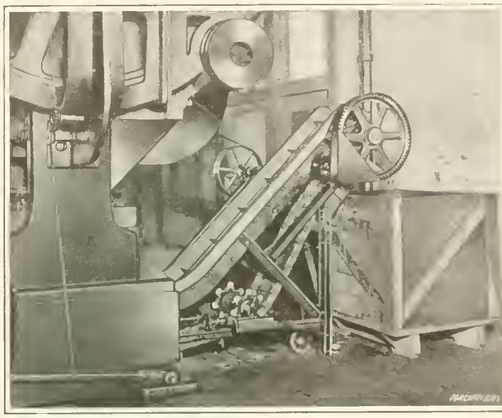


Fig. 2. Opposite Side of Conveyor, showing Angle Irons on Apron

built by the Chain Belt Co., Milwaukee, Wis., for transferring the product of a power press to a truck located at the back of the machine. It will be seen that the conveyor takes the finished pieces from the press and drops them into a box which is so constructed that when full it may be taken away by an elevating truck.

The conveyor is of simple construction, consisting of a series of flat plates which form a continuous apron; these are mounted on two strands of "griplock" roller chain belt. At intervals of about 16 inches, angle irons are attached to the flat plates so that the outstanding legs prevent the work from slipping back while it is being carried up the incline by the conveyor. The conveyor and driving mechanism are mounted on a structural steel frame so that the entire outfit forms a unit which may be easily moved to any part of the factory where it is required. The capacity is for handling over 1500 pieces of work per hour.

EMMERT DRAFTING BOARDS

The Emmert Mfg. Co., Waynesboro, Pa., is now making a line of drafting boards which are particularly adapted for using the vertical or horizontal T-square and combined protractor manufactured by this company. The board is simply constructed of kiln-dried white pine, and is mounted on a substantial iron stand. The inclination can be adjusted to meet the requirements of the draftsman, and a counterweight balances the weight of the board, making it an easy matter to regulate its position vertically; in addition, the board can be moved toward or away from the draftsman. The universal adjustment provided in this way insures a degree of comfort

Fig. 1. Emmert Adjustable Drafting Board for Drawings from 24 by 36 to 36 by 72 Inches in Size

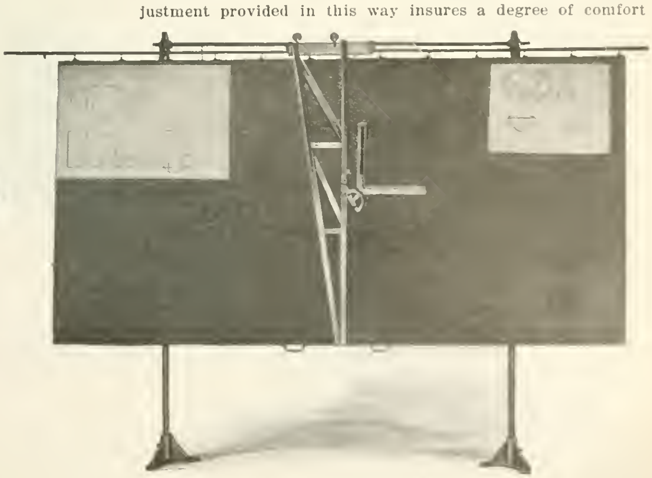


Fig. 2. Emmert Vertical Drafting Board for Drawings from 3½ by 10 to 10 by 25 Feet in Size

which should manifest itself in the quality and quantity of work produced by the draftsman. These boards are made in sizes for handling drawings from 24 by 36 to 36 by 72 inches in size.

In addition to the type of board mounted on an iron stand (shown in Fig. 1), a similar board is made without a stand so that it may be placed directly upon a table in the drafting-room. Fig. 2 shows a vertical board for use in making large assembly drawings, full-sized drawings, etc. This is made in sizes to accommodate drawings from 3½ by 10 feet up to 10 by 25 feet. The board is supported on upright posts and may be placed near the wall where it is out of the way except when wanted for use in making large-sized drawings.

BRINELL METER FOR HARDNESS TESTS

The results of the Brinell test have been generally accepted as a standard of hardness, but the application of this method has been limited for three reasons: (1) It has been impossible to apply the test at any desired point on a large piece of metal or for testing metal products of irregular shape; (2) thin sheets of metal or hollow metal bodies could not be tested because the high pressure applied to the ball resulted in the destruction of such pieces; (3) the apparatus for conducting the test could not conveniently be carried around by metallurgists or testing engineers, so that it was necessary to bring all test samples to the laboratory.

With the view of overcoming these difficulties, the Standard Roller Bearing Co. developed an instrument known as the Brinell meter which weighs only 7 pounds so that it can be easily carried about the factory; and the instrument operates in such a way that the limitations referred to are entirely overcome. The Brinell meter consists of a housing, in the lower end of which is loosely supported a hardened steel ball 10 millimeters in diameter. There is a transverse slot in the housing in which is inserted a steel test bar of known hardness, and the housing carries a hardened steel plunger, the lower end of which contacts with this bar.

It will be evident from the illustrations that the relative positions of these members are such that the 10-millimeter ball contacts with the test bar on one side and with the metal to be tested on the other side. The height of the transverse slot in the housing is such that the test bar has the necessary amount of vertical play, and the plunger carried by the housing is pushed down by a compression spring so that the test bar is held in contact with the 10-millimeter ball. In making the test, the ball is applied to the work, after which the housing is pushed down so that the bottom of the test bar is clear of the bottom of the slot in the housing. The top of the hardened steel plunger is then struck a sharp blow with a three-pound hammer, which results in producing an indentation in both the test bar and the metal to be tested.

From the familiar principle of mechanics that action and reaction are equal, opposite and simultaneous, it will be evident that the force of the hammer blow is applied equally to

Fig. 1. The Brinell Meter for rapidly making Hardness Tests

Fig. 2. Complete Brinell Meter Outfit packed in its Case

the work and to the test bar, with the result that the indentations produced by the 10-millimeter ball are proportional to the hardness of the metal. We have the familiar formula for the Brinell hardness test:

$$\frac{X}{S} = \frac{D^2}{D_1^2}$$

where X = unknown hardness of material;
S = known hardness of test bar;
D = diameter of impression made in test bar;
D_1 = diameter of impression made in work.

Scales are provided with the instrument which enable the diameters of the impressions to be measured with an accuracy of 1/20 millimeter, and knowing the hardness S of the test

VALUES OF RATIO D : D₁ AND CORRESPONDING HARDNESS FOR TEST BAR HAVING HARDNESS VALUE OF 170

Ratio	Brinell Hardness	Ratio	Brinell Hardness	Ratio	Brinell Hardness	Ratio	Brinell Hardness
0.90	137	1.07	194	0.99	167	1.16	229
0.91	140	1.08	198	1.00	170	1.17	233
0.92	144	1.09	202	1.01	174	1.18	237
0.93	147	1.10	206	1.02	177	1.19	241
0.94	150	1.11	210	1.03	181	1.20	245
0.95	153	1.12	213	1.04	184	1.21	249
0.96	156	1.13	217	1.05	187	1.22	253
0.97	160	1.14	221	1.06	190	1.23	257
0.98	163	1.15	225	....	...	....	...

Machinery

bar, it is an easy matter to solve this equation for the unknown hardness of the work.

To facilitate making the test, tables have been compiled for different values of the known hardness S of the test bar. To use these tables, it is merely necessary to measure the diameters of the impressions and then obtain the value of the ratio $\frac{D}{D_1}$. Then referring to the table, the corresponding value of the hardness is found opposite the proper value of the ratio. The table which accompanies this article is calculated for a hardness value of 170, which is the hardness of one of the standard test bars. Test bars with a hardness of 170 are suitable for use in testing metals with hardness values ranging from 130 to 225; for testing materials with hardness values ranging from 200 to 300, the hardness of the test bar should be 250.

To explain the method of obtaining hardness numbers both by calculation and the use of the table, the following problem will be carried through. Suppose the diameter D of the impression in the test bar is 4.2 millimeters, and the diameter D_1 of the impression made in the work is 4.0 millimeters. The known value S of the hardness of the test bar is 170. Substituting these values in the Brinell equation, we have:

$$X = 170 \frac{4.2^2}{4^2} = 187.$$

The value of the ratio will be:

$$\frac{D}{D_1} = \frac{4.2}{4} = 1.05.$$

Referring to the table for a ratio value of 1.05, we find the value of the hardness is 187 which checks the calculated result.

It will be evident that tests can be conducted very rapidly with this instrument, and as it is packed in a leather case 9¼ by 6¼ by 2¾ inches in size and weighs only seven pounds, it is very convenient to carry about the factory. As a result, the instrument is suitable for the use of inspectors who have occasion to make trips through industrial plants. Another application is in the testing of shipments of raw materials which are bought on specifications that include a hardness clause. The regular equipment furnished with the Brinell meter includes three test bars having a hardness of 170, three test bars having a hardness of 250, twelve 10-millimeter hardened steel balls, two scales for measuring the diameters of impressions, one set of direct-reading tables, a set of instructions, and a wrench for opening the instrument. Special test bars may be furnished of any desired hardness. After the test bars have been used up on all sides, they can be ground to remove the impressions and make them suitable for further service. The Brinell meter, patented by the Standard Roller Bearing Co., is manufactured, under a sole license agreement, by Herman A. Holz, 50 Church St., New York City.

NEWTON LOCOMOTIVE FRAME DRILLING MACHINE

The Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa., is now building a drilling machine which has sufficient range and flexibility to provide for the performance of drilling operations on all parts of locomotive engines of various sizes; and this machine is particularly adapted for drilling locomotive frames. The spindles have an automatic geared feed of 18 inches, and a vertical adjustment of 18 inches through direct-connected gearing for the fast hand traverse, and through worm and wheel for slow hand adjustment. Four changes of feed are provided, which are 0.0078, 0.0126, 0.0156 and 0.0185 inch per revolution. The range of spindle speeds is from 28 to 456 revolutions per minute.

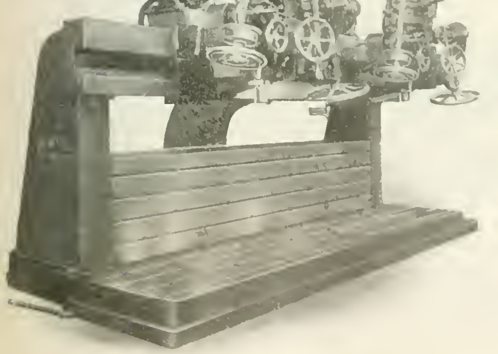


Fig. 1. Front View of Newton Locomotive Frame Drilling Machine, with Work-tables run back to expose Floor Plate

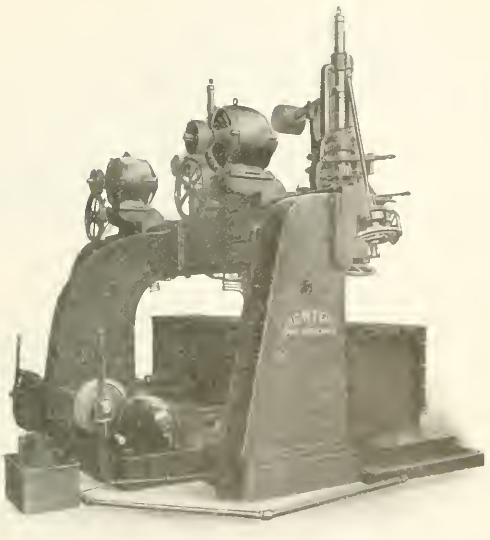


Fig. 2. Partial Rear View of Machine shown in Fig. 1, with Work-tables moved out under Drill Spindles

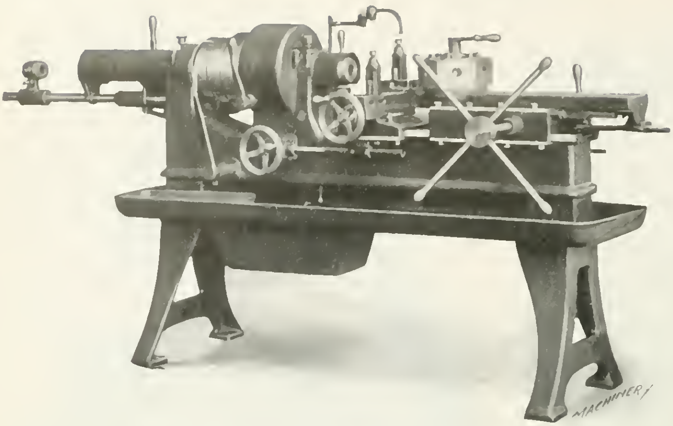
The spindles are driven by ten-horsepower electro-dynamic motors which run at from 300 to 1200 revolutions per minute. Motion is transmitted through horizontal driving shafts, on each of which is mounted a double train of bevel gears, and thence through vertical shafts and spur gears which give two changes of speed in addition to the variation provided by the motors. The spindles are counterweighted to facilitate the return movement. They are bored No. 5 Morse taper and provided with retaining and drift key holes. Reversing fast traverse is provided, for moving the saddles on the rail from the minimum distance between spindles of 48 inches to the maximum distance of 15 feet. Hand horizontal adjustment of the spindles is obtained by a handwheel at the bottom of the arm.

The gear-box which controls the feed is mounted on the column, the different gear combinations being engaged by a spring key controlled by a small hand-lever. Lateral hand adjustment is provided for the position of the spindle saddle on the arm from a minimum distance of 6 inches to a maximum distance of 24 inches from the face of the cross-rail. The arm has two bearings at the top of the cross-rail which are removable to facilitate renewal, and square lock gibbed bearings are cast integral with the brass taper shoes to afford means of compensating for wear. The motor brackets are cast integral with the arm to provide the required rigidity for heavy work.

The cross-rail is of the box type construction and ribbed to give additional rigidity. The machine is furnished with two adjustable work-tables, each of which is of the box type and has vertical and horizontal working surfaces with T-slots for clamping the work. It will also be noticed that the base of the machine is extended to form a floor plate in which T-slots are cut for securing large pieces of work ready for drilling. When using the floor plate, the tables are pushed back to the position shown in Fig. 1, this movement of the tables being obtained by motor-driven screws. The movement of the two tables is independently controlled; and in addition to moving the tables back to expose the floor plate, this adjustment is employed for bringing the work clamped to the tables into the desired position under the drill spindles. The principal dimensions are as follows: floor space occupied, 19

by 20 feet; maximum distance from floor plate to bottom of spindles, 81 inches; maximum distance from end of spindle to top of adjustable work-table, 48 inches; minimum distance from top of floor plate to bottom of spindles, 64 inches; and minimum distance from end of spindle to top of adjustable table, 43 inches.

KENT-OWENS SCREW MACHINE

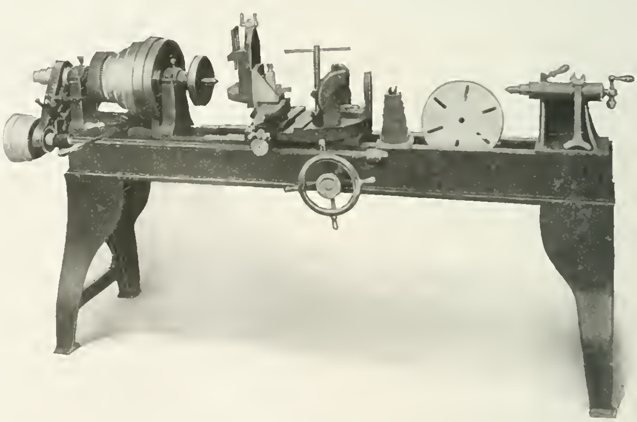


Kent-Owens No. 4 Friction-head Hand Screw Machine

The No. 4 friction-head hand screw machine shown in the accompanying illustration is manufactured by the Kent-Owens Machine Co., Toledo, Ohio; and the P. H. Biggs Machinery Co., 809 Hippodrome Bldg., Cleveland, Ohio, has the sales agency. The spindle bearings are bronze-bushed and provided with oil reservoirs; and it will be seen that the head and bed are cast in a single piece with guards to provide adequate protection for all the gearing. Independent automatic stops are furnished for each position of the turret. The cut-off slide has hand lateral adjustment along the bed, and the cross-slide adjustment is actuated by the usual arrangement of screw and handwheel. Machines of this type are built either with or without power feed to the turret. Tapered gibs are used in making adjustment for any wear which may develop in the turret slide. The spindle has a capacity for handling stock up to 1 5/8 inch in diameter; and provision is made for lubricating the work and tools by a pump which draws cutting compound from a reservoir located beneath the oil pan.

SAMUEL K. LANDIS LATHE

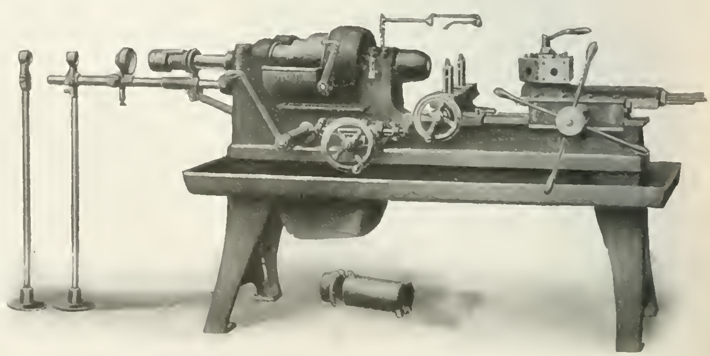
The accompanying illustration shows what is known as a combination engine, turret and milling lathe which is built by Samuel K. Landis, 53 North Duke St., Lancaster, Pa. The machine is said to be adapted for such operations as cylinder boring, drilling, milling, and slotting, in addition to the usual classes of lathe work. It will be seen that in place of the usual lathe carriage, there is a special carriage which carries a turret. This turret is square at one side and round at the other; the square end is provided with a raised guide which supports a compound rest, while various tools may be secured to the opposite side of the turret. The head is so constructed that the clutch, reverse and back-gears are conveniently controlled by means of the two hand-levers shown. The spindle bearings are lined with phosphor-bronze, and the gears are carefully enclosed to provide for the safety of the operator. The bed is sufficiently braced to give the required rigidity.


Samuel K. Landis Combination Engine, Turret and Milling Lathe

The principal dimensions and specifications for this machine are as follows: swing over ways, 17 inches; swing over carriage, 10 inches; length of bed, 7 feet; distance between centers, 52 inches; diameter of hole through spindle, 1 9/16 inch; ratio of back-gears, 3½ to 1; capacity for thread cutting, eight to thirty threads per inch; and weight of machine, 1400 pounds.

HIMOFF SCREW MACHINE

The Himoff Machine Co., Inc., 128 Mott St., New York City, is now building a hand screw machine which is made in No. 2 and No. 4 sizes. It will be seen that the head is cast integral with the bed, and the bed is provided with ribs to stiffen the construction. In this connection attention is called to the pulley guard which is cast integral with the head so that it also assists in reducing the possibility of strain or vibration. The spindle is machined from a 50-point carbon steel forging which is bored and threaded to receive a collet nose, and then hardened and ground. The turret is revolved automatically by the backward movement of the turret slide. Handwheel feed for the cross-slide is a standard


"Hercules" Screw Machine made by Himoff Machine Co.

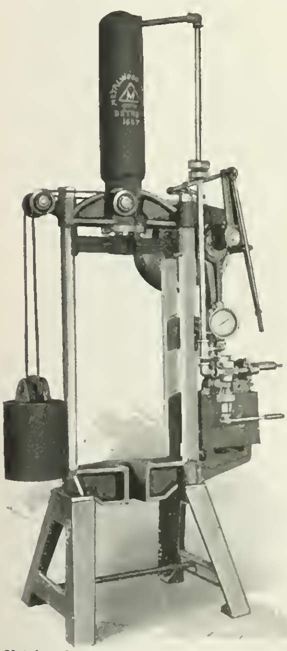
feature of this machine, and positive stops are furnished for the longitudinal feed to the cut-off slide. The No. 4 machine may be furnished with power feed for both the cross-slide and turret. Special features of these screw machines are positive length stops for the cross-slide, and the provision of a chain oiling system for the spindle bearings.

The principal dimensions of the No. 2 machine are as follows: capacity of chuck, up to 1 inch in diameter; diameter of hole in spindle, 1¼ inch; swing over bed, 14 inches; swing over cut-off slide, 6 inches; maximum length of work that can be turned, 6 inches; maximum distance from end of spindle to turret, 14 inches; width of driving belt, 2¾ inches; available spindle speeds, 460, 288 and 184 R. P. M.; floor space occupied, 2 feet, 3 inches by 6 feet; and weight of machine, 1310 pounds.

The principal dimensions of the No. 4 machine are as follows: capacity of chuck, 1½ inch; diameter of hole in spindle, 1 27/32 inch; diameter of turret holes, 1½ inch; swing over bed, 16 inches; swing over cut-off slide, 6¼ inches; maximum length of work that can be turned, 8 inches; maximum distance from end of spindle to turret, 18 inches; width of driving belt, 3½ inches; available spindle speeds, 165, 108 and 70 R. P. M.; floor space occupied, 2 feet, 3 inches by 6 feet; and net weight of machine, 1650 pounds.

METALWOOD BROACHING PRESS

To meet the requirements of heavy broaching operations, the Metalwood Mfg. Co., Leib and Wight Sts., Detroit, Mich.,



Metalwood Vertical Hydraulic Broaching Press

has recently added to its line of hydraulic presses the 35-ton vertical broaching press illustrated and described herewith. The press is provided with a five-horsepower Metalwood duplex pump which runs at 200 revolutions per minute. To facilitate handling the broach, the hole in the platen is made U-shaped. The features of the machine are its capacity for handling heavy work, speed of operation and economy of floor space.

In tests conducted with the press while the pump was running at 170 revolutions per minute, the following results were obtained: average time for down stroke, 38 seconds; average time for return stroke, 8 seconds; and pressure developed, 45 tons. The principal dimensions of the machine are as follows: diameter of ram, 4½ inches; stroke of ram, 30 inches; diameter of round column, 2¾ inches; size of rectangular columns, 2 by 3 inches; maximum distance from face of ram to platen, 44 inches; space between columns, 23¼ inches; distance from floor to face of platen, 31 inches; diameter of hole in platen, 4 inches; total height of machine, 10 feet, 6 inches; floor space occupied, 32 by 39 inches; and weight of machine, 3200 pounds.

REED-PRENTICE SHELL LATHE

To meet the requirements of turning shrapnel and high-explosive shells the Reed-Prentice Co., Worcester, Mass., has developed a machine which employs many of the principles of construction used on the automatic turning and facing machine of this company's manufacture. The lathe is driven by a ten-horsepower Westinghouse motor mounted on the head, from which power is transmitted to the spindle through direct-connected gearing. Any type of motor may be furnished according to the requirements of the shop, and a handwheel is provided on the motor by means of which the drive is controlled. In order to eliminate chatter and vibration, a pair of herringbone gears is employed in the head.

It will be noticed that the handle which binds the tailstock spindle in any required position is placed beneath the spindle rather than above it. This method has the advantage of leaving an unbroken surface to support the upward thrust which occurs when the cutting tools are in operation. No changes of feed have been provided, as the builders of this lathe determined the most satisfactory rate of feed for the work for which the machine is intended and constructed it accordingly.

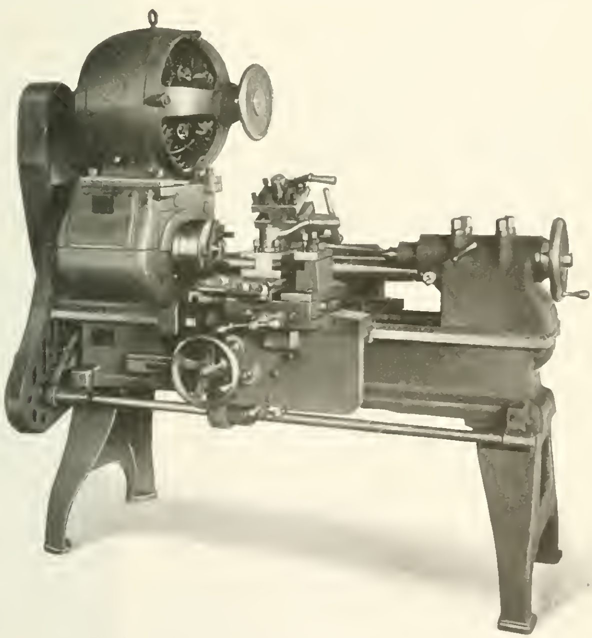


Fig. 1. Reed-Prentice Automatic Shell Turning and Facing Lathe

This does away with the possibility of an unskilled operator using any other than the most suitable rate of feed. The apron carries a drop-worm mechanism which is disengaged at a predetermined point to stop the feed automatically.

It will be seen that there are turret tool-blocks at both the front and back of the machine to provide for the use of roughing and finishing tools. The front turret tool-block is placed beside a stationary tool-block. The first tool in the turret and the tool in the stationary block perform the rough-turning operation, after which the turret is indexed to bring the finish-turning tool into the working position. It will be evident that while the finishing tool is at work the roughing tool in the fixed block moves past the work without actually touching it. The tools are actuated by a former which governs the

contour of the work by automatically regulating the position of the cross-slide.

The rear tool-block is supported by a bar from which it swings to provide the feed motion for facing the end of the shell, turning a "radius" on the end of the shell, and turning the copper band seat. The movement of this tool-block is governed by a cam carried by the carriage; a roller attached to the tool-block runs in this cam and swings the tool-block on the supporting bar. The arrangement of the tools for facing, turning the radius at the end, and rough- and finish-turning the band seat is clearly shown in Fig. 3. These operations are performed at the same time that the turning operations are handled by the tools at the front of the cross-slide. Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City, have the sales agency for this machine.

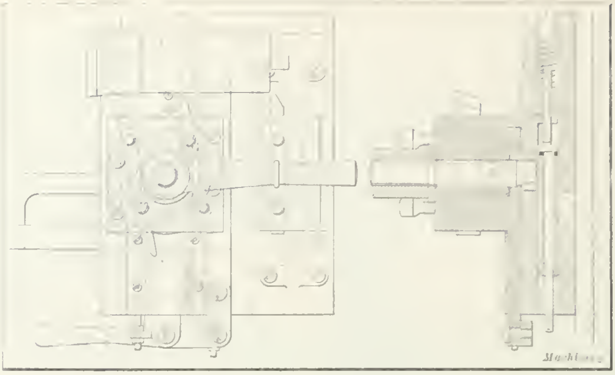


Fig. 2. Arrangement of Tools used for Turning Operations

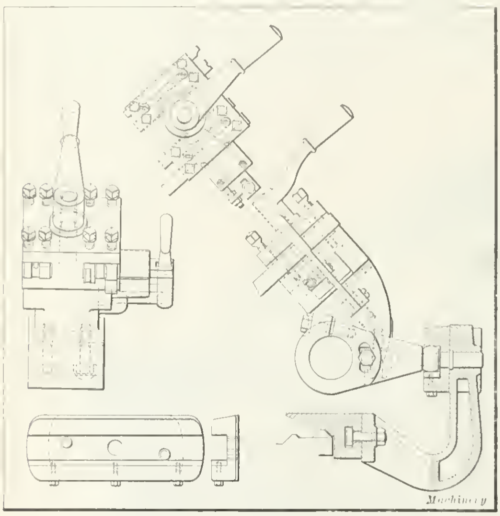
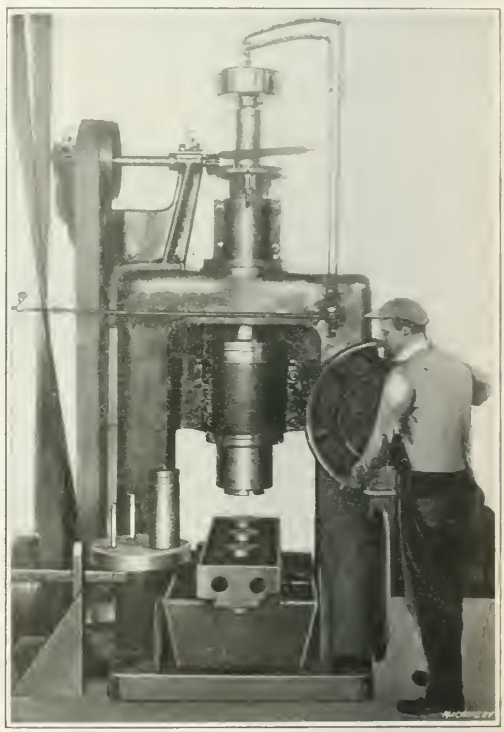


Fig. 3. Arrangement of Tools used for Facing and Band-seat Turning Operations

DUNLAP PROJECTILE BORING MACHINE

The projectile boring machine illustrated and described herewith is a recent addition to the line of the Dunlap Machinery Sales Co., Dayton, Ohio, and represents a departure from ordinary practice in the design of machinery for shell boring. The machine is fitted with a pneumatic chuck and the end of the spindle is enlarged to provide for carrying jaws for holding various sizes of shells up to 6 inches in diameter. The enlarged end of the spindle provides a bearing surface 14 inches in diameter by 16 inches long; the bearing is lined with babbitt. The feed motion is obtained through a handwheel at the front of the machine or by power; and a quick hand or power traverse of the spindle is available in either direction. The heavy platen shown in the illustration is provided with holes for holding a series of tools, and is carried on a slide cast integral with the base of the machine. A platen centering device provides for centering any tool with the spindle, after which the platen is locked firmly in place so that the centering pin is not called upon to take any of the strain.

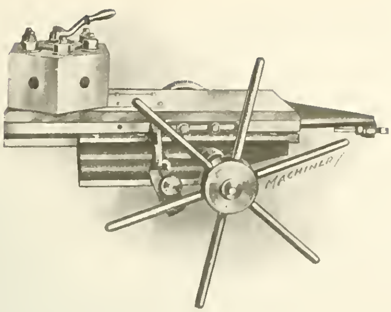
The advantages claimed for this machine are that the shell is inverted so that the chips drop out and do not interfere with the action of the cutting tools; and that the machine is sufficiently rigid to enable the tools to form the powder pocket and diaphragm seat absolutely concentric with the outside wall of the shell, irrespective of any eccentricity of the forged hole. The principal dimensions of the machine are as follows: capacity, for boring shells up to 6 inches in diameter; floor space occupied, 84 by 50 inches; width of driving belt, 6 inches; available power feeds, 0.007, 0.011, 0.016, 0.023, 0.034 and 0.053 inch per revolution of the spindle; and weight of machine, 10,000 pounds. The equipment furnished with the machine includes a lubricating pump and piping, an air chuck and connections, and the necessary wrenches for making adjustments.



Vertical Projectile Boring Machine built by Dunlap Machinery Sales Co.

HIMOFF TURRET

For application on any of the lathes of its manufacture, the Himoff Machine Co., Inc., 128 Mott St., New York City, manufactures the "Hercules" turret attachment shown in the accompanying illustration. This attachment is planed to fit on



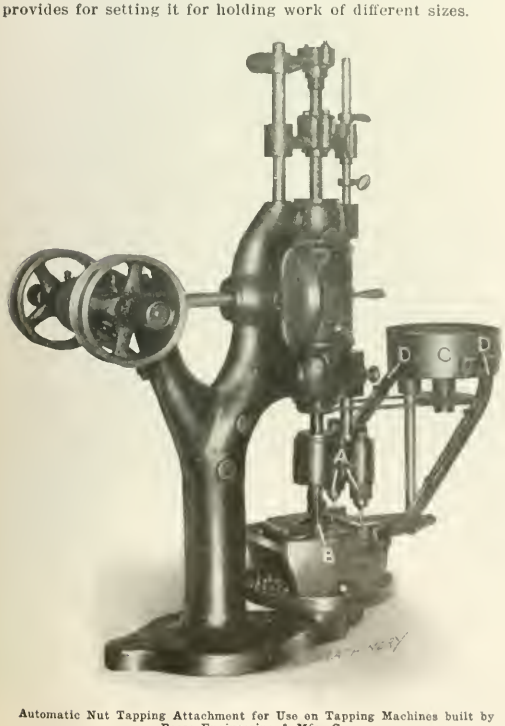
Himoff Turret for Use on Engine Lathes

the ways of the lathe and can be furnished with power feed to special order. The illustration makes the arrangement of this device quite clear without further description.

POESE AUTOMATIC NUT TAPPER

The Poese Engineering & Mfg. Co., Cleveland, Ohio, has recently added to its line a two-spindle automatic nut tapping attachment for use in tapping spark plug nuts and similar pieces. This attachment is used on the tapping machine of this company's manufacture; it consists of a two-spindle head *A* which is driven by feed-screw *B* of the tapping machine, the taps being fed in or backed out of the work according to the direction of rotation of the feed-screw.

The nut blanks to be tapped are placed in hopper *C* from which they are delivered to the attachment through chutes *D*. In order that the work may come to the fixture with the proper side up, an agitator driven by a small round belt pushes the pieces through gates in the hopper which are slightly larger than the work, and they are so formed that the pieces can only pass through when in the correct position. A cam is attached to the end of the feed-screw, and as the tapping head feeds down this cam holds the two pieces of work securely in position against an adjustable stop. The adjustment of the stop provides for setting it for holding work of different sizes.



Automatic Nut Tapping Attachment for Use on Tapping Machines built by Poese Engineering & Mfg. Co.

During the return of the tapping head, the springs pull the fixture plate back and release the work; then two more blanks slide into place ready for the next cycle of operations to be performed. As each two pieces are tapped, they are pushed into a receiver which is taken to the next department when full. It is stated that on 5-40 brass nut blanks, the capacity of the machine is 2000 nuts per hour; so that the operator handling five machines can tap 100,000 nuts in a ten-hour day.

NEW MACHINERY AND TOOLS NOTES

Hydraulic Press: Metalwood Mfg. Co., Leib and Wight Sts., Detroit, Mich. A quick-acting hydro-pneumatic press capable of making ten full strokes per minute, while developing its full rated capacity. This press is intended for the performance of flanging or upsetting operations.

Engine Lathe: Weir Frog Co., Cincinnati, Ohio. A 24-inch quick-change double back-geared lathe built along the general lines of a lathe formerly manufactured by the Rahn-Larmon Co. The Weir Frog Co. has taken over the style D 24- and 26-inch lathes formerly made by the Rahn-Larmon Co.

Three-oven Furnace: American Incandescent Heat Co., Delta Bldg., Boston, Mass. A heat-treating furnace constructed on patented principles developed by Alfred Smallwood of Birmingham, England. The patent rights for this country have been obtained by the American Incandescent Heat Co.

Heavy-duty Lathe: Davenport Locomotive Works, Davenport, Ia. In the April number of MACHINERY, reference was made to a single back-geared engine lathe of this company's manufacture. A similar lathe is now being built which is furnished with a three-step cone pulley and double back-gears.

Screw Machine: Charles Stecher Co., Chicago, Ill. A plain head hand screw machine which is similar to the machine formerly built by this company except that power feed has been provided for the turret. Automatic stops are provided for use in handling repetition work. The machine swings 14 inches.

Shell Lathes: Hill Pump Co., Anderson, Ind. A line of heavy-duty turret lathes designed for work on the smaller sizes of shells. The machines are made in two sizes, known as Nos. 3 and 6, and simplicity of design is characteristic of both. The range of available speeds and feeds is ample for the class of operations for which these machines are intended.

Light Screw Machine: W. K. Millholland Machine Co., Indianapolis, Ind. A machine constructed along the same general lines as previous types of Millholland screw machines except that it is built lighter. The turret mechanism operates automatically. The hexagon turret has tapped holes to hold special fixtures in addition to tools that fit in the regular holes in its faces.

Punching and Riveting Machine: Vulcan Engineering Sales Co., 2059 Elston Ave., Chicago, Ill. A pneumatic machine for use in shops doing light work on which punching and riveting operations must be performed. The machine is made in two styles, one of which is mounted on a bench for stationary service, while the other is set up on a truck so that it may be conveniently moved about the shop.

Lubrication Pump: C. F. Roper & Co., Milford, Mass. A line of geared pumps for circulating oil, cutting compound or water to cutting tools and bearings on machinery. These are made in two styles, one of which is adapted for use on machines where the cutting tools work in only one direction, while the other is automatically reversed for use on machines where the tools cut in both directions.

Double-end Surface Grinder: Stenotype Co., Indianapolis, Ind. A double-end plain surface grinder adapted for handling the lighter classes of grinding met with in many lines of manufacturing. Both the table feed and cross feed are hand operated, and the screw dials are graduated to 0.001 inch. The table traverse movement is provided by a hand-lever. The double-end construction makes the machine very compact so that the floor space occupied is relatively small.

Oxy-acetylene Torches: Oxy-acetylene Torch Co., Greenfield, Mass. A line of cutting and welding torches. One noteworthy feature of the design consists of a roller attachment for guiding the torch over the metal when performing cutting operations. Both cutting and welding torches are provided with a "universal head" by means of which the flame may be swung through an angle of 270 degrees while the torch is in operation to enable the welder to reach easily any desired position on the work.

Heavy Punch and Shear: Cleveland Punch & Shear Works Co., Cleveland, Ohio. This is a universal machine provided with ample capacity for handling a variety of work, including multiple punching, shearing and pressing operations. The machine is heavily constructed and is provided with capacity for exerting pressure of 750 tons. The housings are each made of a single piece, and have a 15-inch gap; the bottom face of

the plunger is 30 inches wide, and it is provided with T-slots extending from front to back.

Factory Signal System: American Model & Instrument Co., Worcester, Mass. A fire alarm and individual call signal system for use in industrial plants. The instrument is controlled by the operator of the telephone switchboard and sounds bells, buzzers and horns in the factory to call the attention of any official who is away from his own office when wanted. This is known as the "Amico" universal industrial code signal system and is used to give fire alarms in addition to calling officials to the telephone.

Motor-driven Grinders: Standard Machine & Electric Co., Indianapolis, Ind. These grinders are of two types, one of which is driven by an alternating-current motor and the other by a direct-current motor; in other respects the design of both machines is essentially the same. An important feature of the design is that pushing down a foot-treadle closes the electric switch to start the grinding wheels rotating, and this switch is automatically opened when the operator leaves the machine. As a result the consumption of current is reduced to the amount actually required to drive the machine while it is in use.

Double-spindle Surface Grinder: Grayson Tool & Mfg. Co., Indianapolis, Ind. A double-end grinder fitted with separate spindles and mechanism so that it consists of two distinct machines mounted on a single base. This construction requires the use of a minimum amount of floor space and still allows two operators to work independently of each other. The main features of the machine consist of automatic and hand feeds, protection for all bearings, ample working stroke for the table, long knee bearing on the column, cushioned table stops, centralized control for each end of the machine, wipers for all slides and an effective lubricating system.

* * *

LOCATING TROUBLE

BY A. L. HAAS*

It is an axiom of research work, universally true but little realized in the shop and drawing-room, that in any investigation only one factor must be regarded as variable while the remainder are treated as constants for the time being. In other words, to pursue a number of clues to a successful issue, they should be dealt with singly and in due sequence. Often the reverse policy obtains; half a dozen matters are dealt with simultaneously, and when the trouble is eliminated there is uncertainty as to which alteration should be credited with the improvement. The argument that if the job is accomplished, the exact means are immaterial is wide of the mark. The experience and knowledge afforded by correct diagnosis is of the greatest future value. Indeed, if the exact means are not known the experience is totally wasted. If several alterations are effected together, these may mutually hamper each other. A single remedy among the number may be the correct specific; and the multiplicity of remedies that were tried may perhaps prove worse than the disease.

The worker having laboratory experience is sometimes criticized by the practical man for the slow methods of investigation he employs. To the true investigator exact knowledge is of relatively greater value than the individual problem in hand. Repetition of result from the same fundamental factors is the only method of knowledge on which to build further. The principle of "one thing at a time" is a counsel of patience that is at times difficult to follow. When one thing is under consideration for amendment, others subconsciously suggest themselves; the correct policy under the circumstances is to make a careful record of them, but keep to the immediate single issue. One of the commonest faults of a man with the inventive faculty is this tendency toward simultaneous action along several lines. The practical engineer is not so often troubled in this way; and in going over the work of the inventor, he is often tempted to amend several points on the job. In fact, it sometimes appears easier to reconstruct his idea entirely than confine attention to the troublesome details that must be changed.

The designer is often criticized for some detail which may seem easy to improve. What the critic at times fails to remember is the complexity of choice open; for some good and well considered reason, the detail with manifold drawbacks was retained, as it afforded an easy solution not vital to the job. However, it is claimed that mistakes are not made over the drawing board or that the average designer is a mental superman, visualizing his work from every standpoint. Cut and try is the rule of the engineering universe, but it should be confined to a single issue for the particular occasion. The designer is as dependent upon the results in practice for future planning as any of the other individuals in the business who may be engaged in testing, outside erecting or in the machine shop. Troubles incidentally realized, unless fundamental, often fail to get back to their authors. Small adjustments are made, the job is completed and found satisfactory, but the experience afforded is not a vital matter and has a knack of evading the man who could apply the same remedy in the embryo shop on some future job.

In an ideal concern with a tactful and sympathetic management, it would be found that the designer was in touch with the man in the shop, the foremen, testers and erectors. The difficulty of adequate discussion is not unrealized, but unless the designer is faced with real criticism and to some extent forced to declare his reasons, he may travel on in happy ignorance to the detriment of the products made from his designs. Take, for example, the question of governing oil engines, which is one of the thorniest questions of design. Several successful systems are in operation, all of which depend upon mechanism of a delicacy unparalleled elsewhere for similar purposes. A valve with a total lift of 0.010 inch has this lift variable. In conjunction with this, is a full pump with a shock stroke—in fact, a liberal blow. The whole mechanism is controlled by a necessarily sensitive governor. The conditions to be met are difficult, the mechanism for considerations of inertia must be slight, even flimsy, and the economic success is made or marred by minute adjustments on the test bed. The difference made by inferior tuning up may amount in an engine to hundreds of gallons of oil per annum, between one engine and its duplicate. Ability to obtain the most economical results is, in this instance, independent of both the shop and the designer. It demands experience coupled with an endowment of the scientific spirit on the part of the specialist. To alter more than one adjustment at a time would be fatal. The difference in the results obtained by the adjuster is largely due to a realization of the doctrine of non-interference, except with a single variable at a time.

It may be broadly stated that the entire field of metal working lies in patient attention to minute details, and, in the case of trouble, the detection of the smallest of these may be the cornerstone of ultimate success. For this reason alone, leaving out altogether the attraction that mechanism possesses, the trade will always have perennial interest. This explains why actual experience bulks so largely in the equipment of the engineer. Skill in its broadest aspect is compounded of experience wedded to detail, while mechanical judgment that is correctly catalogued among the rare virtues, is built upon a similar foundation. Whether the subject be the design of important plants or machines, or the more detailed work of the shop, economies can be effected, troubles located and complexities simplified by the combination of experience with the right attitude of mind, and by observing the principle of "one thing at a time."

* Address: 116 Crowborough Road, London, S. W., England.

* * *

A wise policy is of more avail than a large plant; good management, than perfect equipment. * * * The factory invariably reflects the manager. The special problem of today is, then, to select and train, or rather, to train and select, our industrial leaders. * * * The possession of wealth, and hence power, does not necessarily fit a man for leadership. * * * The scientific method thrives best when all have equal opportunities, and our chances of getting proper industrial leaders is far greater when we have a whole people to choose from, than when they are selected from any one class.—*H. L. Gantt, in Industrial Leadership.*

* * *

The Ford Motor Car Co. built 58,329 cars in the month of March, the largest production record in its history. On March 25, the company turned out 2763 cars, the largest day's production. This was at the rate of nearly two a minute for twenty-four hours.

CUSTOMS INFORMATION

DECISIONS ON SEWING MACHINE NEEDLES, BEET KNIFE SHARPENERS, STEEL STRIPS, AND PROTESTS ON CAST-IRON VESSELS FOR RETORTS

BY JULES CHOPAK, JR.*

The Board of General Appraisers considered the question of the proper duty on so-called "Randall" needles, which the evidence showed were especially constructed and designed for harness-making, and that their use in connection with shoemaking was incidental and exceptional, and reached the conclusion that they were sewing machine needles. They were classified for duty by the government at the rate, 20 per cent, taken on sewing machine needles, paragraph 135 of the tariff act. The importers protested this assessment, claiming that the needles were free of duty, under paragraph 555, which admits without duty, when imported, "needles, hand sewing and darning, and needles for shoe machines." The importers' claim was based upon the last clause of the free list paragraph, on the theory that the use in shoe machines made the needles free of duty.

Questions of this sort for tariff interpretations have always been very close. While the articles are "needles for sewing machines," still if they are "needles for shoe machines"—a special kind of sewing machine—they are more properly classifiable under the more narrow and limited clause. When it is found that the use is not exclusive, or even that the articles are not especially adapted for use on shoe machines, but may be used on harness machines—sewing machines—then the question of the extensiveness of the respective uses has a very important bearing. The rule is not altogether uniform, but the weight of the authorities is that the exclusive use, or chief use, or special construction for use in shoe machines, makes the articles dutiable as such. In this case, it was found that the special construction and adaptability was not for shoe machines, and that that use was rare. Hence the claim was not allowed.

Steel Strips Not Sheets

Another case passed upon by the Board was cold-rolled high-carbon steel, 6 feet long, 5½ inches wide, and ⅛ inch thick. It was classified for duty at 15 per cent under paragraph 109, as steel "sheets." The importers claimed that the proper duty should be 12 per cent under paragraph 105 on the ground that the merchandise was not sheets but strips. Paragraph 105 provides for "strips of steel not specially provided for." The clear-cut issue made was whether or not merchandise bearing the above dimensions was sheets or strips. The Board held it was strips, lowering the duty accordingly. This decision opens up a point which does not seem to have been considered; that is, if ⅛ inch thickness is correct for a "strip." In other words, would a strip be thinner, such as No. 15 wire gage, or about 1/14 inch? It may very well be that strips do not come so thick, although sheets do, of course. The decision also opens up an incongruity in the tariff law, doubtless overlooked by Congress, for it makes an article of greater width and thickness, with a probable greater value, dutiable at a less rate than is charged on the same article having slightly smaller dimensions. Paragraph 114 takes 15 per cent duty on "steel in strips not thicker than No. 15 wire gage (about 1/14 inch) and not exceeding 5 inches in width, whether in long or short lengths, in coils or otherwise, and whether rolled or drawn through dies or rolls, or otherwise produced." The merchandise in question would undoubtedly be classified here if it were not so thick and so wide. But if it is more valuable than that which is not thicker than 15 wire gage and not over 5 inches in width, then why should it pay less duty? Of course, this is a question to be addressed to Congress for consideration in revising the present tariff law.

Beet Knife Sharpeners

The Board of General Appraisers followed a decision of the Customs Court at Washington, holding that circular steel files known as "fraises" used to sharpen the knives and blades of beet slicing machines, were free of duty under paragraph 391, exempting from duty "machinery for use in the manufacture of sugar." The "fraises" do not directly enter into the manufacture of sugar, but the Court gave the clause a broad construction, taking in everything which might have an incidental use. The beet slicing machines have a direct relation to manufacturing sugar, but are not of use unless the blades, when dulled, are sharpened. Under this decision, then, the sharpeners are exempt from duty, too.

* Customs Lawyer, 29 Broadway, New York City.

Protests Now Under Consideration

Protest: Large cast-iron vessel, used in retorts, machined. *Assessed:* 20 per cent under paragraph 167 as manufactures of metal. *Claim:* 10 per cent under paragraph 125 as cast-iron pipe, and all castings of iron which have been machined or otherwise advanced in condition by processes or operations subsequent to the casting process, but not made up into articles or finished machine parts.

The protests of this class involve a legal question, simply, of a clear statement of facts which includes the latter part of the castings classification. What does the expression "but not made up into articles or finished machine parts" mean, as applied to this case? Here we have a large casting which was machined. Was it "made up into articles"? This paragraph might be understood to mean that the castings which are parts of an article are dutiable at 10 per cent, if they are not finished or already made up. That view carried a little further would be that single cast articles are excluded. This is not very certain for a fair reading of the entire clause, which opens by saying "all castings." "All castings" cannot exclude and include one-piece castings at the same time.

The 20 per cent rate, under the classification of manufactures of metal not especially provided for, has no special value for application. The clause is merely a basket, open and standing ready to receive anything which cannot be classified elsewhere. These articles will take that duty only if the castings provision appears not to cover. While the language of paragraph 125 could be more clear and greatly improved upon, reading it fairly as it is, there is some merit to the claim that this cast vessel is within its terms. However, the thoughts of the judges who decide the case, their liberality or strictness, will largely govern the decision.

* * *

SCIENTIFIC MANAGEMENT IN GOVERNMENT WORKSHOPS

A committee of ten engineers headed by Henry R. Towne, chairman, has been organized to oppose legislation antagonistic to efficiency in American industry. The committee has issued a pamphlet entitled "A Call to Arms," in which attention is drawn to certain legislation now pending in Congress. The Tavenner bill provides that it shall be unlawful for any officer, manager, superintendent, foreman or other person having charge of works of any employe of the United States Government to make time studies with a stop watch or other time measuring device. The bill provides that no premium or bonus or cash award shall be paid to any employe in addition to his regular wages, except for suggestions resulting in improvement or economy in the operation of any government plant. The Vandyke bill is of similar tenor.

In reviewing the matter, the pamphlet states that labor, material, and expenses or overhead are the three factors embracing the cost of every product. Scientific management is a term used to designate the application of scientific methods, the human efficiency to benefit the employe by lightening labor, augmenting output and by increasing earnings, and to benefit the employer by augmenting the output of his plant and thus decreasing the cost of products. In view of the mutual advantages that accrue from improved methods of manufacture, the better utilization of human effort and the increased productiveness of investment in machinery and plants, the objection of labor leaders, legislators and others to scientific investigations of manufacturing methods seems absurd. To forbid the government by law to purchase materials made in an establishment where scientific management is used, would compel the government to use materials made in the least progressive and efficient plants, often, if not always, at higher costs. It would tend to discourage instead of encourage American manufacturers in preparing to meet the competition of other countries.

FOREIGN TRADE OF JAPAN AND UNITED STATES

SOME CHANGES IN TRADE CONDITIONS RESULTING FROM THE WAR

When the Choshu clan started the revolution that has since been recognized as the awakening of Japan, it took for its motto, "Japan, Strong for Defence and Aggression." To attain this end it carefully studied European and American methods and tried to adopt those that it thought were the best; the result is seen in the commercial development of the nation. It doubled its foreign trade in the eight years preceding the war with China while in the twenty years preceding the war with Russia its share of the world's trade increased from 0.4 to 1.5 per cent. During this same time Germany's share grew from 10 to 11.3 per cent; the United States, from 9.01 to 10.5 per cent; and Great Britain's fell from 12.8 to 10.8 per cent. But it is since that war that Japan's foreign trade has attained its greatest growth, for the results of the war gave the nation a new outlook and its statesmen new ambitions.

The development of Japan's aggressive strength is shown by the fact that if the Pacific mail steamers had been withdrawn last November, of the 490,000 tonnage that would then be available in the Pacific, Japan owned and controlled, through subsidies, 430,000. As a result of this control, cargo space to all Asiatic ports has been held at a high premium, for most of the space in the Japanese boats has been reserved by the government for goods shipped to and from the ports of Japan. One magazine writer recently said: "The present war has been Japan's opportunity. She has been a diligent reaper, but she has not yet got her reapings safely housed, nor is she convinced that the opportunity is exhausted. The period from now to the end of the war marks, perhaps, the crisis of Japan's existence as a world's power, when she must either firmly grasp her opportunity or see her ambitions fade forever." Whether or not this is true, Japan is now obtaining a large share of the world's trade. Although normally its imports exceed its exports by several millions, in 1915 its exports were larger by about $84,000,000. One result of this expansion of Japan's foreign trade is, according to Dr. Frederick Starr, of the University of Chicago, that over 1000 millionaires have been created since the European war began. The *New Zealand Herald* says:

> There is hardly a manufactured article that Japan is not turning out at the present time, and she makes no secret of the fact that she is endeavoring to get a strong hold on the world's markets, especially those that were formerly flooded with German goods. There have arrived in Wellington goods that prior to the war Japan had not attempted to manufacture; these include ironmongery and such implements as garden tools (which are evidently intended to be a replica of the American-made article), locks, shelf brackets, sash rollers, hasps and staples, leather purses (all grades and varieties), scents and soaps, lead pencils, ink, erasers, stationery of all kinds, fountain pens, surgical and rubber goods (such as hot-water bottles), barbers' instruments, vacuum flasks, Panama hats, basket ware, and suit cases. In brush ware the Japanese have made great strides, and they are now going in for the better quality of article.

Not only does the Asahi Glass Co. now supply the domestic demand but it sells one-half of its output in foreign markets. The demand for Japan's paper is so great that several of its mills are planning to enlarge their plants, especially to supply the Chinese markets, and also to manufacture their own wood pulp. The export of Portland cement, started after the outbreak of the war, averages from 50,000 to 100,000 barrels a month to Australia, the Dutch Indies, British India, and other Eastern countries. Last year, Japan's exports of shell buttons, mostly to European countries, increased in value $529,000; its toys are sent to England, Australia, India, and North and South America. Seventy, and not forty, per cent of its ceramic ware is now sent to foreign markets. Besides, in its production, machinery has replaced hand labor, the kilns have been improved, and coal is used, so that a former week's output is now obtained in a day. Japan's flour is being shipped to England and the South Sea Islands, and its control of the China trade, through the Mitsui Co., was one of the reasons why the United States shipments to Chosen fell from $583,788, in 1914, to $84,824 in 1915, while Japan's shipments increased from $851 to $106,160, and China's from $2754 to $111,483. The products of its nine hundred match factories, with an annual output of $7,470,000, may now be bought in England and are rapidly being introduced in most other countries; men returning from Mexico speak of the aggressive advertising campaign for this match now being carried on there. While many match factories are being started in China, they are completely dominated by the Japanese interests, as the Chinese must buy all of their supplies from Japan.

In order to develop its trade in southeast Manchuria as thoroughly as possible, Japan has erected, in Antung, China, with Japanese workmen and from Japanese materials, a building in which it will exhibit goods manufactured in Japan and the agricultural and mineral products of that part of China. In the erection of this museum, the effort has been made to show as many as possible of the uses of the various materials employed. To aid the development of its Chinese trade, the Manchurian Bank has been opened, in Mukden, with a capital of $4,985,000 and the Sino-Japanese Bank, in Shanghai, with a capital of $9,970,000. The director of agriculture and commerce is now advising all Japanese manufacturing companies that must spend much money on their plants or in finding markets in China to erect plants in China. He says, "The valley of the Yangtze is destined to become the center of the industrial activities in the East when the time comes for the East to awaken to new industrial activities," and states that all lines of industry ministering to the daily needs of the people, such as spinning, weaving, flour mills, glass and soap making, printing, iron work, the working of blown metal, ship building, etc., are most promising and have a good future.

Japanese cotton goods are rapidly supplanting those of England in the South Sea Islands and the Indies, and have entered New Zealand, Australia, and Africa; its mills have also begun the manufacture of the higher counts of thread and the finer cloth. Its shipyards have steadily increased in size and ability until they can produce almost any vessel desired. Aided by the government's subsidies, dye works and laboratories for the preparation of medicine are being erected. Great Britain's consul-general at Kobe says: "The making of machinery is increasing yearly and the demand for oil and gas engines is met largely by locally made machines. Since the outbreak of the war the difficulty which British firms experience in accepting orders for prompt delivery has diverted here many orders that might have been expected to go to Great Britain. The war has also revolutionized the refining of zinc in Japan. It is expected that when all the works now planned are in working order they will handle the nation's entire output of zinc ore."

An effort is now being made to develop the wool industry, although the native grasses are not suitable for pasturage; the Imperial stock farm at Hokkaido recently purchased for this purpose a large number of sheep from Australia and New Zealand. An effort is also being made to control the mineral development of Chosen by the enactment of mining laws that confine the management of such works to citizens of Japan. The sale of Japanese goods in New Zealand has increased so rapidly that Japan is planning the establishment of a steamship line between the two countries by way of Australia, while the diversion of Japanese steamers from the Suez Canal route around the Cape of Good Hope has resulted so favorably to Japan's trade with South Africa that a line will connect African and Japanese ports even when the Suez Canal route is again available. It is also reported that, besides buying immense quantities of munitions from Japan, Russia has been making efforts to obtain a loan of $75,000,000.

In 1915, Japan's total exports to the United States, the Philippine Islands, and Hawaii, amounted to $116,305,202. Of this, $3,147,339 was for copper ingots and slabs; $69,233,318 for silk; $693,192 for beans and peas; $886,521 for maize; $1,897,659 for cotton goods; $3,380,765 for hemp, chip, and straw braids; $6,000,756 for tea; $637,055 for brushes and feather dusters; $419,508 for toys.

Results of War on United States

The past two years have also seen the foreign trade of the United States grow; but this growth has been in spite of obstacles caused by the war rather than from the development of carefully studied plans for such an emergency. The beginning of the war found this nation depending almost entirely on foreign vessels for the transportation of its goods; now it is rapidly building up a merchant marine of its own and its flag is now seen in most of the world's ports. It was dependent on other nations for banking facilities outside of its own boundaries, now it is opening its own banks in Central and South America and is planning to open some in Europe. It was largely dependent on foreign importers for its sales in foreign markets; now it is selling direct. Its capital indebtedness to the Old World is diminishing so rapidly that soon it will be negligible. At the same time it has lent capital to the Entente Alliance, $500,000,000 in one transaction, and to France, South American countries, Canada, Switzerland, and Scandinavia. Besides, it has loaned the credit of its vast banking resources to various countries, directly and indirectly. It has not only cancelled its indebtedness abroad but it has created a foreign debt on which the United States will receive interest and dividend. It now has the largest stock of gold that, so far as is known, was ever owned by one people. The aggregate resources of its national banks at this time are $3,000,000,000 greater than the aggregate resources of the Bank of England, the Bank of France, the Reichsbank of Germany, the Bank of Russia, the Bank of the Netherlands, the Swiss National Bank, and the Bank of Japan. In fact, the American dollar has supplanted the English pound as the unit of foreign trade to such an extent that the Pan-American Conference, in April, decided to make the unit of all Pan-American commerce "a weight of gold exactly one-fifth of the value of the United States gold dollar."

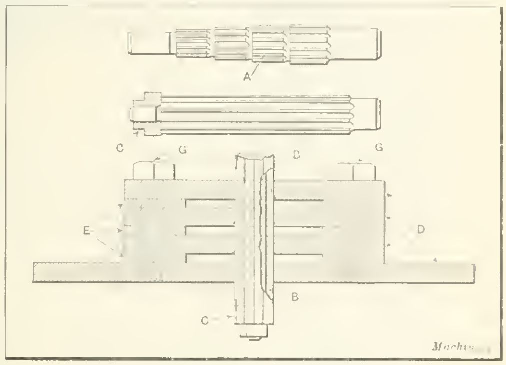
American goods are in demand all over the world. The United States is now the largest exporter of manufactured goods; the value of its exports of manufactured products in 1915 was $1,784,000,000, or $350,000,000 more than Great Britain's. Japan cannot operate its extensive shipyards without American steel, and she must buy American cotton for the manufacture of her finer cloth. Italy, Russia, France and Spain are constantly seeking American steel and steel products; they are also studying American factory methods so as to reorganize their industries along the most efficient lines possible when peace is restored. Twenty Chinese naval officers and cadets and one captain and six lieutenants of the Spanish navy are studying the methods of the New London Ship & Engine Co.

In April, England purchased 100,000 tons of copper, although it had purchased 60,000 tons only last fall; while the bulk of this will be used in the manufacture of munitions, a large part is also necessary for the British ships now being built. An investigator for the Bureau of Foreign and Domestic Commerce says that for several years the United States will be called upon to supply South America annually with from 750,000,000 to 1,000,000,000 board feet of lumber for use in finishing buildings. Twelve vessels will be required to transport to Russia the cut lumber recently purchased by that nation. Most of the New Zealand shoe factories are equipped with American shoe machinery and one American firm last year increased its sales of farm machinery in New Zealand $100,000. An American syndicate has opened manganese mines at Madinga on the Gulf of San Blas, Colon, Panama, about seventy miles east of Colon, from which it has shipped 900 tons to New York, and, when vessels are available, will mine 1500 tons a month. Ten thousand tons of American cast-iron pipe will be used in the construction of an aqueduct in Uruguay, which proposition a New York bank is financing. Twenty million pounds of tobacco was sold by one American firm to European countries in April, while last year 67,576,800 pounds of rice were sold in foreign markets, the larger part being markets that were formerly supplied by English exports. New financing for concerns manufacturing war munitions, dye stuffs and chemicals, and engaged in the shipping business has involved capital issues of $625,276,000; and importers in Australasia and Spain are urging the formation of steamship lines between the United States and those countries. D. E. J.

BROACHING METHOD OF MANUFACTURING SPUR GEARS

Herman W. Martin, 7 E. 42nd St., New York City, is developing a process of producing spur gears by which, he states, the cutting of the teeth can be done for less than half the cost of present methods. Various details in connection with the tools and method used for a small brass pinion are shown in the accompanying illustration. Briefly, the process is one of forcing the gear blanks through a series of serrated plates which are progressively arranged so that each plate takes off a predetermined amount of material—in short, broaching the gears with external broaches or dies.

An interesting feature in the process is the manufacture of the die-plates. A blank A is turned up to form a series of cylindrical steps, the smallest of which is used for the first die-plate, while the intermediate and largest steps are used to produce the other plates. After the cylindrical work has been done on the cutter blank the teeth are milled to correspond with the pitch of the gear required and the broach is hardened ready for use. The lower illustration in the figure shows the assembled drawing plates D. These plates are broached by the

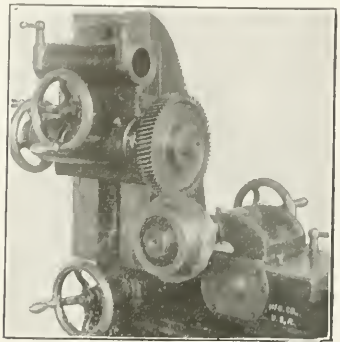


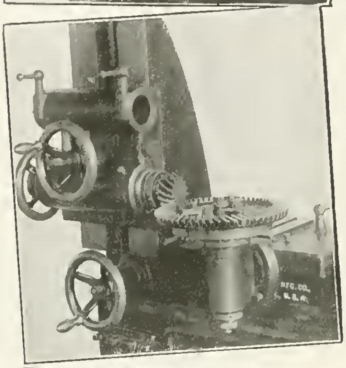
Broaching Dies for cutting Spur Gear Teeth

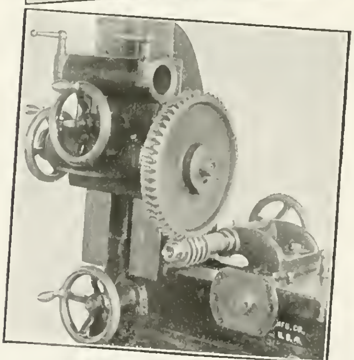
tool A so that they operate on the work progressively, the upper and intermediate plates each taking out a small amount of metal while the lower one finishes the work. The spacing plates E which are interposed between the die-plates allow the chips to work out and also provide air space so that the heat generated by friction will radiate readily. The plates are made of machinery steel and are carburized and hardened, after which the upper surfaces surrounding the holes are ground to a cutting edge. The plates are bolted together by the bolts G, suitable dowels being used to keep them in alignment. Mr. Martin states that this process can also be applied to a bar from which the pinions can be cut off after they have been machined. A description of a process somewhat similar to this appears in MACHINERY for April, 1914, on page 673, in an article on "Commercializing a Process by Means of Press Work," by Chester L. Lucas.

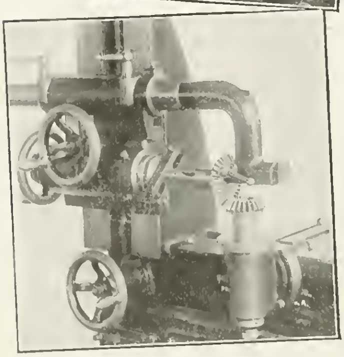
* * *

The annual report of the Fried. Krupp A. G., of Essen, Germany, for 1914-1915, states that the net profits for the year amounted to about $21,500,000, as compared with $8,400,000 in the preceding year. The large requirements of war material during the year increased the total amount of business done to nearly two and one-half times the corresponding total in the previous year. The growing demands on the capacity of the firm necessitated large extensions to the plant. For this reason a further increase of the capital was necessary, amounting to about $8,500,000. The capital stock during the year covered by the report was about $53,000,000, and the net surplus about $24,000,000. During the year about $4,000,000 was turned over to benevolent funds, including war allowances. A dividend of 12 per cent was declared, the remainder of the profits being added to the surplus. It has been decided to create a "Krupp Foundation," which will favor large families of fallen or severely wounded soldiers, the fund amounting to $5,000,000.









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Brown & Sharpe Bevel Gear Testing Machine

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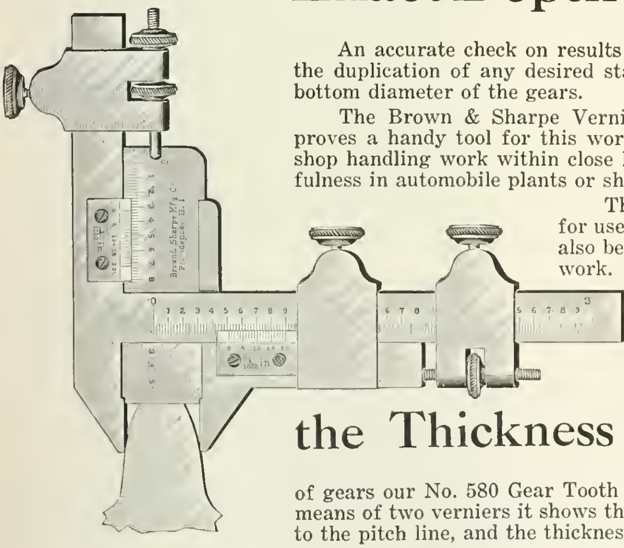
Brown & Sharpe Vernier Caliper No. 573

For Determining the Exact Depth of Gear Teeth



An accurate check on results in gear cutting, one which insures the duplication of any desired standard, is found by measuring the bottom diameter of the gears.

The Brown & Sharpe Vernier Caliper No. 573, shown above, proves a handy tool for this work. It is especially valuable in any shop handling work within close limits and finds a wide field of usefulness in automobile plants or shops cutting transmission gears.

The jaws of the vernier are made thin for use of fine pitch gears but the tool may also be used like our 12″ Vernier on other work.

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of gears our No. 580 Gear Tooth Vernier is handy and reliable. By means of two verniers it shows the distance from the top of the tooth to the pitch line, and the thickness at the pitch line.

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CONFERENCE ON ENGINEERING COOPERATION

The second conference of the committee on engineering cooperation was held in Chicago, April 13 and 14, and was attended by representatives of forty-two national, state, and local engineering and technical societies from all parts of the United States. The purpose of the conference was to bring about a closer relation among engineers and engineering organizations, to discuss ways to improve standards of engineering practice and to gain a clearer recognition of the engineer as a civic asset. Prof. F. H. Newell of the University of Illinois was chairman and C. E. Drayer, secretary of the Cleveland Engineering Society, was secretary of the committee on engineering cooperation which had the meeting in charge. Subjects discussed were practicability and limits of cooperation, employment, ethics and legislation. Cooperation from the standpoint of the state society was presented by Paul Hansen and Clyde T. Morris; from the standpoint of the national societies the subject was presented by P. Junkersfeld, Horace C. Gardner, DeWitt V. Moore, J. F. Hale, C. H. McDowell and John H. Peyton. The subject was presented from the standpoint of the local society by F. G. Gasche, A. J. Himes, H. L. Keck and Lewis R. Ferguson. C. E. Drayer gave an illustrated talk on publicity for engineers.

* * *

SPRING MEETING OF A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers was held in New Orleans, La., April 11 to 14, inclusive. The visiting members were the guests jointly of the Louisiana Engineering Society, the New Orleans association of members of the American Society of Civil Engineers and the local membership of the American Society of Mechanical Engineers. The headquarters were at the Hotel Grunewald.

The program, as usual, began with registration and an informal reception Tuesday evening. On Wednesday, the paper "Organizing for Industrial Preparedness" was presented by Spencer Miller and was followed by an extended discussion. The paper emphasized the importance of the industrial census of the country, to be undertaken by representatives of five of the national engineering societies at the invitation of President Wilson. On Wednesday afternoon, the members and friends took a boat trip to inspect the harbor and the recently constructed cotton warehouse which is unusual in its mechanical equipment. Other engineering works of interest were also seen. In the evening, W. B. Thompson, commissioner of public works of the City of New Orleans, addressed the members, and on Thursday the following papers were presented, followed by discussions:

"Capacity and Economy of Multiple Evaporators," by E. W. Kerr.

"The Evolution of Low-lift Pumping Plants in the Gulf Coast Country," by William B. Gregory.

"Mechanical Equipment used in the Port of New Orleans," by William von Phul.

On Thursday afternoon, the visiting members and guests were given an opportunity of visiting the New Orleans Country Club, and in the evening a reception and dance was attended. On Friday, the following papers, followed by discussions, were presented:

"Establishing a Standard of Measurement for Natural Gas in Large Quantities," by Francis P. Fisher.

"Deviation of Natural Gas from Boyle's Law," by Robert F. Earhart and Samuel S. Wyer.

"Some Experiments on Water-flow through Pipe Orifices," by Horace Judd.

"Dynamic Balance," by N. W. Akimoff.

"The Measurement of Viscosity and a New Form of Viscosimeters," by H. C. Hayes and G. W. Lewis.

"On the Transmission of Heat in Boilers," by E. R. Hedrick and E. A. Fessenden.

On Friday afternoon, an excursion was made to the reclaimed lands near New Orleans to inspect the extensive tracts that had been reclaimed and turned to useful purposes.

PERSONALS

Thomas J. Egan, formerly of the Dexter Folder Co., Pearl River, N. Y., has taken the position of superintendent of the Brown Cotton Gin Co., New Haven, Conn.

J. T. Smoody, formerly of the engineering department of the American Thread Co., has joined the staff of the Chile Exploitation Co., 120 Broadway, New York City.

Alexander C. Brown, vice-president of the Brown Hoisting Machinery Co., Cleveland, Ohio, has been appointed general manager, succeeding Richard B. Sheridan, who has resigned to take another position.

J. B. Doan has been elected president of the American Tool Works Co., Cincinnati, Ohio, succeeding the late Franklin Alter. Robert S. Alter has been elected vice-president and foreign manager, and Henry Luers, treasurer.

William S. Chase, formerly sales manager of the National-Acme Mfg. Co., Cleveland, Ohio, was married April 12 to Ada B. Parrish, at Alhambra, Cal. Mr. and Mrs. Chase will live on their ranch at Del-Ca-Mar, Meridian, Idaho.

The many friends of Vernon Job, manager of the Western office of the Independent Pneumatic Tool Co., 61 Fremont St., San Francisco, Cal., will be pleased to learn that he is rapidly recovering from an attack of appendicitis.

W. V. Houck, assistant superintendent of the King Sewing Machine Co., Buffalo, N. Y., has taken a position as factory manager with the Sterling Engine Co. of Buffalo. Mr. Houck was with the Garvin Machine Co. of New York for ten years.

W. L. Schellenbach, for several years chief engineer with the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, has taken offices at 520 First National Bank Bldg., Cincinnati, where he will devote himself to consulting engineering and machine design.

OBITUARIES

Victor A. King, a well-known gunmaker who was for seven years superintendent of the Winchester Repeating Arms Co., New Haven, Conn., died at his home in West Haven, March 19, aged eighty-nine years. Mr. King went to New Haven in his youth and was employed by the old Whitney Arms Co. in Whitneyville, Conn. At that time, he worked on the first order of Colt's revolvers ever made.

COMING EVENTS

May 10-12.—Triple convention of the Southern Supply and Dealers Association, the National Supply and Dealers Association and the American Supply and Machinery Manufacturers Association, at Pittsburg, Pa. William Penn Hotel, headquarters.

May 11-13.—Conference on scientific management at Ann Arbor, Mich., under the auspices of the Taylor Society. The conference is to be held at the University of Ann Arbor. Secretary, Henry W. Shelton, 35 College St., Hanover, N. H. Reservations in charge of Prof. Joseph A. Bursley, University of Michigan, Ann Arbor, Mich.

May 16-17.—Annual meeting of the National Association of Manufacturers at the Waldorf-Astoria Hotel, New York City. George S. Boudinot, secretary, 30 Church St., New York City.

May 22-27.—Third national safety exposition of the American Museum of Safety at the Grand Central Palace, New York City. Arthur Williams, president, and Dr. William H. Tolman, director, 18 W. 24th St., New York City.

June 12-16.—Midsummer cruise of the Society of Automobile Engineers on the Steamship "Noronic," leaving Detroit June 12 and returning June 16. Reservations can be made by application to W. H. Conant, treasurer, 601 Kerr Bldg., Detroit, Mich.

June 14-16.—Annual meeting of the Master Car Builders Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 14-21. Annual meeting of the Railway Supply Manufacturers Association at Atlantic City, N. J., in connection with the A. R. M. M. and M. C. B. Associations. J. D. Conway, secretary and treasurer, 2136 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual meeting of the American Railway Master Mechanics Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 27-July 1.—Annual meeting of the American Society for Testing Materials at Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

August 15.—Annual meeting of the International Railroad Master Blacksmiths Association, Chicago, Ill. A. L. Woodworth, secretary and treasurer. C. H. & D. Ry., Lima, Ohio.

September 5-8.—Annual convention of the Traveling Engineers' Association at Chicago, Ill. W. O. Thompson, secretary, New York Central Car Shops, E. Buffalo, N. Y.

September 11-16.—Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Clarkson College of Technology, Potsdam, N. Y. Bulletin for 1916 containing calendar 1916-1917 and outline of courses.

Northwestern University, Evanston, Ill. Annual catalogue 1915-1916 containing calendars for 1915-1916 and 1916-1917.

School of Mines and Metallurgy. University of Missouri, Rolla, Mo. Catalogue 1915-1916 containing calendar for 1916-1917.

Lowell Textile School, Lowell, Mass. Annual report of the trustees of the Lowell Textile School, for the year ended June 30, 1915.

National Association of Manufacturers, 30 Church St., New York City. Proceedings of the International Trade Conference held under the auspices of the National Association of Manufacturers of the United States of America in cooperation with banking and transportation interests of the United States, at New York City, December 6 to 8, 1915. The object of the conference was to consider ways and means for facilitating international transactions which had been seriously interrupted by the war. The principal problems dealt with related to transportation, credit and exchange.

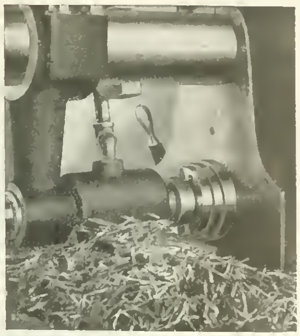
Putting Absolute Rigidity Where It's Most Needed

The rocking of the knee on a milling machine is as fatal to accurate milling as rocking a boat is to the safety of its passengers.

This is particularly true of long flat pieces. If the knee rocks on the column due to twisting strains, why, then, it's hopeless to look for accuracy on such work.

And it is the knee which is entirely responsible. Don't blame a bent table or a short saddle.

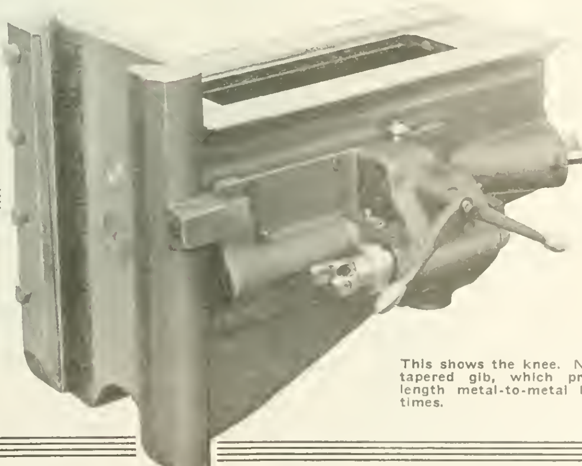
That is why this "better point" about Cincinnati Milling Machines is so important.



The No. 5 Plain High Power Cincinnati Miller takes a cut ⅜" deep, 5" wide at 20" per minute feed in hammered steel, and the work can be returned freely under the cutter without lowering the table. With the older form of knee, this is impossible.

The Rigid Knee—Properly Connected to the Column

First, the metal in the knee where it fits the column has been increased. Second, the old form of gib has been replaced with a heavier gib, *tapered in length*, and parallel in section such as that used for the table bearing. This gives a long metal-to-metal bearing the full length of the knee. No clamps—no screws are used. And the knee does not rock on the column—it positively does not!



This shows the knee. Note the heavy tapered gib, which provides a full length metal-to-metal bearing at all times.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI OHIO, U. S. A.

Conference Board of Safety and Sanitation, Magnus W. Alexander, secretary, West Lynn, Mass., is issuing a periodical entitled "The Spirit of Caution," which deals with fundamental factors of safety and sanitation problems as encountered in industries generally. This publication is prepared primarily for the attention and guidance of managers, superintendents and foremen, but the distribution among employes generally will develop a wholesome regard for the effective prevention of accidents. Shop posters have been prepared to assist in the prevention of accidental injuries and to promote proper treatment of wounds. These can be obtained from the Conference Board. The April number of "The Spirit of Caution" discusses the "careless habit" and shows illustrations of common accidents that result from the carelessness of the workmen.

NEW BOOKS AND PAMPHLETS

Effect of Certain Pigments on Linseed Oil. By E. W. Boughton. 10 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 71.

General Design of Critically Damped Galvanometers. By Frank Wenner. 34 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 273.

Leakage of Currents from Electric Railways. By Burton M'Collum and K. H. Logan. 51 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 63.

Standardization of Automobile Tire Fabric Testing. By Walter S. Lewis and Charles J. Cleary. 18 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 68.

Modern Practice in the Construction and Maintenance of Rail Joints and Bonds in Electric Railways. By E. R. Shepard. 122 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 62.

Standard Test Specimens of Zinc Bronze. Part I.—Preparation of Specifications. By C. P. Karr. Part II.—Microstructure. By Henry S. Rawdon. 67 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 59.

Concrete on the Farm and in the Shop. By H. Colin Campbell. 149 pages, 5 by 7¼ inches. 51 illustrations. Published by Norman W. Henley Publishing Co., New York City. Price, $0.75.

This is a practical treatise on everyday uses of concrete for inexperienced persons desiring to make their own concrete structures. It describes the construction of tanks, troughs, cisterns, fence posts, stable floors, hot-beds, walls, foundations, panel fences, etc.

Invar and Related Nickel Steels. 68 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 58.

This circular is chiefly a compilation (from sources which are often inaccessible) of the properties of nickel steels with particular reference to the properties of the non-expanding alloy known as "Invar." It contains chapters on the magnetic, electrical, thermal and mechanical properties, applications, sources, and brief statements on microstructure and constitution.

Standard Density and Volumetric Tables. 67 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 19.

The wide application of hydrometers as measuring instruments in the industries makes it very important to define the various scales of indication of these instruments in terms of fundamental units. In this circular the conditions are announced under which the testing of hydrometers will be conducted and specifications are given as to the construction, standardization and accuracy required for hydrometers in order that they may be approved as precision instruments.

Location of Engine Cooling and Lubrication Troubles Made Easy. By Victor W. Page. Chart, 24 by 30 inches. Published by Norman W. Henley Publishing Co., New York City. Price, $0.25.

This combination chart shows all components of the approved form of water cooling group as well as of a modern engine lubrication system. All points where defects exist that may result in engine overheating both in cooling and oiling systems are shown. The defects in the cooling systems may occur in the radiator, circulating pump, water piping, cooling fan and engine. Oil system defects are analyzed, giving the symptoms, trouble and remedy, the same as in the cooling system.

Magnetic Testing. 50 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 17.

Since the operation of motors, magnetos, transformers and generators depends upon the magnetic properties of iron and steel, the magnetic testing of these materials is of the greatest importance to the electrical industry. The design and efficiency of such apparatus depends upon a thorough knowledge of the magnitude of those magnetic properties which can only be ascertained by careful tests. The scope of the work of the Bureau of Standards in magnetic testing is given, and the methods of measurement employed are described in considerable detail.

Steel and Its Heat-treatment. By Denison K. Bullens. 431 pages, 6 by 9 inches. 223 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $3.75 net.

The importance of proper heat treatment of steel is now widely appreciated, due chiefly to the development of heat-treating practice by the automobile manufacturers. No mechanism is subjected to more severe service than a motor car running at high speed over poor roads. The necessity of building machines that are both light and dependable has revolutionized the practice of manufacturers of axles, gears and other vital car parts. This book, by a consulting metallurgist, was written in the light of recent experience with a keen appreciation of the nature of the problems and the needs of steel users. It treats of the testing of steel; the structure of steel; annealing; hardening; tempering and toughening; case carburizing; case-hardening and thermal treatment; heat generation; heat application; carbon steels; nickel steels; chrome steels; chrome-nickel steels; vanadium steels; manganese, silicon and other alloy steels; tool steel and tools; pyrometers and critical range determinations, etc. It is a work that we highly recommend to all in need of a modern treatise on heat-treatment and the characteristics of heat-treated steels. Modern apparatus is illustrated and described, and there is much valuable material, including formulas not elsewhere available.

NEW CATALOGUES AND CIRCULARS

Scranton Pump Co., Scranton, Pa. Bulletin 107 on Scranton triplex plunger pumps.

Fairbanks, Morse & Co., Chicago, Ill. Bulletin H 178 B descriptive of Type Y semi-Diesel oil engines of the horizontal pattern.

St. Louis Machine Tool Co., St. Louis, Mo. Catalogue 15 of St. Louis grinding, polishing and tapping machines and tapping chucks.

Hunter Saw & Machine Co., Pittsburg, Pa. Circular of Hunter duplex inserted-tooth saw blades, giving the results of endurance tests made on these saws.

Speed Controller Co., Inc., 257 William St., New York City. Circular descriptive of the "Speedco" arc controller, an automatic precision feed for projection arc lamps.

Hunter Saw & Machine Co., Pittsburg, Pa. Circular of inserted-tooth setting device for setting teeth in Hunter duplex inserted-tooth saw blades up to 70 inches in diameter.

Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich. Circular of the Murchey adjustable hand sizing taps, made in all sizes from 1¼ inch to 12 inches diameter.

Beighlee Electric Co., Cleveland, Ohio. Catalogue of Beighlee pyrometers of the thermo-electric type. Agent for the Eastern states, Herman A. Holz, 50 Church St., New York City.

Skinner Chuck Co., New Britain, Conn. Circular giving dimensions and capacities of Skinner universal geared screw chucks and scroll chucks, made with reversible and non-reversible jaws.

Vanadium-Alloys Steel Co., Pittsburg, Pa., has issued two folders descriptive of its "Vasco Choice" and "Vasco Non-shrinkable" grades of tool steel. These folders will be sent free upon request.

Conway & Co., Cincinnati, Ohio. Catalogue 12 B treating of Conway patent friction clutches of the compression and expansion types. The CMT clutch is designed expressly for countershaft service.

National Machinery Co., Tiffin, Ohio. National Forging Talk No. 9 describes a new design for grip slide alignment on forging machines, as exemplified in the National heavy-pattern forging machine.

Fairbanks, Morse & Co., Chicago, Ill. Bulletin 11102 C outlining the details of construction of Fairbanks-Morse Type Y oil engines, adapted for all general power purposes and made for belt or direct drive.

Link-Belt Co., Chicago, Ill. Bulletin 229 illustrating and describing the new Link-Belt traveling water-intake screen which prevents driftwood, vegetation and miscellaneous trash from entering condenser intake pipes.

Roller-Smith Co., 203 Broadway, New York City. Bulletin 100 descriptive of electrical instruments for signal system testing, including direct- and alternating-current portable volt-ammeters and direct-reading portable ohmmeters.

Metalwood Mfg. Co., Detroit, Mich. Circular of the Metalwood quick-operating ten-ton flanging press, operating with a frequency of ten full strokes per minute and developing the full rated capacity of ten tons per stroke.

J. N. Lapointe Co., New London, Conn. Circular of the No. 3B broaching machine which supersedes the No. 3 machine formerly built. All gears are encased and are self lubricating. High-speed return is provided for the broach.

General Electric Co., Schenectady, N. Y. Booklets Y 784 and Y 785 devoted to street lighting brackets and center span fixtures for "Mazda" lamps, and "Novalux" street lighting units for "Mazda" series lamps, respectively.

George Gorton Machine Co., Racine, Wis. Bulletin 748 describing the Gorton 8 C universal horizontal routing machine for routing vent and powder grooves in fuse rings. The production maintained with this machine is from 25 to 30 rings per hour.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Bulletin 140, comprising a manual for operating Lodge & Shipley lathes. It contains directions for erecting and oiling the lathes and adjusting them for accuracy, and describes the various parts in detail.

Volcano Torch & Mfg. Co., Erie, Pa. Supplement to catalogue 19 showing the improved "Volcano" kerosene blow torch with an adjustable burner which can be directed vertically or horizontally. This torch is made in two styles, each providing a flame from 12 to 14 inches long.

Curtis Pneumatic Machinery Co., 1568 Kienlen Ave., St. Louis, Mo. Catalogue 63 covering the Curtis line of pneumatic machinery, which includes air compressors, air hoists, trolleys, trolley systems, sandblasts, pneumatic and hydro-pneumatic elevators and jib and traveling cranes.

Link-Belt Co., Chicago, Ill. Pamphlet 238 descriptive of Types AE and ZB Link-Belt grab buckets. The AE grab was designed to meet the demand for a high-speed bucket of greater digging power than can be secured with ordinary grabs. The ZB bucket is intended for the general run of work.

Moore Oil Co., Cincinnati, Ohio. Pamphlet of Moore cutting compounds, cutting oils, drawing compounds, soluble oils and quenching oils, giving directions for mixing, proportions to use, and information concerning the classes of work and kinds of materials on which these compounds give the best results.

Link-Belt Co., Chicago, Ill. Booklet 267 entitled "Moving Material Indian File," treating of the problems of transporting material throughout factories. The booklet illustrates conveyors for handling packages, barrel conveyors with automatic loaders, and various other types of conveying apparatus.

American Roller Bearing Co., Pittsburg, Pa. Bulletin 1003 treating of the application of roller bearings to all designs of machinery and equipment. The pamphlet illustrates and describes in detail the design and construction of American roller bearings and shows examples of machines equipped with these bearings.

Detroit Electric Welder Co., Detroit, Mich. Circular of Detroit electric spot and butt welders of all capacities. These machines can be used for welding a range of material from the lightest gage stock up to the heaviest, with a range of spots from one a minute up to 200 a minute, depending on the requirements of the work.

National Tube Co., Pittsburg, Pa. Three-year calendar—1916, 1917, 1918—with poster "Over-shadowing Supremacy," illustrating the relative merits of the grand prize, medal of honor, gold medal, silver medal and bronze medal awarded at the Panama-Pacific International Exposition. The "National" products received the grand prize.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 3029 descriptive of Ingersoll-Rogler Class ORC duplex Corliss steam-driven air compressors; form 3036 descriptive of Ingersoll-Rand turbo blowers of the single-stage double-flow low-pressure type; form 4120 treating of Leyner-Ingersoll water drills, illustrating these drills in use in mine work.

Wardwell Mfg. Co., 114 Hamilton Ave., Cleveland, Ohio. Catalogue illustrating and describing the Wardwell line of saw and knife sharpening machinery and tools for the care of woodworking saws, metal cutting saws, planer and jointer knives, etc. Many of the machines shown in this catalogue are now being placed on the market for the first time.

Nordberg Mfg. Co., Milwaukee, Wis. Bulletin 27 A descriptive of Nordberg high-compression two-cycle oil engines, which are built in three sizes as follows: single-cylinder 50 H.P., single-cylinder 100 H.P., and twin-cylinder 200 H.P., running at speeds of 300 and 270 and 270 revolutions, respectively. Copies of this bulletin will be sent free upon request.

Goodell-Pratt Co., Greenfield, Mass. Supplement to catalogue 12 showing thirty new tools, comprising adjustable wrenches, speed indicators, motor-cycle sets, motor sets, ratchet rim wrenches, ratchet braces, high-speed hand drills, breast drills, chisel and punch sets, socket wrench sets, cotter-pin pullers, circular glass cutters, double-end wrenches, aluminum level, etc.

Babson Statistical Organization, Wellesley Hills, Mass. Circular advertising Babson's statistical reports for use in purchasing coal and coke, copper, zinc, tin, iron, steel and rubber. By means of these reports it is possible to predict with some degree of certainty the price of raw materials for a certain definite time, and thus to purchase these materials with the greatest economy.

Cleveland Punch & Shear Works Co., Cleveland, Ohio. Calendar giving working days in each week for the months of April to September, 1916. On the front of each sheet are illustrated one of the Cleveland line of punches and work which can be done on these machines. The back of the sheet comprises an order blank for ordering Cleveland standard and special punches and dies.

National Tube Co., Pittsburg, Pa. Bulletin 26 treating of the welding of National pipe. The characteristics of National pipe are peculiarly adapted to the autogenous welding process. The bulletin il-

lnstrates the welding of pipe lines and repairs that have been made on National tubing by autogenous welding, and contains a comprehensive discussion of the process, including costs for butt welding and cutting pipe.

West Haven Mfg. Co., New Haven, Conn. Circulars of drive pin punches in sets with points ranging in diameter from 1/16 to 3/8 inch; sets of center punches of 3/16, 1/4 and 9/32 inch body diameter; sets comprising one pin punch, one drive punch, one prick punch and three sizes of center punches; sets of one-piece screwdrivers, six inches in length, with blades of 2 3/4 by 3/16 inch; and slide or rigid T-handle tap wrench.

George Automatic Roller Bearing Co., 4614 Spring Grove Ave., Cincinnati, Ohio. Catalogue descriptive of the George automatic roller bearing, a unique type of bearing composed of tapered rollers separated by means of balls, no cage being employed. The conical ends of the rollers, acting in conjunction with the balls, overcome any tendency of the rollers to skew out of their true rolling axis. The booklet is illustrated with blueprints which make the construction very clear.

H. W. Wilson Co., White Plains, N. Y. Copy of the Industrial Arts Index published in February, April, June, October and December. This is a cumulative index to engineering and trade journals. The annual index for 1915 is ready, and contains 509 double column nonpareil pages. The index is of general interest to all who keep in touch with engineering literature. It saves them the trouble of making individual card indexes of their own, a very tiresome and laborious task.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of portable floor cranes and hoists. The Canton portable crane and hoist is mounted on a four-wheel truck and has an overhanging arm which permits it to be run up next to a machine tool, a locomotive or other machine so that the load can be lifted or lowered into place. The hoist is made in a size suitable for use in garages and light machine shops, as well as in other sizes suitable for railroad shops, heavy machine shops, etc.

National Tube Co., Pittsburg, Pa. Bulletin 25 on National pipe in large buildings. This bulletin contains the pictures of many large buildings in New York, Chicago and other cities that have been equipped with National steel pipes. Data on the production of iron and steel pipes are included. Other valuable data for engineers are given, such as is found in handbooks. These include properties of pipe; of solid and tubular beams; safety factors and safe working fiber stresses; loss of head in pipe by friction; relative discharging capacities of pipe; flow of steam, etc.

W. S. Rockwell Co., 50 Church St., New York City. Bulletin 30, descriptive of Rockwell automatic furnaces for annealing, hardening, tempering, etc. The illustrations show special equipment for continuous heat-treatment of shells, billets and material of like nature, continuous end-heating furnaces, semi-automatic annealing and hardening furnaces, continuous die annealing and hardening furnaces, automatic hardening furnaces and automatic rotary annealing furnaces. This bulletin is not intended as a catalogue only of furnaces, but rather as a discussion of the problems attending the development of automatic heating.

Mortimer J. Silberberg, 122 S. Michigan Ave., Chicago, Ill. Circular of the master chronograph for time study. The watch is a guaranteed high-grade seventeen-jewel timepiece which gives direct readings and operations per hour, thus eliminating mental and written computations. The circular analyzes the three prime causes for lost time and motion: (1) Improper tools, machinery or lack of facility furnished the employe. (2) Lack of knowledge on the part of employe as to how the work in hand can be completed with the least number of motions and least amount of exertion or fatigue. (3) The employe's not being physically or mentally fitted for the particular class of work apportioned to him. The master chronograph may be used for eliminating lost time and motion and for placing employes most advantageously for themselves and their employers.

Brown & Sharpe Mfg. Co., Providence, R. I. Catalogue 136 of machinery and tools. This well-known catalogue has been issued regularly for years and is found in the tool chests or libraries of many machinists and toolmakers as well as manufacturers' files. The business of Brown & Sharpe was founded in 1833, and from a very small beginning it has grown until now the present buildings have 1,029,900 square feet of floor space, or about 23½ acres. Besides the regular lines of machinery and machinists' tools shown in previous catalogues, a number of new machines, attachments and tools are listed, among which are No. 00 band milling machine, No. 3 heavy automatic gear cutting machine, No. 5 automatic gear cutting machine, No. 13 heavy automatic gear cutting machine, No. 1 spur gear testing machine, No. 0 spur gear testing machine, bevel gear testing machine, "Ilex" micrometer caliper (a low-priced caliper made to meet manufacturing requirements), dial test indicator, sets of standard tools, etc.

General Electric Co., West Lynn, Mass. Booklet describing the apprentice system of the company which has been developed under the direction of M. W. Alexander. The apprentice system was developed in order to train young men for service in various branches of the company's activities or in power and lighting stations, transportation companies and other industrial establishments using electrical machinery and steam apparatus. The booklet is illustrated with views of the apprentice training room, machine shop, class room, pattern shop, patterns made by apprentices, apprentice training room foundry, class room in mechanical drawing, class room in mechanics, motor winding department class room, electrical test department class room, etc. The booklet will be of general interest to all young men desirous of securing the sort of training afforded by this apprenticeship course, and it should also be of interest to manufacturing concerns that have realized the need of training young men for their service and are developing plans to provide it.

S. K. F. Ball Bearing Co., Hartford, Conn. Catalogue entitled "Ball Bearings as an Automobile Sales Factor," which is intended to help automobile salesmen promote the sale of cars by giving attention to the relative advantages of ball bearings. However, the book will repay the attention of users of ball bearings in any type of machine. Two pages contain questions and answers on ball bearings, some of the questions being: What are bearings used for? What types of bearings are used in motor cars? Which are the most widely used? Why? What is a ball bearing made of? What are the distinct advantages of S. K. F. ball bearings? Some of the subjects discussed are the use of bearings in general, features that determine the best types of bearings, and the ball as a supportive element. A brief sketch of the origin, constituents and manufacture of S. K. F. steel is given, and the fundamental features of design of S. K. F. ball bearings are explained. The section entitled "Where and Why S. K. F. are Used" gives the following uses: on axles, rear hubs, full floating type axles, three-quarter floating axles, semi-floating axles, final drives, propeller shafts, jack-shafts, transmissions and front wheels. The engineers glossary included gives some engineering details of S. K. F. bearings, such as testing the hardened steel, construction of the S. K. F. retainer, application of ball bearings to worm drives, etc. Curves are given for determining the loads on worm and worm-wheel bearings. Mention of this book would not be complete without reference to the excellence of its typographical appearance. Each page has a decorated border showing attractive views of automobiles on the city street, in the mountains, on the race-track, tractors engaged on construction work, etc. The illustrations are many and of a particularly high grade.

TRADE NOTES

Wyman & Gordon Co., Worcester, Mass., manufacturer of drop-forgings, has changed its name to the Wyman-Gordon Co.

J. J. McCabe, 30 Church St., New York City, has moved his office to the Singer Bldg., 149 Broadway. The McCabe warehouses are in Jersey City, N. J.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, has opened a branch sales office at 416 Citizens Bldg., Cleveland, Ohio, in charge of Charles E. Newell.

S. K. F. Ball Bearing Co., 50 Church St., New York City, has transferred its main office to the factory at Hartford, Conn. The New York office will be continued at the above address.

Morton Mfg. Co., Muskegon Heights, Mich., manufacturer of draw-cut shapers and keyseating machinery, was awarded the grand prize for its exhibit at the Panama-Pacific International Exposition at San Francisco.

Sherritt & Stoer Co., Inc., 603 Finance Bldg., Philadelphia, Pa., has been appointed exclusive sales agent for the Beaudry "Champion" and "Peerless" power hammers in the Philadelphia district.

Peter Bros. Mfg. Co., Algonquin, Ill., is building a 45- by 120-foot, two-story brick and cement addition to its plant, costing $10,000. The new building will increase the company's capacity for the manufacture of the Woodstock safety tapping chucks and attachments.

Desmond-Stephan Mfg. Co., Urbana, Ohio, manufacturer of the "Diamo-Carbo," Sherman, Huntington, "Magazine," Sherman-Huntington and "Diamond" grinding wheel dressers, has acquired the business of the Rupert Co. of Indianapolis, Ind., manufacturer of Huntington dressers.

Maino Machine Tool Co., Jackson, Mich., is the name of a new concern that has purchased the shaper business of the Walcott & Wood Machine Tool Co. of Jackson. The Maino Machine Tool Co. will manufacture and market the Walcott & Wood shapers hereafter. Harry Maino is the president of the new concern.

E. S. Cullen Machinery Co., 340 Leader-News Bldg., Cleveland, Ohio, is a new machinery selling concern organized by E. S. Cullen, formerly connected with the Niles-Bement-Pond Co. The new company will specialize in the selling of machine tools, locomotive and railway shop equipment, locomotive cranes, etc.

Sheffield Machine & Tool Co., 35 S. St. Clair St., Dayton, Ohio, is building special machinery, fixtures, jigs, dies and tools for manufacturers. In developing its facilities, the company will need more machinery, and it requests the catalogues of concerns building machines and accessories suitable for the class of work it is now engaged in.

Lober Art Brass & Specialty Co., Toledo, Ohio, is doing a large amount of heavy gage steel spinning for automobile concerns. This work is mostly for experimental cars and gives the plant engineers a chance to try out steel parts before ordering the dies. In some cases where the amount is not large, the company has filled quantity orders and thus has saved tool cost and made prompt shipments.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa., recently sold the electrical equipment for driving a new 40-inch reversing rolling mill to the National Tube Co. for installation in its plant at Lorain, Ohio. This rolling mill, when completed, will be one of the largest in the country. The reversing motor will develop 15,000 horsepower and will run at a maximum speed of about 120 revolutions per minute.

Albaugh-Dover Co., Chicago, Ill., manufacturer of cream separators and specialist in gear cutting, has made plans for a new machine shop 90 feet by 175 feet which will cost from $25,000 to $30,000. The plant is operated on the 24-hour schedule, and has been working day and night for more than three years. The addition was required to take care of the increased volume of business in cream separators and gear cutting.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., recently shipped a 13,000-pound "Chicago Pneumatic" air compressor and four "Hummer" hammer drills, to the International Trading Co., New York City, who will reship these machines to South America, where they are to be used in the construction of sewerage systems and water works in the cities of Paysanda, Mercedes and Salto in the Republic of Uruguay.

American Tool Works Co., Cincinnati, Ohio, held its annual meeting of stockholders March 30, at which the estate of the late Franklin Alter was represented by Walter Hofer and Clifford Wright. The following officers were elected: J. B. Doan, president; Robert S. Alter, vice-president and foreign manager; Henry Luers, secretary and treasurer. The following directors were appointed: J. B. Doan, Robert S. Alter, L. E. Voorheis, Clifford Wright and Walter Hofer.

Quigley Furnace & Foundry Co., Springfield, Mass., has added to its business a brass rolling mill department for the production of flat brass. A new name, Metals Production Equipment Co., has been adopted as being more comprehensive of the products. No change will be made in the general policy or management. The furnace, foundry and powdered coal departments will be continued as heretofore. The sales office of the company is at 105 W. 40th St., New York City.

Crofoot Gear Works, 31 Ames St., Cambridge, Mass., have taken over the New England Gear Works of Boston, including the good will, and have moved the entire plant to their factory in Cambridge. The new factory has been occupied for nearly a year, and in addition to the machinery acquired from the New England Gear Works, the company has installed a large number of new machines which provide facilities for a wide range of work. The factory is five stories high and fireproof.

Bullard Machine Tool Co., Bridgeport, Conn., has let a contract to the Turner Construction Co. of New York City for a continuation on Railroad Ave. of the concrete building which extends from Allen St. to Railroad Ave. on Broad St. The present building is 278 feet long, five stories high, and 50 feet wide. The new building is of similar construction, 110 feet long, and will replace the four-story brick machine shop which now occupies the site. The addition will increase largely the manufacturing facilities.

Steel Products Engineering Co., Springfield, Ohio, is the Springfield branch of the Gem City Machine Co., which was incorporated for $100,000 March 1. The company has purchased a 3½-story building, formerly occupied by the American Concentrator Co., located at Dakota Ave. and Columbia St. The building affords something over 10,000 square feet of floor space and it has been equipped for making tools of all kinds and for doing contract manufacturing. The tool-room equipment of the old company has been more than doubled, and one department has been added for all kinds of contract manufacturing.

Walcott Lathe Co., Jackson, Mich., is the successor to Walcott & Wood Machine Tool Co. The Walcott & Wood Machine Tool Co. was the successor to George D. Walcott & Son. These companies have been manufacturing lathes in Jackson for the last thirty-five years. The shaper business has been sold to the Maino Machine Tool Co. of Jackson, which will continue the manufacture of shapers under the name of Walcott. The Walcott Lathe Co. has a shop affording about 60,000 square feet of floor space and is building lathes in 14-inch, 18-inch, 20-inch and 25-inch sizes. The shop is equipped with up-to-date machinery, most of which is motor-driven, and it has all the facilities required to produce lathes in quantities.

J. N. Lapointe Co., New London, Conn., gave a banquet to about 140 of its employes at the Crocker House in New London, Saturday evening, April 8. The banquet is given each year for the purpose of establishing and cementing friendly social relations, and in order that this object shall be fully appreciated and understood the company makes a substantial gift each year to each employe in the shape of a bonus divided among them in proportion to their earning capacities. This bonus is 3 per cent of the total sales of the company and amounts to an average of a 10 per cent bonus of each employe's wages. Thus, if a man makes $1200 a year, his bonus is about $120. The friendly spirit manifested at the banquet convinced a representative of MACHINERY who was present that the company's liberal policy works to the mutual advantage of both the company and employes. J. N. Lapointe and Frank Lapointe were presented with handsome traveling bags by the employes as a token of appreciation. The company has been very successful in establishing sympathetic relations, a condition altogether too rare in manufacturing concerns generally. A tract has just been purchased at Pequot and Maple Aves., with twelve tenements, adjoining the present plant which will afford room for doubling its capacity.

THE INDUSTRIAL PRESS, Publishers, 140-148 Lafayette St., New York

A Typical Letter and the Answer

Philadelphia, May 5th, 1916.

MACHINERY, New York City.

Gentlemen:—We enclose a brass washer which is to be turned down to 2 1/4" O. D. by 2 3/64" I. D. and to be 1/8" thick.

Kindly give us your opinion as to how the tool should be ground to cut this smoothly and quickly, and what kind of a machine you think would be adapted for this particular kind of work.

Yours truly,

.... Company.

.... Treasurer.

The answer, worked up by one of MACHINERY'S editorial staff, is too long for publication here, but a simple statement of what it contained will doubtless interest many readers.

(1) The answer suggested a machine most suitable for the work, and an alternative machine. (2) Also a tooling arrangement for an exceptionally fine job, or for a commercial job of no great accuracy. (3) Detail drawings were furnished, with sufficient data for the manufacture of the tools specified, the construction of which was thoroughly explained. (4) Methods of holding the work were given for both settings (the first and the second) and type of holding device best suited. (5) Holding devices suggested were such as could be readily obtained. Tools used for cutting were of a simple nature, easily bought or cheaply manufactured. (6) In addition to tools shown in detail, definite recommendations as to cutting speed were given, assuming the material to be of yellow brass cut without use of lubricant. (7) Method of grinding the tool was covered, with caution in regard to keeping it sharp in order to produce a good finish. Directions for grinding tools to cut either hard or soft material were given. (8) Finally, the production per hour was given, and the inquiry was considered answered.

Journalistic service as MACHINERY sees it, is essentially a part of the industry represented. It not only records industrial history and helps make it; not only stimulates and encourages enterprise and progress, but effectively participates in the practical solution of technical and trade problems. Besides the Book and the Torch, which are its emblems, technical journalism must know also the working instruments of the industry.

Roll Hardening

Chester L Lucas

The hardening of large steel rolls used for metal rolling, especially those required in brass mills, jewelry manufacture and kindred lines, presents one of the most difficult branches of the steel hardener's art. A finished roll often represents a cost of several hundred dollars, and the responsibility resting on the hardener is no small matter. The rolls must be hardened without developing flaws, cracks or soft spots, which means that the roll must be heated evenly and to the proper temperature; when dipped, it must be cooled immediately and uniformly. In order to secure the hardness required, the bath is charged with salt and ice. This article describes the method of heating and quenching, testing for hardness, and the grinding and lapping of the rolls after hardening.

THE inspector and the steel hardener travel the same road through life. When things go right, little attention is paid to them, but as soon as trouble arrives, they are the most unpopular men in the shop. Owing to the variation in steel, the treatments it has undergone and the shapes that must be handled, there is a risk attendant upon any steel hardening operation. In hardening rolls for rolling mill use, the roll must be hardened all over to a great depth; therefore this risk is greatly magnified because the steel must be "forced" to secure this ultra-hard condition. The hardener has always before him the possibility of a soft roll or, worse yet, during the anxious moments when the roll is under water, he may hear that sharp cracking sound that indicates that he has a cracked roll on his hands. The Standard Machinery Co. of Providence, R. I., has been a manufacturer of rolling mills for years, and consequently has made a specialty of roll hardening. Through this company's courtesy the operations connected with roll hardening are here described.

Metal Rolling Machinery

The general subject of metal rolling may be roughly divided into two classes: hot rolling and cold rolling. In hot rolling, which is the method used in producing structural iron shapes and other large sections, the rolls used are made of chilled castings. In cold rolling, which is the process employed for reducing the thickness of sheet steel, brass, copper, gold and silver sheets, the rolls are made of tool steel, hardened and finished to a high degree of accuracy in order that the rolled product may be accurate in thickness and finish.

As it is with the latter class of rolls that this article is to deal, one of these rolling mills, a product of the Standard Machinery Co., Providence, R. I., is reproduced in Fig. 4. From this illustration, in conjunction with Fig. 7 which shows a section through the working end of a typical rolling mill, an idea of the way the rolls are supported and driven may be obtained. With this understanding the hardening operation will be better appreciated. The drive of the rolling mill is from a motor beneath the machine, and through a series of reduction gears rotation is transmitted to the lower of the helical gears at the left-hand end of the machine as viewed in Fig. 4. This helical drive smoothly couples the rotation of the two rolls. From the rear end of the machine motion is

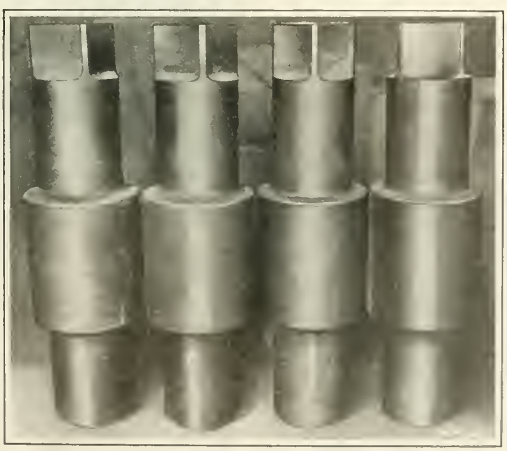


Fig. 1. Two Sets of Rolls ready for hardening

Fig. 2. Packing Roll in Hardening Pot

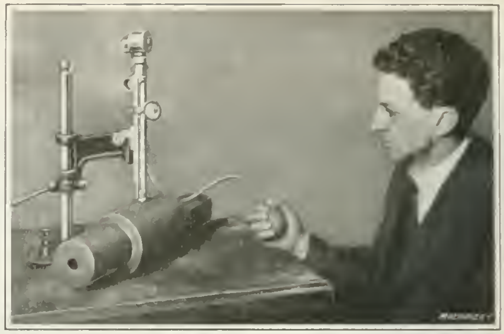


Fig. 3. Testing Hardened Roll with Scleroscope

transmitted to the rolls proper by square bars known as "wabbler" coupling bars. The ends of these bars are loosely fitted in cast couplings that connect the ends of the wabbler bars with the drive at one end and with the rolls at the other. The fit of the couplings is very loose to admit of the vertical adjustment of the rolls in their housings that is necessary to secure varying thicknesses of rolled material. These couplings are made from castings so that, being the weakest members of the drive, they will break before the more expensive parts in case of overload.

The sectional illustration, Fig. 7, is taken through a pair of rolls, 10 inches in diameter by 15 inches long. From the upper part of Fig. 10, which shows this roll in detail, it may be seen that the total length is 37 inches. The journals are 8 inches diameter by 8½ inches long, and the wabbler ends are 5 inches long by 6 inches square.

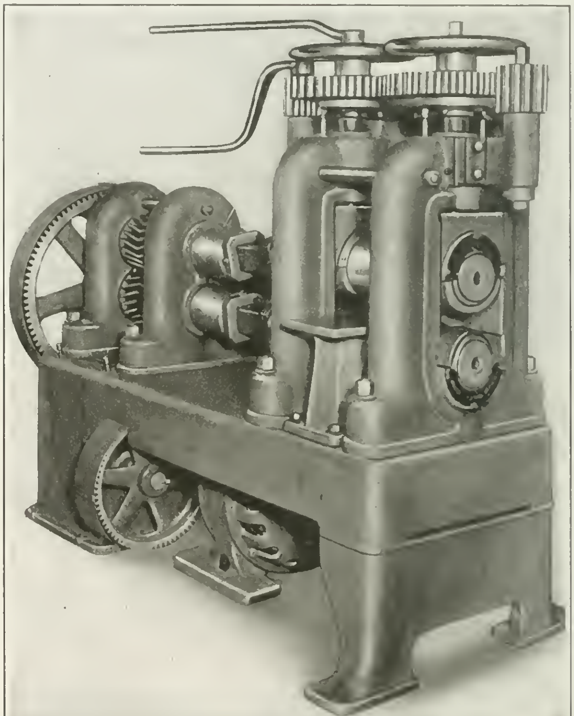


Fig. 4. Standard Machinery Co.'s Rolling Mill

The rolls on Standard Machinery Co.'s rolling mills are mounted in roller bearings, and the roller bearings, in turn, are supported in the housing blocks of the machine. The upper pair of the housing blocks may be raised or lowered to vary the distance between the rolls, thereby governing the thickness of the metal rolled.

Fig. 1 illustrates two pairs of rolls 8 inches in diameter by 10 inches long, and gives a good idea of the proportions of the journals or bearing sections of the roll in comparison with the working surfaces. Fig. 10 gives the actual dimensions of a pair of 10-inch by 15-inch rolls and illustrates different types of wabbler ends that are sometimes employed for driving the rolls instead of the square end. The square wabbler is most commonly used, especially in the smaller sizes of mills, while styles *C* and *D* are used in mills having rolls 12 inches in diameter or over.

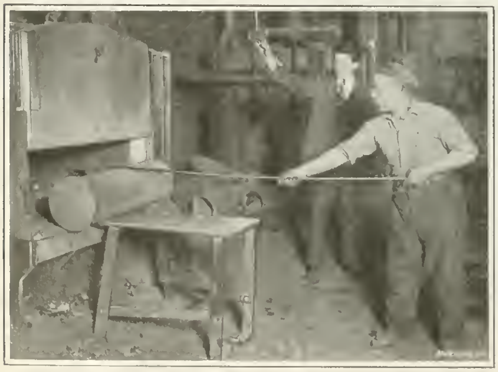


Fig. 5. Starting the Heat

Fig. 6. Putting Roll in Quenching Cradle

Preparing the Rolls

In manufacturing these steel rolls, tool steel of 0.70 to 1.00 per cent carbon is employed. The smaller sizes of rolls are often turned from bar stock, but the larger sizes are first forged to give better structure as well as to save steel. The machining operations on the rolls are not unusual in any way, and consist in turning to within 0.040 to 0.080 inch of the finished size, the amount depending on the size of the roll. The journals are then turned in the same way, and the wabbler ends are milled to the proper shape and size. Before the rolls go into the hardening furnace, they must be prepared by protecting the wabbler ends with fireclay and asbestos, so they will not harden. The fireclay is applied directly to the wabblers and wound in asbestos cloth. Soft iron wire is used to bind the asbestos cloth in place.

As the rolls require heating for from twenty-four to thirty hours according to the size, it is necessary that they be packed in air-tight boxes. Fig. 2 shows how the rolls are packed in charcoal in the heating pots. Several inches of charcoal surround the roll at every point and effectively protect it from oxidizing. Fig. 9 shows how the covers of the pots are luted with fireclay before they go into the furnace.

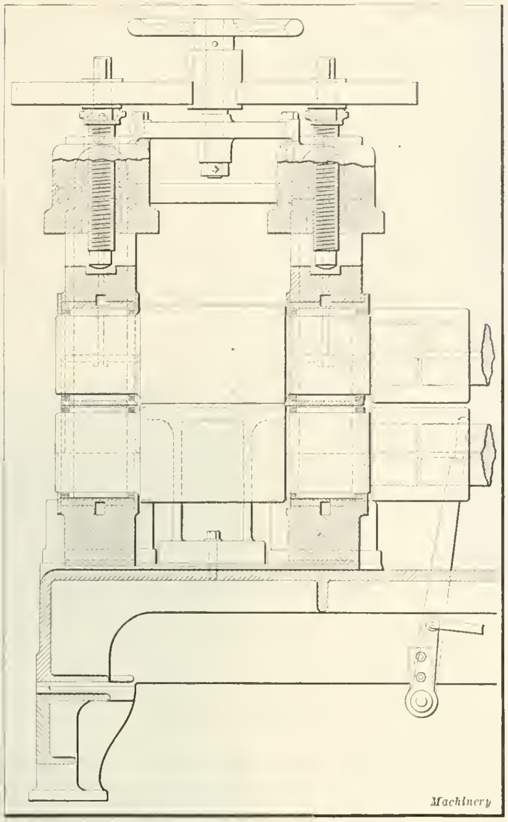


Fig. 7. Section through Head End of Rolling Mill

Heating the Rolls

The heating of the rolls preparatory to hardening is one of the most important steps in the work. The furnaces used are of the oil-burning type, and the front of one of them may be seen in Fig. 5, where the operator is shown charging the furnace. The furnace is brought to a heat of approximately 1000 degrees F. before the roll pots are put in. This temperature is maintained for twelve hours, the pots being frequently turned from time to time to insure an even distribution of heat, and the temperature is then raised to 1500 degrees F. and maintained at this heat for six hours. After this preheating, the temperature is raised to 1650 degrees F. and the heating is continued for another six hours, making a total of twenty-four hours that the rolls are under heat. The heats are carefully checked with a pyrometer and every precaution is taken to insure that the rolls are evenly heated.

Quenching the Rolls

The part of the heat-treatment around which everything else centers is, of course, the quenching, and on account of the nervous strain on the hardener the heats are usually so timed that the rolls will be ready for quenching early in the morning. When he has finished a lot of rolls he quits for the day.

A roll pot is pulled from the furnace, the cover is knocked off, and the roll suspended in a "cradle" ready for quenching. One of the cradles may be seen in Fig. 6, which shows the roll in place just after removal from the heating pot. The cradle consists of a special pair of tongs, the bottom part of which is in the form of a ring to receive loosely one journal of the roll. The two arms of the tongs are brought up to encircle the second journal and prevent it from tipping out of its vertical position. At no point is there a close contact and the working surface of the roll is not touched by the cradle in any way. The opening of the heating pot and the mounting of the roll in the cradle is done, of course, in the quickest possible time so that the roll surface will have no chance to oxidize.

As these rolls range from 150 to 250 pounds in weight, it will be seen that some means must be at hand for handling them more quickly than would be possible with a chain block while they are being quenched. At one side of the quenching tank there is a post about six feet high that acts as a fulcrum for a long oak beam. The short end of this lever is directly over the quenching tank and from it is suspended a hook through which the cradle and the roll to be hardened may be suspended. The opposite end of this long lever is provided with pulley ropes and is manned by two or three laborers just before the roll is quenched.

The quenching tank is six feet in diameter and nine feet deep, and is filled with a saturated brine solution. The tank is provided with a circulating system for keeping the brine cool, and, in addition, a number of small cakes of ice are thrown into the tank just before the hardening operation is commenced.

Fig. 8. Quenching the Roll

As soon as possible after the roll has been taken from the heating pot and mounted in the cradle, it is attached to the hook on the dipping beam and quickly plunged under the surface of the brine in the tank. The laborers on the opposite end of the dipping beam slowly raise and lower the roll, not allowing it to appear above the surface of the brine. This motion is kept up for fifteen minutes, and it is then allowed to remain in the water for about ten minutes. The time varies slightly with the size of the roll being

Fig. 9. Luting Cover in Place preparatory to heating Roll

quenched. After the expiration of this time the roll is transferred from the brine tank to the oil tank for drawing the temper. The oil in this tank is a heavy fish oil and is kept at a temperature of 400 degrees F. The roll is allowed to remain in the tempering oil for from one-half hour to three hours, according to the size. It is then removed and wrapped in heavy burlap and allowed to cool gradually to the temperature of the room.

Testing for Hardness

In testing rolls for hardness, the file is used for surface tests and the scleroscope for checking the degree and depth of hardness. The old way of testing a hardened roll was to strike it a good blow with a two-pound ball peen hammer. If the surface of the roll did not dent under this blow it was considered of sufficient hardness. The scleroscope method is more exacting though less heroic in its operation. Fig. 3 shows the roll under the scleroscopic test, and it must produce a reading of from 85 to 95 on all surfaces to be adjudged of sufficient hardness for the work it must do.

Grinding and Lapping Rolls

The next operations on the rolls before they are inserted in the rolling mill are grinding and lapping. The grinding is an ordinary operation, and consists in finishing on a cylindrical grinder, removing from 0.040 to 0.080 inch, according to the size and condition of the roll. The journals are ground nearly as carefully as the working surfaces of the rolls. After the roll surface has been ground as fine as possible, it is lapped on a cylindrical grinder that is kept apart for that purpose. The lapping is done with a lead lap about 12 inches in diameter, having a one-inch face. Thus the lapping operation is also a cylindrical grinding job in which a charged lead disk is used instead of an abrasive wheel. Crocus and oil are used in paste form, and the lapping operation is continued until the surface is mirror-like in its finish. To lap a roll successfully, the machine on which the work is done must be in a part of the shop where it will not be affected by the slightest vibration. This operation completes the manufacture of the roll, and it is now ready for its place in the rolling mill.

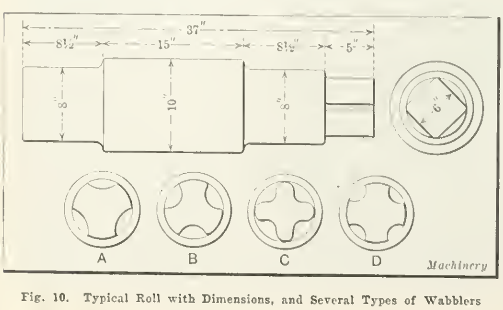
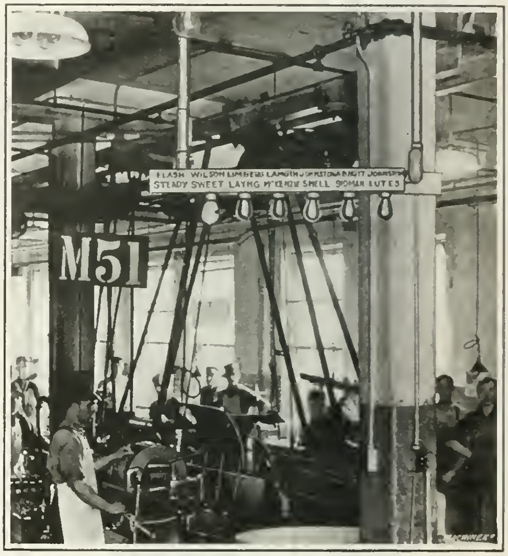


Fig. 10. Typical Roll with Dimensions, and Several Types of Wabblers

FACTORY CALL SYSTEM

Attention has frequently been called to the harmful effects of noise upon the efficiency of workmen. The fact has been fairly well established that both the amount and quality of product turned out in an excessively noisy shop will be inferior to that produced under better working conditions. Investigators have also reached the conclusion that the number of accidents occurring in a shop where there is a great amount of noise is likely to be abnormally large.

For the purpose of calling officials while out in the factory, the Cadillac Motor Car Co., Detroit, Mich., uses a signal light system which entirely does away with the noise incident to many call systems. It will be seen that this consists of a series of colored electric lights which are operated from the telephone switchboard, and that each light provides for calling two men according to whether it is flashed on and off or allowed to glow steadily. As this system is simple and economical, and does not add to the noise in the shop, it is one that should commend itself to the attention of many manufacturers. E. K. H.



Signal Lamp System for calling Men to Telephone

* * *

IMPROVED INTERNAL TRANSPORTATION FACILITIES

A twenty-story hotel, costing $9,000,000, will be erected opposite the Pennsylvania Station, New York City. When completed the hotel will contain 2200 rooms. It will be located on Seventh Ave., between 32nd and 33rd Sts. A subway station connecting with the hotel basement will give access to the new subway system and a tunnel will connect it with the Pennsylvania Station opposite. It will be possible for a guest to go to any part of the city reached by the subway system, or to take trains for the West, South, North or New England without going from under cover. The local and long-distance transportation facilities are nearly ideal. This is in refreshing contrast to the time—not so long ago—when each city and town tried to make it difficult for a traveler to pass through on his journey without spending much money for lodging, food and local transportation. The modern theory of efficiency is directly opposed to the old obstructionist's idea. A great city like New York gains by facilitating the transaction of business. The traveler who can go about easily and cheaply and who is properly taken care of while he is within the "city's gates" will, in the end, be more profitable than he who is cheated and tricked, delayed in the transaction of his business and met at every turn by demands for "baksheesh."

JIG AND FIXTURE DETAILS—CLAMPS AND STRAPS

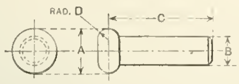
STANDARDS USED BY GENERAL ELECTRIC CO.

BY R. F. POHLE*

IN the design of jigs and fixtures, there are a great many details that may be standardized. Tables I to V show dimensions used for different kinds of pins used in jig design. These tables embody the practice of the General Electric Co., at Lynn, Mass., the standards having been developed by R. F. Pohle, in charge of one of the tool designing departments.

* Address: General Electric Co., Lynn, Mass.

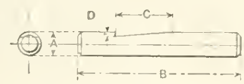
TABLE I. JIG STOP-PINS



A	B	C	D
1/4	0.1885	3/8 to 5/8	1/16
5/16	0.1885	1/2 to 3/4	3/32
3/8	0.251	1/2 to 3/4	3/32
7/16	0.3135	1/2 to 1 1/16	3/32
1/2	0.376	1/2 to 1 1/4	3/32
9/16	0.4385	5/8 to 1 3/8	1/8
5/8	0.501	3/4 to 1 1/2	1/8
3/4	0.564	7/8 to 2	5/32
7/8	0.6265	7/8 to 2	5/32
1	0.7515	1 to 2 1/8	3/16

Machinery

TABLE II. MILLED SPRING-PINS



A	B	C	D
0.1865	3/4 to 1 1/2	3/8	3/64
0.249	1 to 2	1/2	1/16
0.3115	1 1/4 to 2 1/2	11/16	5/64
0.374	1 1/2 to 3 1/2	3/4	3/32
0.4365	1 3/4 to 4 1/2	7/8	3/32
0.499	2 to 5 1/2	1	7/64
0.5615	2 1/4 to 6 1/2	1	1/8
0.623	2 1/2 to 7 1/2	1 1/8	5/32
0.748	2 3/4 to 8 1/2	1 1/4	5/32
0.873	3 to 9	1 3/8	3/16
0.998	3 to 9 1/2	1 5/8	3/16

Machinery

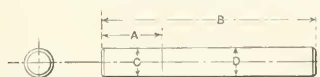
TABLE III. TAPER HINGE-PINS

1/8" TAPER PER FOOT

A	B	A	B	A	B
5/8 to 1	0.107	3/4 to 1 1/2	0.176	1 3/8 to 3 1/8	0.325
3/4 to 1 1/8	0.121	3/4 to 2	0.202	2 1/8 to 3 5/8	0.384
3/4 to 1 1/4	0.137	1 to 2 3/8	0.234	2 3/4 to 4 1/2	0.451
3/4 to 1 1/2	0.155	1 to 2 1/2	0.276	2 3/4 to 4 3/4	0.532

Machinery

TABLE IV. STRAIGHT HINGE-PINS

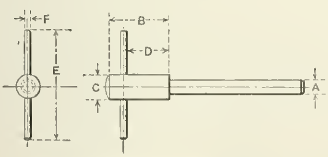


A = ABOUT 2D

B	C	D	B	C	D
1/2 to 1 1/2	0.126	0.124	1 3/4 to 4 1/2	0.376	0.374
1/2 to 1 3/4	0.1572	0.1552	2 to 5	0.4385	0.4365
3/4 to 2	0.1885	0.1865	2 1/4 to 5 1/2	0.5015	0.4985
1 to 2 1/2	0.2197	0.2177	3 to 6 1/2	0.6265	0.6235
1 1/4 to 3	0.251	0.249	3 1/2 to 7 1/2	0.7515	0.7485
1 1/2 to 4	0.3135	0.3115			

Machinery

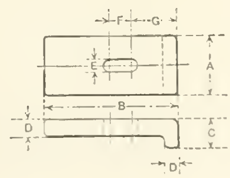
TABLE V. JIG DRAW-PINS



A	B	C	D	E	F
0.750	2	15/16	1 1/4	3	1/4
0.7812	2	15/16	1 1/4	3	1/4
0.8125	2 1/8	1	1 3/8	3 1/8	1/4
0.8437	2 1/8	1	1 3/8	3 1/8	1/4
0.875	2 1/4	1 1/16	1 1/2	3 1/4	1/4
0.9062	2 1/4	1 1/16	1 1/2	3 1/4	1/4
0.9375	2 3/8	1 1/8	1 5/8	3 1/2	5/16
0.9687	2 3/8	1 1/8	1 5/8	3 1/2	5/16
1.000	2 1/2	1 1/4	1 3/4	3 3/4	5/16
1.0625	2 1/2	1 1/4	1 3/4	3 3/4	5/16
1.125	2 5/8	1 3/8	1 3/4	4	5/16
1.1875	2 5/8	1 3/8	1 3/4	4	5/16
1.250	2 3/4	1 1/2	1 7/8	4 1/4	3/8
1.3125	2 3/4	1 1/2	1 7/8	4 1/4	3/8
1.375	2 7/8	1 5/8	1 7/8	4 1/2	3/8
1.4375	2 7/8	1 5/8	1 7/8	4 1/2	3/8
1.500	3	1 13/16	2	4 3/4	3/8

Machinery

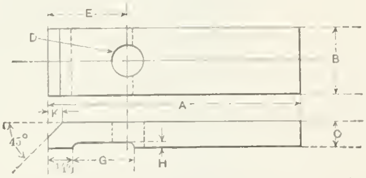
TABLE VI. FORGED STRAPS



A	B	C	D	E	F	G
3/4	1 11/16 to 1 15/16	3/8	1/4	21/64	3/8	7/16
3/4	2 3/16 to 2 7/16	3/8	1/4	21/64	1/2	7/16
15/16	1 11/16 to 2 3/16	7/16	5/16	21/64	1/2	1/2
15/16	2 7/16 to 2 15/16	7/16	5/16	21/64	3/4	5/8
1 1/8	2 to 2 3/4	1/2	3/8	25/64	1/2	5/8
1 1/8	3 1/8 to 3 1/2	1/2	3/8	25/64	3/4	3/4
1 1/4	2 1/2 to 3	3/4	1/2	33/64	1/2	1
1 1/4	3 1/2 to 4	3/4	1/2	33/64	3/4	1
1 1/4	4 1/2 to 5	3/4	1/2	33/64	1	1
1 1/2	3 1/2 to 4	1	5/8	41/64	3/4	1 1/4
1 1/2	4 1/2 to 5	1	5/8	41/64	1 1/8	1 1/4
1 1/2	5 1/2 to 6	1	5/8	41/64	1 1/2	1 1/4
1 3/4	4 to 4 3/4	1 1/4	3/4	49/64	1	1 3/8
1 3/4	5 1/2 to 6 1/4	1 1/4	3/4	49/64	1 1/2	1 3/8
1 3/4	7 to 7 3/4	1 1/4	3/4	49/64	2	1 3/8

Machinery

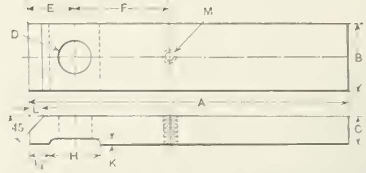
TABLE VII. CLAMP STRAPS



A	B	C	D	E	G	H	K
1 15/16	15/16	5/16	5/16	3/4	1/2	1/16	1/8
2 7/16	15/16	3/8	5/16	7/8	1/2	1/16	1/8
2 15/16	15/16	7/16	5/16	1	1/2	1/16	1/8
3 7/16	15/16	1/2	5/16	1 1/4	1/2	3/32	3/16
4 3/16	15/16	9/16	5/16	1 1/2	1/2	3/32	3/16
2	1 1/8	3/8	3/8	3/4	9/16	3/32	1/8
2 1/2	1 1/8	7/16	3/8	1	9/16	3/32	1/8
3	1 1/8	1/2	3/8	1 1/8	5/8	3/32	3/16
3 3/4	1 1/8	9/16	3/8	1 1/4	5/8	1/8	3/16
5	1 1/8	5/8	3/8	1 1/2	3/4	1/8	1/4
2 3/16	1 3/16	7/16	7/16	3/4	5/8	3/32	3/16
2 11/16	1 3/16	1/2	7/16	1	5/8	3/32	3/16
3 3/16	1 3/16	9/16	7/16	1 1/8	3/4	3/32	1/4
3 15/16	1 3/16	5/8	7/16	1 1/4	3/4	1/8	1/4
5 3/16	1 3/16	11/16	7/16	1 1/2	7/8	1/8	5/16
2 1/4	1 1/4	1/2	1/2	3/4	5/8	3/32	3/16
2 3/4	1 1/4	9/16	1/2	1	5/8	3/32	3/16
3 1/4	1 1/4	5/8	1/2	1 1/8	3/4	3/32	1/4
4	1 1/4	11/16	1/2	1 1/4	3/4	1/8	1/4
5 1/4	1 1/4	3/4	1/2	1 1/2	1	1/8	5/16
6 3/4	1 1/4	13/16	1/2	2	1	1/8	5/16
4 5/16	1 7/16	5/8	5/8	1 1/4	3/4	1/8	1/4
5 5/16	1 7/16	11/16	5/8	1 1/2	7/8	1/8	5/16
6 5/16	1 7/16	3/4	5/8	1 7/8	7/8	1/8	5/16
7 5/16	1 7/16	13/16	5/8	2 1/4	1	1/8	3/8
8 5/16	1 7/16	7/8	5/8	2 3/4	1	1/8	3/8

Machinery

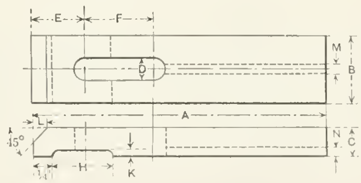
TABLE VIII. LATCH STRAPS



A	B	C	D	E	F	H	K	L	M Diameter and Number of Threads per Inch
1 15/16	15/16	5/16	1/2	9/16	1	1/2	1/16	1/8	No. 14—24
2 7/16	15/16	3/8	1/2	3/4	1	1/2	1/16	1/8	No. 14—24
2 15/16	15/16	7/16	1/2	1	1	1/2	1/16	1/8	No. 14—24
3 7/16	15/16	1/2	1/2	1	1	1/2	3/32	3/16	No. 14—24
4 3/16	15/16	9/16	1/2	1	1	1/2	3/32	3/16	No. 14—24
2	1 1/8	3/8	1/2	5/8	1	9/16	3/32	1/8	No. 14—24
2 1/2	1 1/8	7/16	1/2	3/4	1	9/16	3/32	1/8	No. 14—24
3	1 1/8	1/2	1/2	1	1	5/8	3/32	3/16	No. 14—24
3 3/4	1 1/8	9/16	1/2	1 1/4	1	5/8	1/8	3/16	No. 14—24
5	1 1/8	5/8	1/2	1 1/4	1	3/4	1/8	1/4	No. 14—24
2 3/16	1 3/16	7/16	5/8	3/4	1	5/8	3/32	3/16	No. 14—24
2 11/16	1 3/16	1/2	5/8	1	1	5/8	3/32	1/4	No. 14—24
3 3/16	1 3/16	9/16	5/8	1 1/8	1	3/4	3/32	1/4	No. 14—24
3 15/16	1 3/16	5/8	5/8	1 1/4	1	3/4	1/8	1/4	No. 14—24
5 3/16	1 5/16	11/16	5/8	1 3/8	1	7/8	1/8	5/16	No. 14—24
2 1/4	1 1/4	1/2	3/4	3/4	1 1/8	5/8	3/32	3/16	5/16—18
2 3/4	1 1/4	9/16	3/4	1	1 1/8	5/8	3/32	3/16	5/16—18
3 1/4	1 1/4	5/8	3/4	1 1/8	1 1/8	3/4	3/32	1/4	5/16—18
4	1 1/4	11/16	3/4	1 3/8	1 1/8	3/4	1/8	1/4	5/16—18
5 1/4	1 1/4	3/4	3/4	1 1/2	1 1/8	1	1/8	5/16	5/16—18
6 3/4	1 1/4	13/16	3/4	1 3/4	1 1/8	1	1/8	5/16	5/16—18
4 5/16	1 7/16	5/8	7/8	1	1 1/4	3/4	1/8	1/4	5/16—18
5 5/16	1 7/16	11/16	7/8	1 1/2	1 1/4	7/8	1/8	5/16	5/16—18
6 5/16	1 7/16	3/4	7/8	1 3/4	1 1/4	7/8	1/8	5/16	5/16—18
7 5/16	1 7/16	13/16	7/8	2	1 1/4	1	1/8	3/8	5/16—18
8 5/16	1 7/16	7/8	7/8	2	1 1/4	1	1/8	3/8	5/16—18

Machinery

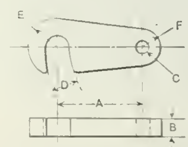
TABLE IX. SLIDE STRAPS



A	B	C	D	E	F	H	K	L	M	N
1 15/16	15/16	5/16	11/32	9/16	3/8	1/2	1/16	1/8	3/16	1/8
2 7/16	15/16	3/8	11/32	9/16	1/2	1/2	1/16	1/8	3/16	1/8
2 15/16	15/16	7/16	11/32	9/16	3/4	1/2	1/16	1/8	3/16	1/8
3 7/16	15/16	1/2	11/32	9/16	1	1/2	3/32	3/16	3/16	1/8
4 3/16	15/16	9/16	11/32	9/16	1 3/8	1/2	3/32	3/16	3/16	1/8
2	1 1/8	3/8	13/32	9/16	3/8	9/16	3/32	1/8	3/16	1/8
2 1/2	1 1/8	7/16	13/32	9/16	1/2	9/16	3/32	1/8	3/16	1/8
3	1 1/8	1/2	13/32	9/16	3/4	5/8	3/32	3/16	3/16	1/8
3 3/4	1 1/8	9/16	13/32	9/16	1 1/8	5/8	1/8	3/16	3/16	1/8
5	1 1/8	5/8	13/32	9/16	1 3/4	3/4	1/8	1/4	3/16	1/8
2 1/2	1 1/8	7/16	13/32	9/16	1/2	9/16	3/32	1/8	3/16	1/8
2 11/16	1 3/16	1/2	15/32	5/8	1/2	5/8	3/32	3/16	3/16	1/8
3 3/16	1 3/16	9/16	15/32	5/8	3/4	3/4	3/32	1/4	3/16	1/8
3 15/16	1 3/16	5/8	15/32	5/8	1 1/8	3/4	1/8	1/4	3/16	3/16
5 3/16	1 3/16	11/16	15/32	5/8	1 3/4	7/8	1/8	3/16	3/16	3/16
2 1/4	1 1/4	1/2	17/32	5/8	3/8	5/8	3/32	3/16	1/4	3/16
2 3/4	1 1/4	9/16	17/32	5/8	1/2	5/8	3/32	3/16	1/4	3/16
3 1/4	1 1/4	5/8	17/32	5/8	3/4	3/4	3/32	1/4	1/4	3/16
4	1 1/4	11/16	17/32	5/8	1 1/8	3/4	1/8	1/4	1/4	1/4
5 1/4	1 1/4	3/4	17/32	5/8	1 3/4	1	1/8	5/16	1/4	1/4
6 3/4	1 1/4	13/16	17/32	5/8	2 1/2	1	1/8	5/16	1/4	1/4
4 5/16	1 7/16	5/8	21/32	3/4	1 1/8	3/4	1/8	1/4	1/4	3/16
5 5/16	1 7/16	11/16	21/32	3/4	1 3/4	7/8	1/8	5/16	1/4	3/16
6 5/16	1 7/16	3/4	21/32	3/4	2	7/8	1/8	5/16	1/4	1/4
7 5/16	1 7/16	13/16	21/32	7/8	2 1/2	1	1/8	3/8	1/4	1/4
8 5/16	1 7/16	7/8	21/32	7/8	2 3/4	1	1/8	3/8	1/4	1/4

Machinery

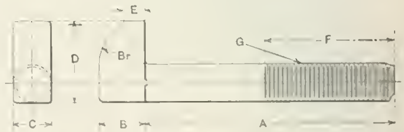
TABLE X. LATCHES



A	B	C	D	E	F
1	1/4	1/4	9/32	3/8	1/4
1	1/4	1/4	11/32	3/8	1/4
1 1/8	5/16	5/16	13/32	7/16	5/16
1 1/4	3/8	5/16	15/32	9/16	5/16

Machinery

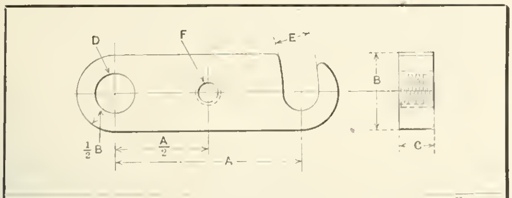
TABLE XI. HOOK BOLTS



A	B	C	D	E	F	G Diameter and Number of Threads per Inch
1 1/2 to 4	7/16	3/8	13/16	3/16	1 1/8	3/8—16
1 3/4 to 5	9/16	1/2	1 1/16	1/4	1 3/8	1/2—13
2 to 7	11/16	5/8	1 5/16	5/16	1 5/8	5/8—11
2 1/2 to 8	13/16	3/4	1 9/16	3/8	2	3/4—10
3 1/4 to 9 1/4	15/16	7/8	1 13/16	7/16	2 1/4	7/8— 9
4 to 10 1/2	1 1/16	1	2 1/16	1/2	2 1/2	1 — 8

Machinery

TABLE XII. SWING STRAPS



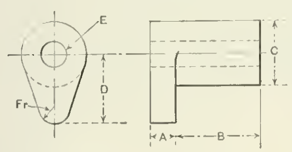
A	B	C	D	E	F Diameter and Number of Threads per Inch
2 to $2\frac{15}{16}$	$\frac{3}{4}$	$\frac{3}{8}$	0.375	$\frac{13}{32}$	$\frac{5}{16}$—18
3 to $3\frac{15}{16}$	1	$\frac{7}{16}$	0.500	$\frac{17}{32}$	$\frac{3}{8}$—16
4 to $4\frac{15}{16}$	1	$\frac{1}{2}$	0.500	$\frac{17}{32}$	$\frac{1}{2}$—13
5 to 6	$1\frac{1}{4}$	$\frac{5}{8}$	0.625	$\frac{21}{32}$	$\frac{1}{2}$—13

Machinery

Jig Stop-pins

The function of jig stop-pins is, as the name implies, to stop the work in a predetermined location. This location is determined with reference to the guides or locating surfaces. The type of jig stop-pin illustrated and tabulated in Table I is particularly adapted for locating castings and other work with a rough exterior, since it presents a minimum of contact surface and is therefore less likely to stop the work against any rough high spots.

TABLE XIII. SWING HOOK STRAPS



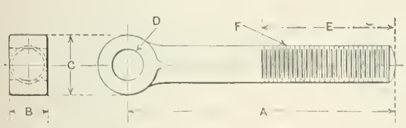
A	B	C	D	E	F
$\frac{7}{32}$	$\frac{1}{4}$ to 1	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{13}{64}$	$\frac{1}{8}$
$\frac{1}{4}$	$\frac{5}{16}$ to 1	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{17}{64}$	$\frac{3}{16}$
$\frac{5}{16}$	$\frac{1}{2}$ to $1\frac{1}{2}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{21}{64}$	$\frac{3}{16}$
$\frac{3}{8}$	$\frac{1}{2}$ to 2	$\frac{7}{8}$	$\frac{15}{16}$	$\frac{25}{64}$	$\frac{1}{4}$
$\frac{7}{16}$	$\frac{5}{8}$ to $2\frac{1}{4}$	1	$1\frac{1}{16}$	$\frac{29}{64}$	$\frac{5}{16}$
$\frac{1}{2}$	$\frac{3}{4}$ to $2\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{3}{16}$	$\frac{33}{64}$	$\frac{3}{8}$
$\frac{5}{8}$	$\frac{7}{8}$ to 3	$1\frac{5}{16}$	$1\frac{3}{8}$	$\frac{41}{64}$	$\frac{1}{2}$
$\frac{3}{4}$	1 to $3\frac{1}{2}$	$1\frac{9}{16}$	$1\frac{11}{16}$	$\frac{49}{64}$	$\frac{9}{16}$

Machinery

Spring-pins

It is often necessary to support rough work at more than three points, but owing to the fact that it cannot be relied upon to bear at more than three points, the other bearing points must be made adjustable. The dimensions of spring-pins given in Table II will be found suitable for devices in which designs of this kind are required.

TABLE XIV. SWING BOLTS



A	B	C	D	E	F Diameter and Number of Threads per Inch
$1\frac{1}{2}$ to $2\frac{13}{16}$	$\frac{3}{16}$	$\frac{1}{4}$	0.125	$\frac{3}{4}$	No. 10—32
$1\frac{1}{2}$ to $3\frac{1}{2}$	$\frac{1}{4}$	$\frac{7}{16}$	0.1875	$\frac{7}{8}$	No. 14—24
$1\frac{1}{2}$ to 4	$\frac{3}{8}$	$\frac{5}{8}$	0.3125	$1\frac{1}{8}$	$\frac{3}{8}$—16
$1\frac{3}{4}$ to 5	$\frac{1}{2}$	$\frac{3}{4}$	0.375	$1\frac{3}{8}$	$\frac{1}{2}$—13
2 to 7	$\frac{5}{8}$	$\frac{15}{16}$	0.500	$1\frac{5}{8}$	$\frac{5}{8}$—11
$2\frac{1}{2}$ to 8	$\frac{3}{4}$	$1\frac{1}{8}$	0.625	2	$\frac{3}{4}$—10
$3\frac{1}{4}$ to $9\frac{1}{4}$	$\frac{7}{8}$	$1\frac{1}{4}$	0.750	$2\frac{1}{4}$	$\frac{7}{8}$— 9
4 to $10\frac{1}{2}$	1	$1\frac{3}{8}$	0.8125	$2\frac{1}{2}$	1 — 8

Machinery

Hinge-pins

There are two types of clamp and jig cover hinge-pins in general use—the straight hinge-pin and the taper hinge-pins. The straight hinge-pin is used more than the tapered pin on account of the expense of making the latter, and of the reaming of a corresponding tapered hole. The reason for making tapered pins is to compensate for wear. The usual taper is $\frac{1}{8}$ inch per foot; the usual taper of ordinary taper pins—$\frac{1}{4}$ inch per foot—is too great for this purpose. Straight pins are made from high-carbon steel. They are not hardened, but are ground to a running fit with the exception of one end, which may be made a drive fit for a length equal to two diameters of the pin. When the practice is to bore out the holes for the hinge-pins, pins less than 7/16 inch in diameter should be avoided, because smaller pins would necessitate the use of boring tools that would not be rigid enough to insure a true hole.

Clamps and Straps

Plain horizontal clamps or straps for use on finished surfaces are shown in Tables VII to IX. The style shown in Table VII is intended for use with work where it is desired to swing the strap around the clamp-screw in order to clear the work. The latch strap, Table VIII, is used in combination with a latch —Table X—and a shoulder screw. The under side of these straps is relieved; otherwise, if the straps should spring under the pressure of the clamping screw, the strap would bear on the edge of the work. The other types of straps and clamping bolts are used for special requirements, whenever the design permits.

* * *

COST OF HIGH-EXPLOSIVE SHELLS

The prices paid for high-explosive shells of various sizes differ greatly in this country, Canada and Great Britain. The accompanying table gives the prices paid in February for British high-explosive shell bodies and forgings, varying from the 15-pound up to the 6-inch high-explosive. In referring to this table, it will be noticed that the Canadian manufacturers have greatly reduced the cost of both forgings and machined shell bodies. The 4.5-inch shell forging has been reduced several times; the first lot was placed at $4.25, the second at $3.60, and the price now paid is $2.95. The price then being paid for complete rounds of 15-pound British shrapnel was $16.85. Twenty-two million shells had been turned out up to this time by Canadian manufacturers, consuming 800,000,000 pounds of steel, 45,000,000 pounds of brass, zinc and copper, 22,000,000 pounds of copper alone, 102,000,000 pounds of lead, 400,000,000 pounds of black powder, 10,000,000 pounds of cordite, 11,000,000 pounds of trinituoluene and 4,000,000 pounds of other explosives. More than 1,100,000 shells are being shipped monthly by Canadian manufacturers, and the total shell orders received amount to approximately $350,000,000.

COST OF BRITISH HIGH-EXPLOSIVE SHELLS

Size of Shell	Operation	Cost in U. S. A.	Cost in Canada	Cost in G. Britain
15-pound	Forging and Machining	.....	$8.30	.....
18-pound	Forging and Machining	.....	8.50	.....
18-pound	Machining	.....	1.85	$3.81
4.5-inch	Forging and Machining	$9.81	7.45	10.33
4.5-inch	Forging	.....	2.95	4.50
6-inch	Machining and Forging	.....	16.85	19.94
6-inch	Forging	.....	7.50	9.73

Machinery

* * *

The total resistance to shear when cutting hot steel may be obtained by the following formula:

$$R = 1.1\left(\frac{5000}{\sqrt{A}} \times A\right)$$

in which

A = area of cross-section in square inches;

R = total resistance to shear in pounds.

GROUP INSURANCE PLAN OF THE CHAIN BELT CO.

The Chain Belt Co., Milwaukee, Wis., manufacturer of chain belts, sprocket wheels, elevating and conveying machinery, concrete mixers, etc., has developed a new plan of group insurance. Under the single policy written by the company each employe who has been with the concern two years or more is given a straight life insurance to the amount of $1000, and those who have been employed less than two years are insured for $500. In the latter class those who complete two years' service will be given the $1000 policy. William C. Frye, president of the company, has written a letter to each employe, from which the following extract is taken:

In order to show our appreciation of loyal and efficient service, I have been instructed by the board of directors to announce that the Chain Belt Co. has contracted with the Equitable Life Assurance Society to insure the lives of those between the ages of twenty-one and sixty-five who have been in our employ continuously for one year or more on April 20, 1916, for the sum of $500, and those who have been in our employ continuously for two years on April 20, 1916, for the sum of $1000 each. In the case of the employe who has been with the company for one year a substitute certificate for $1000 will be given her or him when the term of continued employment will have reached the two-year period. All new employes over twenty-one years of age will receive a certificate for $500 after one year's service. When an employe leaves the insurance expires.

This is time insurance and is given without charge, and in the event of death while the policy is in force the beneficiary named will be paid the amount of the policy by the insurance company. It will be issued for the year ending April 20, 1917, but it is our intention to renew from year to year unless it shall prove unsatisfactory or experience suggests an amendment.

* * *

The Bureau of the Census, Department of Commerce, Washington, D. C., reports that ninety-four establishments were engaged in the manufacture of motorcycles, bicycles and parts during 1914. The value of their products amounted to $25,486,942. The total number of establishments engaged in the manufacture of motorcycles, bicycles and parts in 1909 was 122, but the total value of their products amounted to only $12,069,687. The number of motorcycles produced in 1914 was 62,793, valued at $12,306,447; and 398,899 bicycles, valued at $5,361,229.

DAVID BROWN & SONS WORM GRINDER

For the purpose of correcting worm threads which have been distorted in hardening, David Brown & Sons, Ltd., of Lockwood, Huddersfield, England, have developed the grinding machine shown in the accompanying illustrations. The work to be ground is rotated on fixed centers and traversed past the grinding wheel. The machine is driven by a single friction pulley *A*, Fig. 2, from which power is transmitted to gear-box *B* that gives ten changes of speed. From the gear-box, motion is carried through a worm and wheel *C*, Fig. 4, which rotates driving plate *D* of the fixed head *E*. The required lead for the worm thread is obtained by change-gears mounted on studs *F* at the top of fixed head *E*, the motion being transmitted through the differential gear *G*, Fig. 5, to a lead-screw.

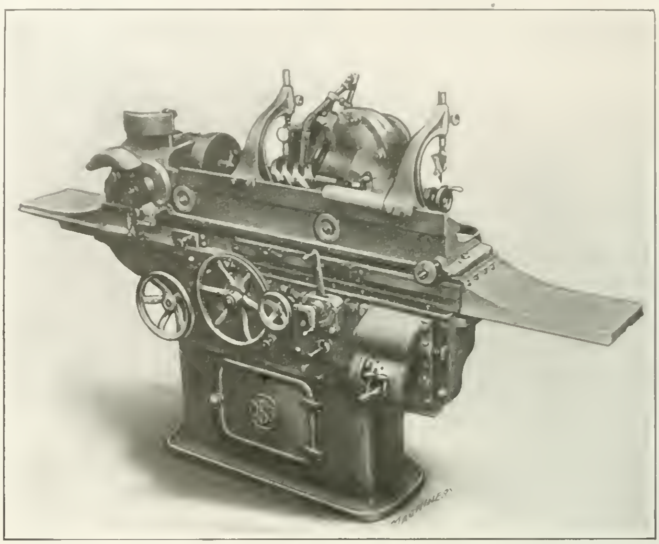


Fig. 1. Front View of David Brown & Sons Worm Grinder, showing Feature of Centralized Control

While the worm is being moved past the grinding wheel by a combination of traverse and rotary movements, the worm thread is ground by the face of wheel *H*. The wheel spindle is driven by pulley *J* from which the power is transmitted through bevel gears; and the wheel head is so designed that the wheel may be easily set in the proper relation to the worm thread both as regards the spiral angle and thread angle. The spiral angle is governed by the position of the wheel spindle which is adjusted by the vertical circular slide *K*, and by the horizontal slide in base *L*. The method of setting the spindle will be best understood by referring to Figs. 2 and 3.

With the preceding general statement of the features of the machine as a guide, we are in a position to take up certain interesting details of its construction. The grinding operation is performed while the worm is traversed past the wheel by a feed motion obtained from gear-box *B*, but the return motion is effected through a direct drive and is at high speed. The trip gear, which is operated automatically by a dog and lever, causes a high-speed clutch to engage and rapidly withdraw the grinding wheel at the moment of reversal. At the end of the return stroke the trip gear causes another reversal and allows the grinding wheel to approach the worm thread until it reaches a micrometer stop. During the quick-return stroke the differential comes into action and causes the worm to be automatically indexed for grinding the next thread. The index change-gears are shown at *N* and the

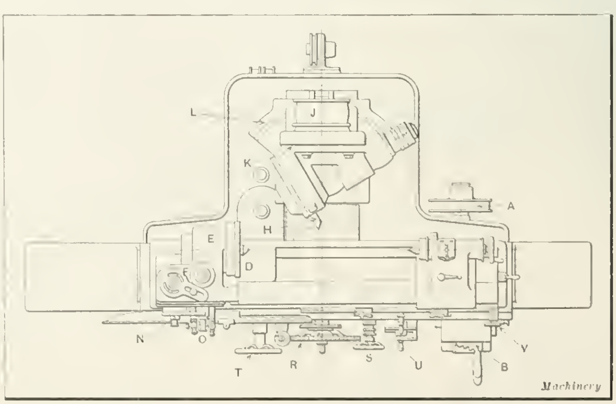


Fig. 2. Plan View of Worm Grinding Machine shown in Figs. 1 and 3

index trip gear at O. Provision is made for eliminating backlash during the quick-return stroke. Right- or left-hand worms may be ground by making suitable adjustment.

It will be evident from Fig. 1 that all handwheels and levers are located at the front of the machine. The central handwheel R controls the automatic movement of the grinding wheel head. Handwheel S is fitted with a micrometer adjustment accurate to 0.0001 inch, and provides for feeding the grinding wheel laterally to the work. This is a special feature designed to retain the correct shape of the worm thread. When the automatic movements are not required, the machine can be operated by hand by means of handwheel T. Lever U provides for stopping all movements at the end of the next quick-return stroke, so that the attendant may have time to gage the work. Then after the gaging has been completed, lever U is once more employed to start the machine upon its next cycle of operations. The top table is pivoted at one end to provide for correction of its parallelism, and it is set for taper grinding by making a proper adjustment of screw V. It will be evident that care has been taken to protect all slides and bearings from damage through abrasive dust finding its way between the working parts.

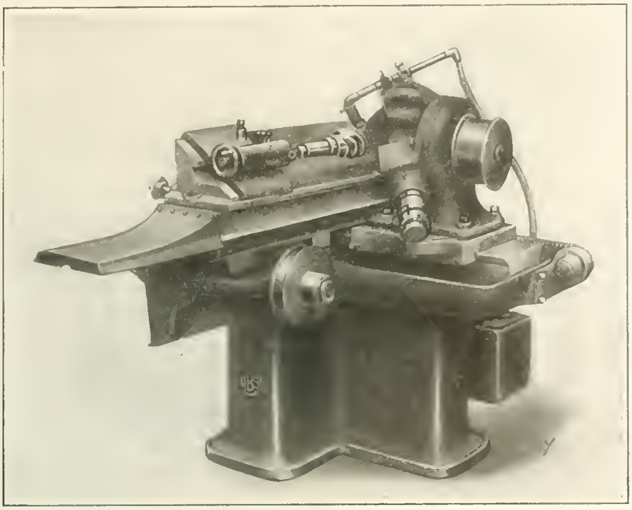


Fig. 3. Rear View of Worm Grinder, showing Work, Single Pulley Drive, and Arrangement of Wheel Head

* * *

SCIENTIFIC CLOCK REPAIRING

The repairing of clocks is looked on as a tinker's job, but a skilled mechanic may devote his attention to scientific clock repairing quite profitably. An eight-day clock had been in use about two years when it began to give trouble by stopping. The representative of the clock maker was called in, and he tinkered with the clock two or three times, but did not stop the trouble. The claim was made that the vibration of the twelve-story building interfered with the beat of the pendulum and when the movements of the building coincided with those of the pendulum the inevitable result was stopping. The owner of the clock was "from Missouri," and he called in an expert. The expert was of the investigating type that takes a clock to pieces and finds the cause of trouble with the same joy that a scientist discovers a new gas or an astronomer finds a new double star. He found that this clock, made by a reputable clock maker whose name is a household word throughout the world, had an imperfect escapement wheel; the teeth were not concentric with the shaft, the hands were not properly counterweighted, and the wheels were out of balance. The works were taken apart, each wheel was poised and balanced, holes being drilled to remove the surplus metal. The escapement was counterpoised to make it beat synchronously with the pendulum. The reason that balancing the wheels and counterbalancing the hands is important is that at some time in the twenty-four hours, all the heavy sides of the wheels and the hands may come together and the main spring may not have power enough to drive against the unbalanced weights. The result is that the clock stops. The fact that this clock runs and keeps good time since the changes were made indicates that the vibrations of the building did not seriously interfere with the working of the clock. The fault was due to the imperfections of design and manufacture—imperfections that the buyer had a right to expect would not exist in a high-priced timepiece.

* * *

"Circular mil" is a term used in electrical wire measurements with which the ordinary mechanical man is unfamiliar. In the measuring of diameters and areas of electric wires, this measurement is commonly used. A circular mil is the area of a circle 0.001 inch in diameter. The expression "circular inch" is also used. A circular inch is the area of a circle 1 inch in diameter. Hence, 1 circular inch equals 1,000,000 circular mils. A circular inch also equals 0.7854 square inch, and a square inch equals 1.2732 circular inch, or 1,273,239 circular mils.

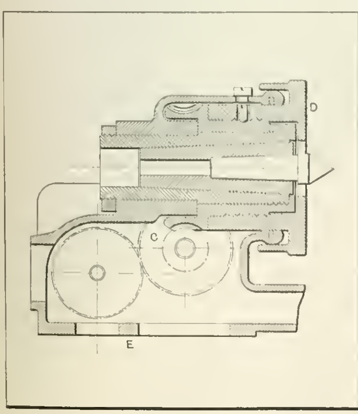


Fig. 4. Cross-section through Driving Center showing Drive through Worm and Wheel C

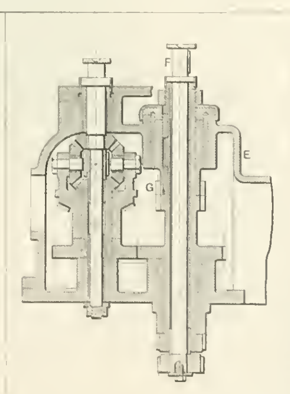


Fig. 5. Gearing provided to give Required Lead for Worm Thread

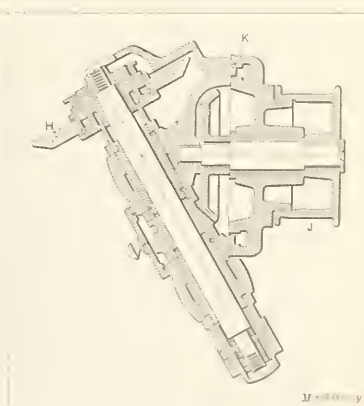


Fig. 6. Cross-section through Wheel Spindle, showing Arrangement of Drive

DRILLING MACHINE DESIGN

SOME DEFECTS AND SUGGESTIONS FOR IMPROVEMENT

BY A. USER

NO matter how many nor how few machine tools may be used in finishing a machine part, the drilling machine is nearly always included; yet this machine seems to have received less consideration and study by designers than most other metal working machines. In MACHINERY'S "Product Index" to advertisers there is usually a full column or more devoted to drilling machines of various types; yet, how many of these machines will bear an analytical examination by an efficiency student and come through without serious demerits charged against them? This refers particularly to machines intended for medium weight work, although several of the criticisms apply with equal force to nearly all types.

Limitations in Speed Range

First, let us consider speed and feed limitations and gradations—the most universal faults of the drilling machine. The writer has before him a late catalogue of a recently developed line of drilling machines of the single-pulley all-geared type, manufactured by a well-known firm; these machines are probably as advanced in design as any in their field. Selecting a twenty-four inch single-spindle vertical machine as an example, we find that the speed limitations are from 25 to 248 R. P. M. and that the speeds available are eight in number as follows: 25, 40, 50, 62, 100, 157, 197 and 248 R. P. M., or, expressed in percentage, the increases in speed from the lowest to the highest are made in the following erratic order, 60, 25, 24, 61 +, 57, 25 + and 26 — per cent. Assuming that the nature of the metal to be drilled is such that high-speed drills may be run at 60 feet per minute peripheral speed with the greatest efficiency, these speeds will be correct for drills of about the following diameters: 9, 5 5/8, 4 9/16, 3 11/16, 2 5/16, 1 7/16, 1 3/16 and 15/16 inch, respectively; or for carbon steel drills of about half the diameters given.

It is difficult to conceive to what class of customers the designer was catering when he designed this machine. It is more elaborate and expensive than one could hope to sell readily to the little shops and repair men, and as a manufacturing tool, it probably would never be called upon to drive a 9-inch drill and but very seldom a 2 5/16-inch drill. Furthermore, all progressive manufacturers have long since found that they cannot afford to use carbon steel drills, so of what use are the four lower speeds? How are drills under 15/16 inch diameter to be handled efficiently? The writer's experience is that drills less than 15/16 inch in diameter are more often used in 24-inch machines than larger ones. How are drills of intermediate sizes to be driven efficiently? Suppose, for example, that we wish to drive a 2½-inch drill and that the speed of 100 R. P. M. (which is correct for a drill of 2 5/16 inches diameter) is prohibitive because of the unreasonable amount of changing and grinding occasioned thereby; our only alternative, then, is to drop to 62 R. P. M., with a resultant efficiency of about 67 per cent. In other words, if the proper speed (92 R. P. M.) could be obtained, the output would be 48 per cent greater. Running at the top speed of 248 R. P. M., the efficiency of drills under 15/16 inch diameter would be about as follows: ¼ inch, 27 per cent; ⅜ inch, 41 per cent; ½ inch, 54 per cent; ⅝ inch, 68 per cent; ¾ inch, 81 per cent; ⅞ inch, 95 per cent. For what class of trade were speeds made to vary by steps of from 24 to 61 per cent?

I might also cite the case of another make of drilling machine of this size and the same type except that speed changes are accomplished by the familiar four-step cone pulley and back-gears. This machine has been very popular for many years, and if you run it at about double the speed recommended you can obtain a speed range of from 13 to 1000 R. P. M. by eight steps as follows: 13, 25, 45, 48, 160, 300, 533 and 1000 R. P. M., which, with 60 peripheral feet per minute as the most efficient speed, would be about correct for drills of the following diameters: 17 5/8, 9 3/16, 5 1/16, 2 3/4, 1 7/16, 3/4, 7/16 and 1/4 inch, respectively. How about the intermediate sizes in this case? If you must run a 13/16-inch drill at a speed which is correct for a 1 7/16-inch drill, it is running with less than 57 per cent efficiency, or in other words, it would be doing over 75 per cent more work if the correct speed were obtainable, other conditions being constant.

Limitations in Feed Range

What is true of speeds is also true of feeds; the first-mentioned machine has eight feed changes as follows: 0.004, 0.007, 0.010, 0.015, 0.021, 0.035, 0.050 and 0.075 inch per revolution, which, expressed in terms of percentage, show advances made by each step from the lowest to be: 75, 43 —, 50, 40, 67 —, 43 — and 50 per cent. Why should we be given the greatest relative feed change where the closer gradations are the most necessary, *viz.*, in the use of the smaller drills?

The second-mentioned machine has eight feeds as follows: 0.006, 0.007, 0.010, 0.017, 0.023, 0.029, 0.040 and 0.064 inch per revolution. These gradations, especially the first four, seem to conform with ordinary needs more than those of the machine first mentioned; yet I fear that conditions occasionally arise when 0.006 inch feed per revolution is too much, for instance, when using small drills in hard, tough stock.

Lack of Rigidity

So much for the most prominent faults of the regulation vertical drilling machine, but it has others which should also be mentioned. One of these is weakness in design, which permits springing under the strain of feed pressure, causing the drill to gouge in as the point breaks through. If the work is tough and hard, the drill "rides" for a turn or two, until sufficient pressure is accumulated to force it to take hold, which it does with such a vengeance, under these conditions, that it results in breakage of the drill or some part of the machine or, more frequently, slipping the belt. Lack of mass, in combination with lack of strength, results in vibration, noise and excessive wear and loosening of joints.

Vibration and Noise of Operation

The use of spur and bevel gears in this class of machinery should also be criticized for the reason that, owing to the relatively high speed, they contribute largely to vibration, and in many cases, especially when considerably worn, they rotate the drill by a rapid succession of impulses not unlike the motion imparted to a chisel by a pneumatic hammer, which, if driving a drill close to its limit of strength is likely to cause breakage. In this connection, let us devote a little thought to the effect of noise upon the efficiency of workmen. By this we mean excessive and unnecessary noise, such as is wearing upon one's nerves and destructive of tranquility of mind and body. It is, of course, impracticable, except possibly by elaborate psychological experiments, to obtain anything approximating a valuation of this factor in "cold cash"; but everyone realizes that it is not possible to accomplish as much work amidst the rattle and clatter of a noisy drill department as it is when the surroundings are comparatively quiet. The effect of noise varies with the temperament of the individual, but let us assume, as a conservative estimate, that the elimination of nerve-racking noise will increase the efficiency of the workman 1 per cent. Would the increased cost of the machine be justified? Assuming that the average drill press operator works eight hours per day, three hundred days per year, and receives 25 cents per hour, $8 \times 0.25 \times 300 \times 0.01 = \$6$. Six dollars will pay 12 per cent on \$50. Will it cost \$50 more to provide helical gears instead of spur and bevel gears? No, fifty cents would be more nearly correct (having in mind the ordinary 24-inch drilling machine).

Insufficient Table Support

Another faulty feature of design is the method of supporting the table usually employed by builders of the average 24-

inch drilling machine. Referring to Fig. 1, it will be seen that the knee, or arm, has a relatively short bearing on the column. The design shown in Fig. 2 is a little better in this respect, but neither of these can reasonably be expected to remain square with the spindle for more than a short time. It is evident that the clamping arrangement is such that when the knee is loosened and raised, the dust or chips which lodge on top of the knee and adhere to the column are worked into the joint, and when again clamped, they prevent the knee from coming back to its original position. The many repetitions of this process, combined with the heavy overhang and short bearing on the column, soon produce a condition which makes it impossible to obtain accurate work. Conditions, in all cases where this style of knee is employed, will be improved if a heavy felt wiper is provided to hug the column close at the top of the knee, thus preventing, to a great extent, the admission of dust and grit to this joint. The clamping arrangement would have been improved had the portion of the knee which encircles the column below the nut-ring been split for clamping purposes and the upper portion left solid.

The possibilities of a well built and well tooled drilling machine are large, in many cases surpassing those of more costly

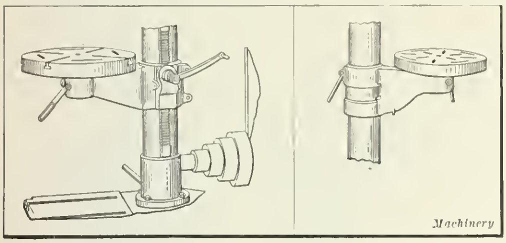


Fig. 1. Drilling Knee with Short Bearing on Column

Fig. 2. Faulty Clamping Arrangement

machinery and higher priced operators; but a table which is square with the spindle is imperative, and this feature alone is worthy of the careful consideration of both designer and purchaser. The writer is acquainted with two manufacturing concerns who have considered this feature of sufficient importance to justify them in building some sizes of drill presses in small lots for their own use, in which particular attention has been given to this point of the design. They have been building these for twelve or fifteen years, at a cost which must necessarily be very high, owing to the comparatively small quantities made at a time and the conditions under which they are constructed. Prominent mechanics who have seen these machines have been favorably impressed, but owing to the fact that they are not on the market, they content themselves as best they may with what they can get.

Summary of Suggested Improvement in Drilling Machine Design

To meet the writer's ideals, a drilling machine should embody the following features:

A speed range to provide a peripheral speed of not more than thirty feet per minute for the largest drill to which the taper hole in the spindle is suited, and not less than eighty feet per minute for the smallest drill which it is reasonable to suppose would be used in the machine *for manufacturing operations* (let the odd jobs suffer, not the everyday tasks).

Gradations of speeds by 10 per cent increases from lowest to highest.

Feeds fine enough for the smallest drill under difficult conditions and coarse enough for the largest drill under favorable conditions, by gradations of not more than 20 per cent from lowest to highest.

Helical gears throughout for both parallel and angular drives.

Sufficient mass and strength in framework to reduce spring and vibration to a negligible quantity.

Work-table which is so designed that it will maintain its accuracy with relation to the spindle, or one which is not adjustable vertically but may be swung aside if necessary.

A permanently attached speed chart, etched on metal giving the revolutions per minute at which all sizes of drills, within the range of the machine, must run to obtain various peripheral speeds.

For maximum economy in production, the feed of a drill should be all that its strength will permit without breakage, and the speed should be such as to necessitate sharpening at short intervals, say every twenty or thirty minutes; under ordinary conditions, it does not pay to run slow to avoid sharpening, as the cost of sharpening done by modern methods is so slight as to be negligible.

Adoption of Improved Design

In a recent conversation with a manufacturer who builds drilling machines among other things, it was suggested that there was considerable room for improvement in this line of machinery, and several of the features herein touched upon were discussed. While he admitted the general truth of the writer's contentions, he stated that if a machine embodying the suggested improvements were built there would be little or no market for it, as the price at which it would have to be sold to be profitable would be prohibitive; to 99 per cent of the buyers a 24-inch drilling machine is a 24-inch drilling machine and the manufacturer with the low price gets the business. Can this be true? Is it possible that the purchasing agent, with no knowledge of mechanics, is still allowed to influence the cost of production in many factories by dictating what machinery the shop must use, being governed not by efficiency but only by price? Is it possible that there are still business managers who will congratulate themselves upon having shrewd buyers when their saving of a sum on an original investment may mean the loss of five or ten times that sum in the increased production possible with the higher priced machine during its first year's use? If this is true, we need not hope for rapid improvement. It is the writer's belief, however, that there are many modern manufactories in which this condition does not obtain, and that the time is at hand when the machine of marked superiority will meet with a demand corresponding to its merits, irrespective of the higher price necessitated by the cost of its production.

* * *

SULPHUR AND PHOSPHORUS IN CASE-HARDENING COMPOUNDS

There is considerable difference of opinion among steel heat-treating experts in regard to the effect of the sulphur and phosphorus in granulated raw bone and charred leather on casehardened steel. Raw bone and charred leather contain phosphorus and sulphur. A metallurgical expert connected with a well-known manufacturing concern recently made a test to determine the infusion of sulphur into steel with charred leather, and he reported as follows:

Charred leather seems to be the most powerful casehardening compound for imparting sulphur to steel. A very careful analysis, checked independently six times, gave the following results in a casehardened steel of about 0.20 per cent carbon. Before treatment, the steel contained 0.020 per cent phosphorus and 0.042 per cent sulphur. After casehardening in charred leather it contained 0.020 per cent phosphorus and 0.217 per cent sulphur; in other words, if the steel were carburized clear through, the sulphur content was increased five times.

Raw bone and charcoal used for casehardening, on the other hand, made practically no change in the amount of sulphur or phosphorus content. This fact does not signify, however, that charred leather should never be used; but the amount of leather should be carefully estimated and kept below a content where it would impair the steel for the particular purpose intended. Leather is a rapid agent in carburizing, and I have used as much as 30 per cent of it in compounds with complete success. This, however, has been for steel sections where a little brittleness was not objectionable and hardness was the sole object sought.

For carburizing thin sections, such as inner and outer races for bearings, I prefer to keep the leather content about 10 per cent. The Feuerfeste Industrie Gesellschaft of Dusseldorf, Germany, however, has patented a compound purposely containing sulphur in the form of sodium sulphate to increase the rate of penetration, sulphur apparently acting as a vehicle in diffusing the carbon in the steel.

It will be readily seen, therefore, that a great diversity of opinion exists on this subject. In fact, it would be as unwise to condemn any particular compound or ingredient as it would be to condemn arsenic as a drug because it is a poison. A safe rule is to analyze a sample of steel before and after carburizing with a given compound.

PRESSURE DEVELOPED BY FRICTION SCREW PRESSES

AN ANALYSIS OF OPERATING CONDITIONS AT SUCCESSIVE STEPS IN THE CYCLE

BY FRITZ J W SPARKUHL*

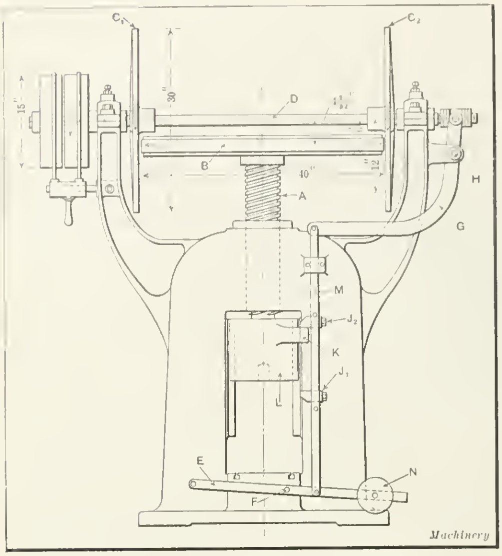


Fig. 1. Operating Mechanism of a Typical Friction Screw Press

THE great family of power presses includes one member which is almost a stranger in this country, *i. e.*, the friction screw press. Machines of this type are also called "percussion" or "spindle" presses, and have been used with unquestionable success in Germany and France for work for which drop-hammers and toggle embossing presses are commonly employed in this country. As the name "friction screw press" signifies, the motion is delivered to the ram by means of a friction drive, and the object of this article is to give a clear understanding of the operation of this drive in connection with a screw actuated ram. We know that a screw and nut are adapted for transmitting the power to the ram of a hand press on account of their simplicity of construction and the means which they provide for obtaining a much higher pressure at the ram than could be exerted by a foot press; for these reasons, the screw and nut principle on hand-operated machines finds frequent application in the construction of stamping, forming and embossing presses used in all branches of sheet metal work.

But when it comes to higher pressures and greater output, the hand press does not possess the required capacity, and a power-driven screw press must be used. This type of press is self-contained and works without shock or vibration so that it does not need a special foundation; and as it works almost noiselessly, and more quickly and accurately than a drop-hammer, it deserves a place in the list of metal working machinery as one of the most suitable equipments for many kinds of work. The ordinary crank or toggle press will not deliver the rapid and cumulative blow which is so essential for the proper performance of embossing operations; but with the reliable and sensitive controlling mechanism with which the friction screw press is equipped, the pressure can be regulated at will, so that the press makes an ideal machine for both the heaviest and finest classes of embossing and coining work. If double-action dies are employed, machines of this type are also well adapted for drawing tinware and other sheet metal products.

Fig. 1 illustrates a typical style of friction screw press. The spindle or screw A, Figs. 1 and 2, is made of tool steel with a pitch properly selected for the style of work to be done. At the top, this screw carries a flywheel or friction wheel B which is of sufficient weight and size to store up the amount of energy required to perform the pressing operation. The face of this wheel is covered with a leather band which should be equipped with a suitable tightening attachment, thus insuring a rigid and perfect connection between the band and wheel, as the leather will stretch in the course of time.

By pressing either of the friction disks C_1 or C_2, which are keyed to driving shaft D, against wheel B, the disk motion is transmitted to the wheel. By depressing or lifting lever E which is fulcrumed at F, driving shaft D, with disks C_1 and C_2, is shifted horizontally through the action of lever G which has its fulcrum point at H. This can either be done by hand through the operation of lever E, by depressing foot-treadle I, or automatically by the engagement of adjustable dog J_1 or J_2 (see Fig. 1) against the projection K of slide L. This results in lifting or depressing connection M which joins levers E and G. The lower dog J_1 is set level with the top of the lower die and reverses the travel of the ram when stop K engages dog J_1. Similarly, upper dog J_2 reverses the travel of the ram when this dog is engaged by stop K. The counterweight N serves to facilitate the reversal of the machine. Fig. 2 shows an improved construction in which only the lower dog J_1 is required. With this design, a latch which acts upon the foot-treadle is released and forces either disk C_1 or C_2 into contact with wheel B through the action of spring O. It is evident that during the up and down motions of the screw and ram, the acting radii of friction disk C_1 or C_2 varies continuously, accelerating or retarding the motion of flywheel B, screw A and slide L.

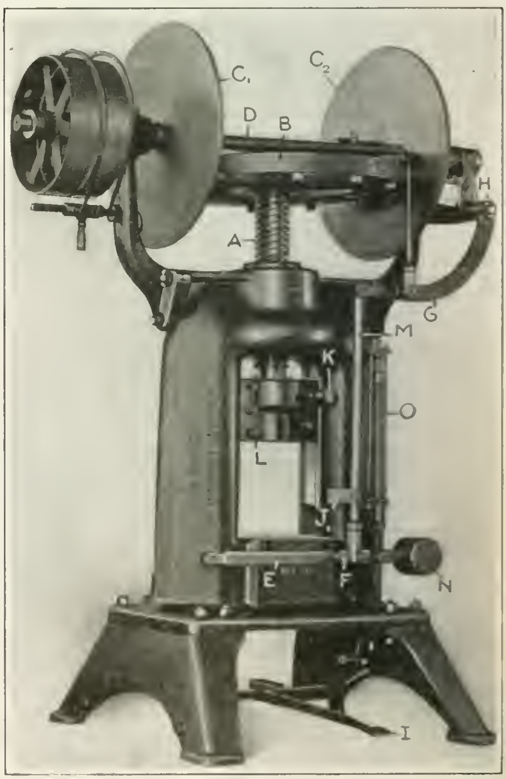


Fig. 2. Zeh & Hahnemann No. 10 Press which has a Capacity of 100 Tons

* Care of Coit Machine & Engineering Co., Irvington, N. J.

In the subsequent calculations the following notations are used:

n = R. P. M. of driving shaft D;
P = force acting on face of flywheel B;
W = combined weight of screw, flywheel, slide and tool;
M = mass of these parts $= \frac{W}{32.2}$;
p = pitch of screw;
R = radius of flywheel;
w_1, w_2 and w_3 = linear velocities of flywheel at different acting radii on friction disks C_1 or C_2;
x_1, x_2 and x_3 = different acting radii of disks C_1 or C_2;
f_1 = coefficient of friction for the screw threads;
f_2 = coefficient of friction for the thrust pivot;
r_1 = radius of screw;
r_2 = radius of thrust pivot.

The coefficient of efficiency N of the screw during the actual embossing action is given by the following equation:

$$N = \frac{m\,(1 - m\,f_1)}{m + f_1 + (1 - m\,f_1)\,f_2 \frac{r_2}{r_1}}$$

where $m = \frac{p}{2\pi r_1}$

At the moment that driving friction disk C_2 which raised the reciprocating parts is released (at a radius x_1 equal to the distance from the middle of the rim of wheel B to the axis of driving shaft D), and that friction disk C_1 is pressed against the face of wheel B, the linear velocity w_1 of wheel B is:

$$w_1 = \frac{2\pi n\,x_1}{60} \text{ feet per second.}$$

The total energy E_1 stored up in the flywheel B is given by the following equation:

$$E_1 = \frac{w_1^2 M}{2} = \frac{w_1^2 W}{2 \times 32.2} \qquad (1)$$

This stored-up energy E_1 causes a tendency toward further raising of the screw, but the force P which is applied by disk C_1 serves to reverse the motion, and this force, together with the weight W of the reciprocating parts, counteracts the raising effect. If we denote the angle in radians through which the screw turns until it comes to rest by α_1, the amount of raising will be given by the following equation:

$$\text{Raising of screw} = \frac{\alpha_1 p}{2\pi} \text{ inches.}$$

The amount of work required for raising the reciprocating parts is as follows:

$$\text{Work required} = \frac{\alpha_1 W p}{2\pi} \text{ inch-pounds.}$$

The force P acting on the circumference of the flywheel uses up $\alpha_1 PR$ units of work, and the flywheel, screw and slide come to rest when the conditions of the following equation are fulfilled:

$$\frac{N_1 M w_1^2}{2} = \frac{\alpha_1 W p}{2\pi} + \alpha_1 PR = \alpha \cdot \left(\frac{Wp}{2\pi} + PR\right) \qquad (2)$$

The center of the rim of wheel B is now at a distance from the axis of driving shaft D which is given by the following equation:

$$\text{Distance} = x_1 - \frac{\alpha_1 p}{2\pi} = x_2$$

The force P, acting in conjunction with the weight W, is now ready to give a downward motion to the screw and ram. The flywheel tends to assume the same velocity as driving disk C_1, and as it was originally at rest a partial sliding action will occur between the friction surfaces, which will only cease when the velocities of the wheel B and disk C_1 are equal. The angle in radians through which the screw must turn until this state is reached is designated by α_2, and the corresponding downward motion has the following value:

$$\text{Downward motion} = \frac{\alpha_2 p}{2\pi}$$

The corresponding value of the acting radius x_3 on the disk is:

$$x_3 = x_2 + \frac{\alpha_2 p}{2\pi}$$

The value of the linear velocity w_2 of the flywheel B for this acting radius is as follows:

$$w_2 = \frac{2\pi n x_3}{60} \text{ feet per second.}$$

For this velocity, the amount of stored-up energy E_2 in the flywheel has the following value:

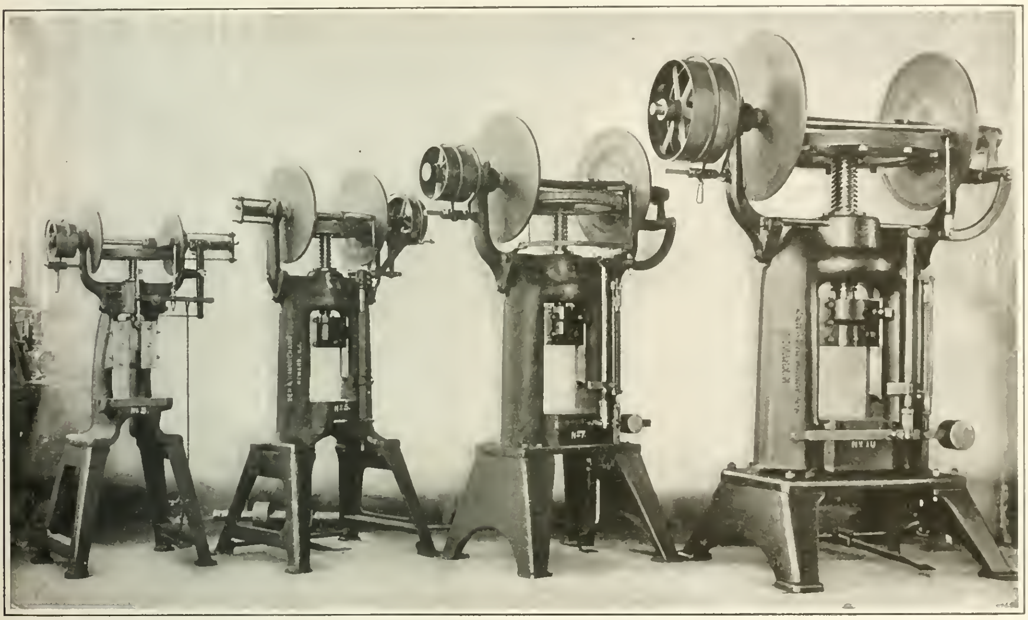


Fig. 3. Group of Four Zeh & Hahnemann Percussion Presses. The Complete Line includes Six Machines, each of which has a Capacity in Tons equal to the Square of the Size Number

$$E_2 = \frac{Mw_2^2}{2} = \frac{w_2^2\,W}{2 \times 32.2} \qquad (3)$$

Let x_4 denote the acting radius at the moment that the punch touches the work. The linear velocity w_3 is then found from the equation:

$$w_3 = \frac{2\pi n x_4}{60} \text{ feet per second.}$$

The value of the accumulated energy at this velocity is:

$$E_3 = \frac{Mw_3^2}{2} = \frac{Ww_3^2}{2 \times 32.2} \qquad (4)$$

Let the distance which the punch travels from the moment it comes into contact with the work until the moment it comes to rest be denoted by t, during which time the screw has to turn through an angle α_3 in radians which has the following value:

$$\alpha_3 = \frac{2\pi t}{p}$$

The driving power P and weight W perform amounts of work equal to $\alpha_3 PR$ and Wt, respectively, from which the following equation may be reached:

$$N\left(\frac{Mw_3^2}{2} + \alpha_3 PR + Wt\right) = Qt \qquad (5)$$

where Q = pressure on thrust pivot in pounds;
N = coefficient of efficiency.

$$\int Q\mathrm{d}t = \int_0^t ct\mathrm{d}t$$

where c is a constant, the value of which depends on the material in question, and this can only be obtained by observation and trial. If we assume that for a certain material the resistance offered to the travel of the punch is in direct proportion to the value of t, we have:

$$\int Q\mathrm{d}t = \int_0^t ct\mathrm{d}t = \frac{ct^2}{2}$$

If we assume that the resistance offered by some other material is proportional to t^2, we have:

$$\int Q\mathrm{d}t = \int_0^t ct^2\mathrm{d}t = \frac{ct^3}{3}$$

With the value of c obtained, we have the following expression for the pressure Q:

$$Q = ct \text{ pounds.}$$

Now the pressure P is released from the disk C_1 and applied to disk C_2, the flywheel being at rest for a very short time with the center of the rim at a distance $x_4 + t$ from the axis of the driving shaft D and trying to attain the same velocity as the disk C_2. Of course, a partial sliding action between the friction surfaces of these two wheels will take place, as their velocities are not the same, the condition being similar to that at the beginning of the down stroke. We find the angle α_4, *i. e.*, the angle through which the screw must turn until the sliding action ceases, from the equation:

$$N\left(\alpha_4 PR - \frac{\alpha_4 Wp}{2\pi}\right) = \frac{Mw^2}{2R^2}\left(x_4 + t - \frac{\alpha_4 p}{2\pi}\right)^2 \qquad (6)$$

During this time the spindle has risen through a distance given by the following equation:

$$\text{Rise of spindle} = \frac{\alpha_4 p}{2\pi}$$

The value of the acting radius x_5 is given below:

$$x_5 = \left(x_4 + t - \frac{\alpha_4 p}{2\pi}\right)$$

With this radius, the value of the velocity w_4 becomes:

$$w_4 = \frac{2\pi n x_5}{60} \text{ feet per second.}$$

The screw has the same velocity until reversing of the motion takes place at a radius of x_1, and from then on the action of the press repeats itself as previously described. Carrying through a numerical example taken from actual practice, will assist the reader to understand the different phases of this subject.

Example: A friction screw press has a screw of 4¾ inches mean diameter, triple threaded with a pitch of 3 inches. The diameter of the friction disks is 30 inches; the flywheel is 40 inches in diameter, and the press runs at 150 revolutions per minute. The pressure between the disk and flywheel is 57 pounds. The screw, flywheel, ram and tool have a total weight of about 1490 pounds, with a calculated mass M of 46.3. The reversing of the drive occurs at a point x_1 which is 6 inches from the axis of the driving shaft D, and the beginning of the pressing operation starts at a point x_4 which is 12 inches from the axis of the driving shaft.

Assuming the values $f_1 = 0.1$ and $f_2 = 0.08$ for the coefficients of friction of the screw threads and thrust pivot, respectively, we calculate a coefficient of efficiency during the period that the pressing operation is being performed, which is found to be 0.6, while for the idle running of the screw a value of 0.9 will be satisfactory. The velocity w_1 of the flywheel at the moment of reversal is:

$$w_1 = \frac{150}{60} \times 2\pi \times \frac{6}{12} = 7.86 \text{ feet per second.}$$

This gives the following value of the stored-up energy E_1:

$$E_1 = \frac{46.3 \times 7.86^2}{2} = 1431 \text{ foot-pounds.}$$

Next we ascertain the angle through which the screw turns until the ram comes to rest at the top of its stroke. By substituting the proper values in Equation (2), we get:

$$0.9 \times 1431 = \left(\frac{1490 \times 3}{2\pi \times 12} + \frac{57 \times 20}{12}\right)\alpha_1$$

$$1289 = 154\alpha_1$$

$$\alpha_1 = 8.36 \text{ radians}$$

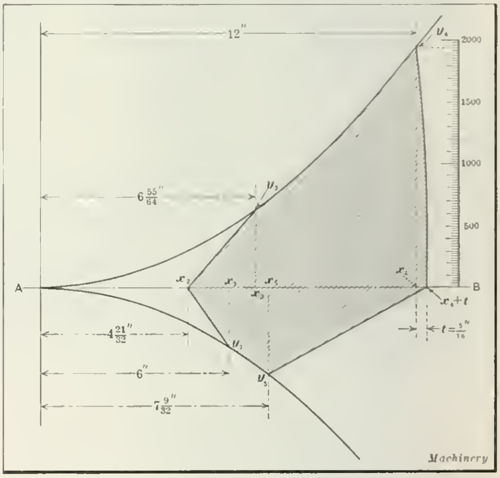


Fig. 4. Diagram showing Amount of Energy stored up in Flywheel at Different Points in Cycle

$$\alpha_1 = \frac{8.36 \times 360}{2\pi} = 479 \text{ degrees.}$$

This angle corresponds to raising the ram through a distance of:

$$\frac{3 \times 8.36}{12 \times 2\pi} = 0.332 \text{ foot.}$$

From the preceding calculations we arrive at an acting radius x_2 at the beginning of the down stroke, that is given by the following:

$$x_2 = 0.5 - 0.332 = 0.168 \text{ foot.}$$

The angle through which the screw turns until the sliding action between the driving disk and flywheel ceases, while the ram is descending, is explained by the following. Assuming a value of 1 inch for the downward motion of the ram before the slipping action ceases, and substituting proper numerical values, we have:

$$\text{Downward motion} = \frac{\alpha_2 p}{2\pi}$$

$$1 = \frac{\alpha_2 p}{2\pi} = \frac{3\alpha_2}{2\pi}$$

$$\alpha_2 = \frac{2\pi}{3} = 2.09 \text{ radians.}$$

This value of α_2 corresponds with an angle of 119.5 degrees, which, by hypothesis, corresponds to a lowering of the ram of 1 inch = 0.083 foot.

The corresponding value of the acting radius x_3 is:

$$x_3 = x_2 + \frac{\alpha_2 p}{2\pi} = 0.168 + 0.083 = 0.251 \text{ foot.}$$

At a radius of $x_4 = 12$ inches = 1 foot, the pressing operation starts; and at this moment the flywheel has attained a velocity of:

$$w_2 = \frac{2\pi n x_3}{60} = \frac{2 \times 3.14 \times 150 \times 0.251}{60} = 3.95 \text{ feet per second.}$$

For this velocity, the energy E_2 stored up in the flywheel is:

$$E_2 = \frac{M w_2^2}{2} = \frac{46.3 \times 3.95^2}{2} = 361.5 \text{ foot-pounds.}$$

The acting radius x_4 at the time the punch engages the work was given as 12 inches = 1 foot. The corresponding value of the linear velocity w_3 is then found to be:

$$w_3 = \frac{2\pi n x_4}{60} = \frac{2 \times 3.14 \times 150 \times 1}{60} = 15.72 \text{ feet per second.}$$

The value of the accumulated energy E_3 at this moment is:

$$E_3 = \frac{M w_3^2}{2} = \frac{46.3 \times 15.72^2}{2} = 5720 \text{ foot-pounds.}$$

Assuming that the work to be done by the press is of such a character that the distance t through which the ram travels from the time the punch engages the work until it comes to rest is ¾ inch, the corresponding angular movement α_3 of the ram is:

$$\alpha_3 = \frac{2\pi t}{p} = \frac{2 \times 3.14 \times 0.75}{3} = 1.57 \text{ radian} = 90 \text{ degrees.}$$

The amount of work done by driving power P is:

$$\text{Work} = \alpha_3 PR = 1.57 \times 57 \times 1.66 = 149.1 \text{ foot-pounds.}$$

The work done by weight of reciprocating parts is:

$$\text{Work} = Wt = \frac{1490 \times 0.75}{12} = 93.2 \text{ foot-pounds.}$$

Bearing in mind that the coefficient of efficiency N during the pressing operation is 0.6, we have from Equation (5):

$$N\left(\frac{M w_3^2}{2} + \alpha_3 PR + Wt\right) = \frac{ct^2}{2}.$$

$$0.6\,(5720 + 149.1 + 93.2) = \frac{c\left(\dfrac{0.75}{12}\right)^2}{2}$$

$$3577.4 = 0.001954c$$

$$c = 1{,}831{,}000$$

$$Q = ct = 1{,}831{,}000 \times \frac{0.75}{12} = 114{,}300 \text{ pounds}$$ total available pressure.

It will be of interest to show one cycle of operations of this machine in graphical form. On the horizontal line AB in Fig. 4, the points x_1, x_2, x_3, x_4, x_5 and $x_4 + t$ are all found by calculation and laid off. The ordinates erected at these points represent the corresponding stored up energies to a suitable scale. Starting with $x_1 = 6$ inches, the energy diminishes from y_1 to zero, which means that the flywheel has no energy left and comes to rest at its highest point. At $x_2 = 4\ 21/32$ inches, reversing of the flywheel motion takes place and a partial sliding action of the friction surfaces on the disk and flywheel is the result, until at $x_3 = 6\ 55/64$ inches, the wheel has assumed the same velocity as the disk, which is distinctly shown as the line of action falls on the parabola produced by plotting the various radii against corresponding values of the linear speed. At $x_4 = 12$ inches, the energy has increased to y_4, and this energy is entirely given up at a radius of $x_4 + t$. Now the drive is again reversed; and a sliding action of the friction surfaces takes place until the point x_5 is reached. From y_5 to y_1 no sliding occurs, as the velocities of the disk and wheel are the same. At x_1 the motion is again reversed and the cycle starts over again. If the diagram is laid out correctly, it affords an excellent means of ascertaining the amount of energy of the flywheel at any distance x_0 as the acting radius from the axis of the driving shaft, which would be represented by the ordinate y_0.

* * *

VELOCITY OF STEAM FLOWING THROUGH VALVES

BY ERNEST A. ANDREWS, JR.*

The formula commonly used for determining the velocity at which steam flows through the ports or valves of an engine cylinder is:

$$V = \frac{AS}{P}$$

where V = velocity of flow through port in feet per minute;
A = net area of piston in square inches;
P = area of port or valve in square inches;
S = piston speed in feet per minute.

Assuming the value of the ratio $\frac{P}{A}$, or making use of this value where it is known, the velocity at which the steam flows through a valve of area P may readily be found for any piston speed by referring to the accompanying chart. The vertical lines represent piston speed in feet per minute, and the horizontal lines, velocity at which the steam flows through the valves in feet per minute; the radial lines indicate different values of the ratio $\frac{P}{A}$ expressed in per cent.

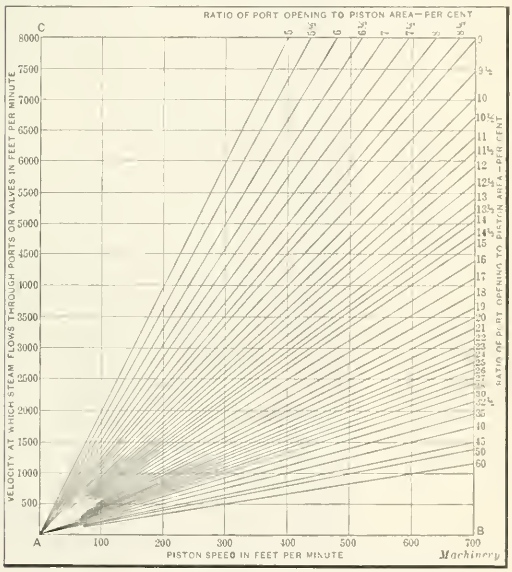


Chart for Use in determining Velocity of Steam Flow through Valves

To illustrate the use of this chart, consider a case in which the valve area P is 14.7 square inches, and the net piston area A 113 square inches. Then the value of ratio $\frac{P}{A} = \frac{14.7}{113} = 0.13$; or area P is 13 per cent of area A. Using this value, and assuming that the piston speed S is 500 feet per minute, we locate this value of S on the base line AB and follow the vertical line at this location until it crosses the radial line indicating the ratio of 13 per cent; then follow the horizontal line from this intersection across the chart to the left-hand margin, where the required velocity of the flow of steam through the valves is found to be 3850 feet per minute.

* Address: 1308 Franklin Ave., Bond Hill, Cincinnati, Ohio.

FORMING SHEET METAL BY THE ROLLING PROCESS

The forming of sheet metal strips by the rolling or channeling process was described in the February, 1916, number of

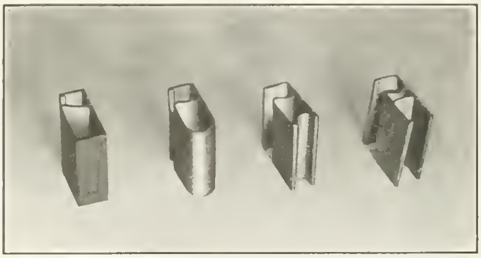


Fig. 1. Sections of Sheet-metal Molding formed by rolling

MACHINERY. A very difficult job of this kind is the production of sheet steel strips of the sections illustrated in Fig. 1 for use as window screen runners. In each case the metal is 0.018 inch thick and the formed strip is 7/16 inch wide and 1 inch deep. The machine for doing this work is shown in Fig. 2. It receives the flat stock at one end and delivers it, completely formed, at the opposite end.

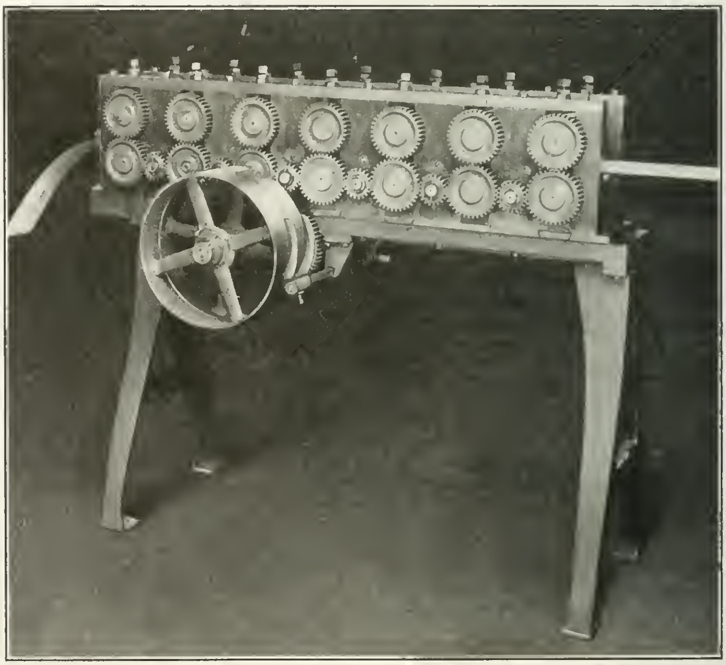


Fig. 2. Cadwell-Vernon Sheet-metal Rolling Machine

Briefly, this metal-forming operation consists in feeding the metal strip between seven pairs of forming rolls, each of which gives it a slightly more advanced shape than that imparted by the preceding pair of rolls. As shown in Fig. 2, the machine is driven by a pulley at the side, which carries rotation through an intermediate shaft to the lower roll at the center of the seven sets of rolls. Each of the lower rolls is connected with the others by means of intermediate spur gears, and as each upper roll is geared to the lower roll, it will be seen that rotating the main driving shaft causes all of the rolls to turn in unison. In Fig. 2 the machine is shown with the gear guards removed to expose the gearing.

The roll shafts are mounted in pillow blocks and the blocks of the upper and lower shafts of each set are kept normally separated by spiral springs. In order to give the desired pressure on the metal, set-screws are provided over each of the roll bearings that may be adjusted so that the metal may be pressed flat while being formed.

In Fig. 3 a top view of the seven sets of rolls is shown. The metal enters the machine from the left, being guided at the sides by gages that keep the strip centered. After leaving each pair of rolls, the metal is guided by a pair of steel strips that insures it entering the next pair of rolls properly.

The sequence of rolling operations on a section of the kind shown in Fig. 1 is illustrated in Fig. 4, from which the amount of work performed by each pair of rolls can be seen. The rolls are made of low-carbon steel, cyanide-treated and hardened in oil. Referring to Fig. 4, the work performed by the first pair of rolls *A* is rough-shaping the steel strip to start the metal flowing in the right direction. The bends are accentuated by the second pair of rolls *B*, and in the third pair of rolls *C* the metal begins to take shape. The function of the first three pairs of rolls is to manipulate the metal into the right position for forming the deep grooves, which is the most difficult part of the work. The work done by the fourth pair of rolls *D* is the forming of the ends of the section, so that the last three pairs of rolls have only to "assemble" the shape.

This assembling operation is started in the fifth pair of rolls *E*. These force the sides of the strip that form the ends of the section inward toward their final position, and in this pair of rolls, the central slot or cavity is finally finished. The sixth and seventh pairs of rolls *F* and *G* complete the rolling in of the sides of the strip. The seventh set of rolls completes the closing together of the sides and at the same time flattens down and smooths out the corners, insuring that they are of the right degree of sharpness and squareness. After leaving the rolls, the strip is run through another machine that closes in the edges, so that one edge is locked around the opposite edge, as shown in Fig. 1. This machine was not really necessary, as the operation could just as well have been included in the first machine if the designer had so desired. The machine for doing this work is about five feet in length, and weighs approximately 1300 pounds. The

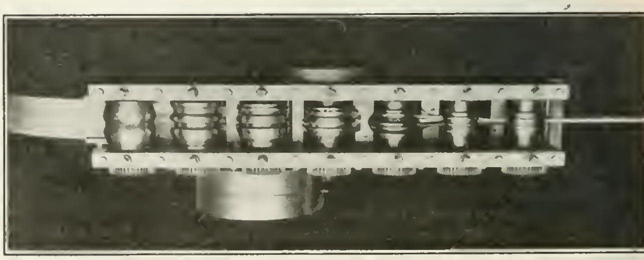


Fig. 3. Plan View of Machine, showing Rolls

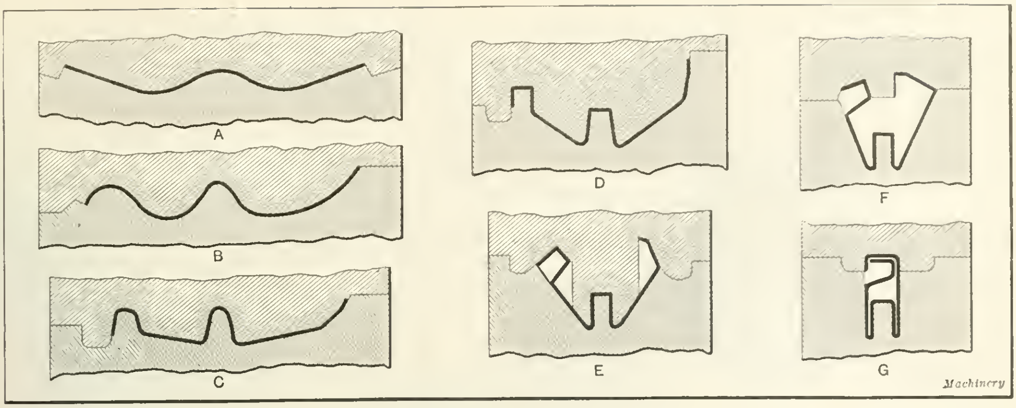


Fig. 4. Diagram showing Progression of Metal through Rolls

amount of power required for driving is very slight; in fact, it can easily be operated by hand, and when power-driven a 2-inch belt can be used.

When these strips were made by the use of presses and dies, eight operations were required, and there was a limit to the length of strip that could be produced. With this rolling machine, the length that can be produced is unlimited, and the finished stock emerges from the machine at the rate of twenty-five feet per minute. A slight lubricant is applied to the stock to keep the surface in good condition. By fitting the machine with different rolls, it is possible to produce almost any shape of molding or metal section.

This machine was built by the Cadwell-Vernon Co. of Jamestown, N. Y., which has made a specialty of sheet-metal forming by rolling. Patents of the machine are pending in the United States and Canada. C. L. L.

* * *

THE TECHNICAL PRESS

BY A. L. HAAS*

The functions filled and the interests served by a paper like Machinery are manifold. Its readers are in occupations which are as wide as the entire mechanical engineering field. Everyone directly—or for that matter indirectly—connected with the trade can find interest and profit from its perusal. There is no man, whatever his position, who does not lose ground unless he reads at least one technical periodical to keep himself informed in regard to new ideas and practice. As a supplement to a restricted field, it possesses a value not to be lightly disregarded.

Access to every text-book printed or to an ideal reference library does not substitute or do away with the necessity for a live technical periodical. The mental effort needed to swallow large treatises is considerable, and it may be said that in most instances they are shelved for reference purposes. If the information contained came in monthly "doses" the effort needed to digest the contents would be considerably lessened. This does not in the least belittle the field an authoritative book serves, but the serial aspect of a technical journal gives it a great advantage as a purveyor of knowledge. Systematic reading of a paper like Machinery, together with the preservation of articles in which the reader finds interest, will at a small cost build up a library of technical information obtainable in no other manner. Unlike a text-book, the matter so obtained has been pre-digested before filing away, and has made for itself a memory, so that mental effort is lessened when consultation is needed.

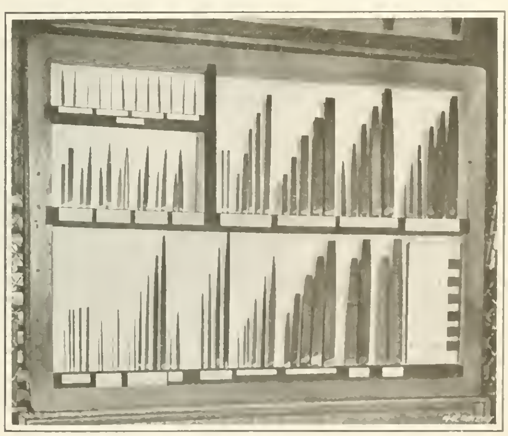
If the "make up" of Machinery be examined, it will be found that the question of preservation of the more important articles is duly considered by the editor. Almost any issue will readily subdivide for filing. The man who reads a live technical journal regularly is less provincial and has broader views and a wider mental horizon than one who does not. He supplements his restricted field or specialized task by fuller comprehension. Even casual reading of matter not directly or remotely bearing upon the reader's work stimulates his faculties and helps to broaden the particular corner in which he is confined, making him feel the brotherhood of craft. This indirect benefit is probably even greater than a direct solution of a reader's difficulty. The bond created between a good technical journal and its readers is of a particularly intimate nature, and is dependent upon both paper and reader. It is a mutual service that is rendered, the dependence of the paper upon its readers consisting in the information and help afforded by the passing along of experience.

* Address: 146 Crowborough Road, London, S. W., England.

* * *

SAMPLE BOARD FOR FILES

The Cadillac Motor Car Co. of Detroit, Mich., recently came to the conclusion that many of the men in its shops were working at low efficiency owing to lack of knowledge concerning the names of different types of files. In many cases it was thought probable that the man knew what kind of file he wanted for his work, but in ordering it from the attendant in the tool supply room, wrote the wrong name on his requisition slip. Then when the file was given to him, he did not wish to admit his error and so took it out to the shop and did the best work he could with it. To overcome this difficulty, a sample board has been placed outside the window of each tool supply room on which there is a complete set of files with the proper name under each file. With this system in use, the workman comes to the tool supply room and looks at the board to determine the right name of the file that he wants before handing in a requisition slip. As a result, he is sure to get the proper file for his work. E. K. H.



Sample Board placed outside Tool Supply Room Window for Guidance of Workmen in ordering Files

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FRICTION, HEAT AND WEAR

The engineer of a well-known firm of ball bearing manufacturers was recently called in to confer with the engineer of a coal mining corporation concerning the suitability of ball bearings for installation in machinery used at the mines. In outlining the requirements of his company, the mining engineer said that the feature of low friction losses in ball bearings was not a point that interested him particularly, because he was able to obtain fuel at such a low cost that increased mechanical efficiency was of minor importance. "What we want," said this engineer, "is a bearing that will not give trouble from heating, and that will have a sufficiently long life to reduce expenses from shut-downs to a minimum."

A little thought will show that this man had overlooked the fact that friction, heat and wear are interrelated phenomena, and that when one appears it is a sure indication that the other two are present. The experienced millwright who finds a bearing with a tendency to become heated immediately proceeds to look for the cause, because he knows that the bearing is consuming an unnecessary amount of power and is wearing excessively.

* * *

DESIGNING MACHINERY TO BE ACCESSIBLE

It is one thing to design a machine that will function correctly and quite another to design one that will function correctly and that still can be readily erected and repaired. The theoretical designer may be quite competent to design a machine that will perform its function so long as everything is working right; but when repairs are needed there is trouble for the repair man. He may find that half the machine must be torn down to get at the worn part requiring repair or renewal. An erector who had years of experience says:

> The writer is an erecting machinist at present engaged in erecting two machines which were never designed—they were simply thrown together haphazard. The situations found are almost beyond belief. Many times the parts that must be adjusted are so made and located as to render such adjustments all but impossible or involve the dismantling of several hundred pounds of parts where it should not be necessary to take any apart. Hours and days must be spent to accomplish what could have been done in a few minutes had the machines been properly designed. I have been erecting machinery for ten years for concerns of international fame, but never have I found such a variety of impracticable constructions as now confront me. Of course the erecting man is in a poor position to object. He is the last in the line of men and has to take whatever is handed him, for he cannot pass it on to the next fellow. Corrective work in the field, however, costs high, and it would seem as though the common kinds of mistakes so frequently met with could be prevented by intelligent supervision in the drafting-room or shop.

The remedy for such conditions as are briefly described in the foregoing is to insist that every machine designer shall consider accessibility an important feature of design. Perhaps the best way to impress that idea on designers would be to give everyone a taste of erecting and repair work before he is allowed to do independent designing.

* * *

RECORDING ENGINEERING QUALIFICATIONS

An interesting investigation is being carried on at the present time to determine the relationship between the records of a student's work in an engineering college and his actual qualifications in practical engineering work. This investigation is now possible because some of the largest industrial concerns in the country, where hundreds of engineering graduates have received their first practical training, are keeping records of the manner in which they perform their duties. In each department where these young men are employed, the man in charge gives the graduates certain marks for accuracy, diligence, punctuality, general character, inventive ability, etc. If the student works in a number of departments, the various marks for each qualification are added, and the average is recorded as a fair estimate of his personality and ability; this record is used in the future in determining the kind of work for which the young engineer is best fitted, and, of course, also for deciding whether or not he should be permanently employed by the concern. The investigators who have compared the standing of students at the universities or the engineering colleges with their performance in practical engineering, have been given access to these records kept by industrial firms, and it is said that interesting conclusions have been drawn from these comparisons. When the investigation is completed, the results will be published.

An interesting fact stated in this connection is that the investigators have found that different colleges develop to a very marked degree different qualifications in the student; and it is said that those institutions which are highly organized with a strong man at the head and of somewhat military regime, turn out students that score higher in accuracy than in inventive ability, while those institutions where the leadership is weaker and the regime less rigid show a higher percentage in the development of originality and of the inventive faculties. These investigations should be of value in determining the lines along which educational institutions should develop in order to best educate young men to meet the requirements of practical engineering. The investigations will show clearly what qualifications are the most valuable in engineering work outside of the college, and will give the educators a basis on which to develop courses that will meet the requirements of the industries. The rating of a student in his college studies and that which is given to him by his first employer ought to show some similarity. If it does not, the engineering school is placing too high a value on certain qualifications which future employers do not esteem very highly; and on the other hand, it neglects those qualities which in practical work count for more. This condition can be improved only by such thorough investigations as are now being made. The educators, once informed of the mistakes made in the past, can begin to shape new policies which will meet the demands of the industries more satisfactorily.

* * *

The need for efficiency which has been so loudly proclaimed throughout the country for several years has had a great deal of influence on shop organization, but it has hardly been heeded at all in the financial and selling ends of business, where it is needed worse than in the shop.—*H. L. Gantt, in Industrial Leadership.*

RATING OF PUNCH PRESSES

The rating of power punch presses is a matter upon which practically no two manufacturers agree. Some rate their presses by number, the number used bearing a certain relation to the diameter of the crankpin. For instance, when a flywheel press has a crankpin, say, 5 inches in diameter, the rated capacity is the square of the diameter, or 25 tons pressure. This practice is followed by the E. W. Bliss Co., but the number given to the press does not always indicate its capacity, which depends, to a certain extent, upon the gearing. Other manufacturers use the diameter of the flywheel and its maximum velocity as a basis upon which to rate the capacity of the press. Zeh & Hahnemann Co. uses a number, the square of which is the rated capacity of the press. For instance, a No. 5 press is capable of exerting a pressure of 25 tons.

The Standard Machinery Co.'s practice is to calculate the diameter of the crankpin in practically the same manner as for a beam supported at both ends, the cross-section of the crankpin being determined by what the tonnage would be at the dead point. In other words, the dead point tonnage is used to indicate the tonnage of the press. By this method, however, the tonnage has no direct relation to the number given, which is chosen arbitrarily.

The Niagara Machine & Tool Works divide their presses into series according to tonnage and general construction. The first one or two figures of the press number indicate the series, and the last, the drive used on the various machines in the series. All presses whose numbers end with the same figure have the same drive; for instance, a No. 4, 14, 34, 44 and 54 all have a No. 4 drive. The ram pressure exerted by the smaller presses—up to 100 tons capacity—is approximately equal to the square of the number indicating the drive. For example, a press with No. 4 drive would exert a pressure of 16 tons. This rule is not used by this manufacturer on presses of a capacity greater than 100 tons per square inch.

The Ferracute Machine Co. divides its presses into series and classes. The series is indicated by a letter and the class by a number, which also indicates the capacity of the press in tons, the final figure showing the position in the series. For instance, a press classified as "S-204" would be a stamping press with a capacity of 200 tons pressure, fourth size; a throated stamping press of the same capacity would be "ST-204"; and a double-acting stamping press with a throated column would be "STD-204." This system, however, is not followed universally by this manufacturer, distinction being made between standard and special presses. In special presses, the number is no indication whatsoever of the ram pressure exerted by it.

The Toledo Machine & Tool Co. rates the nominal capacity of the press in tons as equal to three and one-half times the square of the diameter of the crankpin. For instance, a press having a 2-inch diameter crankpin would exert a pressure of 14 tons. These ratings are based upon experiments as well as calculations and are for an average material, such as 0.45 per cent carbon steel crankshafts. These pressure capacities only hold true for limited strokes of the slide and where these strokes do not exceed the diameter of the shaft; in cases where the strokes are greater than the diameter of the shaft the torsional stresses to which the shaft is subjected have a material influence upon the pressure capacity. The preceding remarks apply only to shafts that are driven from one end; if a shaft is driven from both ends the pressure that would be exerted would be double that secured through a single driveshaft. Another factor affecting the capacity of a press is the period through which it operates and the point at which the pressure is to be exerted. A flywheel press can only exert the pressure at the bottom of the stroke. If the pressure has to be continued for some period or through a certain distance gearing must be resorted to.

The American Can Co. rates the nominal tonnage of the press from the strength of the frame and crankshaft, and establishes a standard stroke; any increase in the stroke changes the capacity of the press. In cases where it is necessary to use the blanking dies absolutely flat, as, for example, in blanking such work as armature disks, a press should be selected which will exert a considerably higher pressure than that required to blank a piece of the same size when a shear can be used on the punch or die. In blanking dies having no shear edge, the strain on the press comes at one point, and is not gradual, as is the case when the die is sheared.

In the absence of any accepted standard of press rating, the Baird Machine Co. has adopted the conventional method of using arbitrary numbers for its line of presses. This concern obtains samples of the work to be done and turns them over to the engineering department for study and consideration. In determining the size of press required, the tooling method is always taken into consideration. Actual tests are then made to determine the pressure required to perform the operation.

In numbering open-back presses, the Waterbury Farrel Foundry & Machine Co. uses an arbitrary system, which dates back to the beginning of the use of presses in the Waterbury district. For instance, a No. 2 or a No. 3 press means a press of approximately a certain weight with a crankshaft and flywheel of a certain size. A No. 3½ press is practically the same as a No. 3 machine, except that it has a longer frame, suitable for a longer stroke. Practically all open-back presses are numbered by the sizes of the shafts and flywheels.

The pillar line of presses manufactured by this concern is rated in a different manner. In this case, the number of the press is obtained by dividing the cross-section area in square inches in one upright by 10; hence, a No. 2 press has 20 square inches in one upright. This rating is based on the assumption that the tension is 2000 pounds per square inch of section, so that a No. 2 press would be capable of exerting a pressure of 80,000 pounds, or 40 tons.

Toggle presses are rated according to capacity, the capacity being determined by the pressure required for doing the same work on a hydraulic press, as indicated by a pressure gage. For example, suppose that the maximum capacity rating of a toggle press is 100 tons; this means that the press will perform an operation requiring a total pressure of 100 tons in a hydraulic press, measured by the gage. It has been the experience of the Waterbury Farrel Foundry & Machine Co. in designing and selling presses that a rating according to tonnage is absolutely valueless from the standpoint of the customer. Unless the customer knows what unit strain was allowed for in making this rating, there is no basis of comparison. The only safe figure to give is the total weight of the machine, diameter of the crankshaft and weight of flywheel.

D. T. H.

* * *

TAKING PHOTOGRAPHS IN SHOPS

A photograph of a shop interior with the men working, in natural poses, is extremely difficult to secure. In the first place, it is generally necessary to give long exposures or to use a flashlight if an instantaneous exposure is made. In the second place, it is hard to get workmen to act naturally when a photographer is around. Their impulse is to face the camera and strike an attitude. This defeats the object of taking a shop interior, especially when it is desired to show processes or the manipulation of machines. It is sometimes necessary for the photographer to resort to a trick in order to get the result wanted. He apparently takes the picture, and then tells the men to resume their places, whereupon he makes the exposure and secures the natural effect desired—perhaps.

If workmen would consider what the object generally is when a photographer appears in their midst, they would concentrate on their work the same as usual, and not pose. If they gave proper consideration to the matter, they would realize how ridiculous it is for men in working clothes, in the grimy atmosphere of a shop, to have their pictures taken at attention. Let the workman attend to his job, and the photographer will be all the better pleased, and he himself will be better pleased when he sees the photograph; it will appear more to his credit if he seems to be working as usual, and not standing with the expression on his face: "Here I am; ain't I handsome?"

THE preceding installments of this article, published in the April and May numbers of MACHINERY, described step by step the machining operations on the parts of the Spanish Mauser military rifle. The principal parts treated were: the barrel, receiver, bolt, magazine and trigger guard, and rifle stock. In this installment the assembling and testing operations on the Spanish Mauser military rifle are taken up, and the equipment and number of operators required to turn out and assemble 200 military rifles in eight hours is specified.

ASSEMBLING AND TESTING OPERATIONS ON SPANISH MAUSER MILITARY RIFLE

The assembling of a military rifle is generally done on the unit group system similar to that adopted by the leading machine tool builders. The various components of the rifle are divided into groups, such as the barrel and assembly, receiver assembly, bolt assembly, magazine and trigger guard assembly, stock assembly and miscellaneous parts. With the layout suggested in the preceding installments, all the machining operations should so complete the parts that no filing or fitting is necessary. There are cases, however, where a slight touch of the file is necessary to remove the upset edges, particularly on soft parts, which have been caused by the parts receiving improper handling during transportation from one department to another. Various methods are used for transporting the work throughout the plant, and arranging it in the most convenient order for the assembler. Probably the most advanced method is to use the truck or conveyor system, and have an open aisle running down the length of the assembling floor. The parts are handled on the conveying gravity system or by wheel trucks, and held on benches before the assembler. For additional details on machines and fixtures used and production, see Table XXXIX.

Operation 1: Barrel Proof Test.—This test is made on every barrel previous to browning, by using an overcharged cartridge, capable of producing a maximum chamber pressure one-third greater than the maximum pressure obtained with a regular service cartridge. Before making this test it is the practice of some governments to assemble the sight bases, and also to leave the cartridge chamber 0.002 inch smaller than the finished size. For proof testing, the barrel, receiver and bolt are assembled, the action being completed with "standard" components used for that purpose. The barrel is clamped rigidly in a special fixture, and the tester is protected by having the testing device enclosed in a heavy shield. After testing, the barrel, receiver and bolt are examined to see that they are sound. The chamber is then reamed to the required size in a hand reaming fixture.

Operation 2: Tin Seats on Barrel for Front and Rear Sight Bases.—This consists in depositing a low melting point solder on those portions of the barrel where the sight bases are to be located.

Operation 3: Press on and Sweat Rear and Front Sight Bases on Barrel.—In performing this operation, the barrel is held in a special fixture in such a manner that the registering point previously marked to line it up with the receiver is located definitely. Then the sight bases are located in relation to this mark by a special device in the fixture. Operating handles are then moved to force the sight bases on the barrel, after which a bunsen burner is applied to the barrel until the

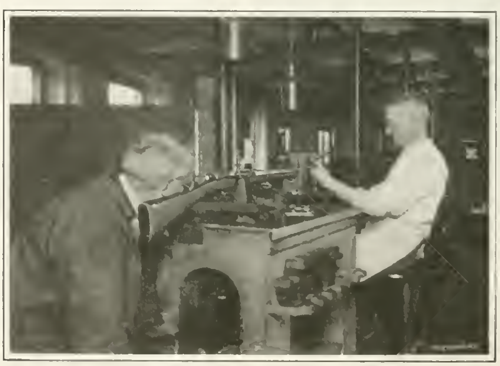

Fig. 67. Setting the Sights in Line with the Axis of the Barrel

solder paste is melted. The hurner is then removed and the solder allowed to set hefore removing the barrel.

Operation 4: Drill and Countersink Locking Screw Holes in Sight Bases.—This operation is accomplished on a two-spindle sensitive drilling machine, using a special fixture for holding the barrel. A combination drill and countersink is used.

Operation 5: Fit and Assemble Front Sight.—This is a bench operation, and consists in fitting the front sight into the slot in the front sight base. As the front sight must be a good driving fit in the base, it is left a little large and then fitted to drive in. The operator simply locates it in approximately the correct position, as it is located accurately in a subsequent operation.

Operation 6: Fit and Assemble Rear Sight Leaf Spring, Leaf, Slide, and Catch.—This is also bench work and consists in first fitting the leaf spring in the rear sight slide base, then putting in the screw, then fitting the leaf to the projections on the sight base and driving in the fulcrum pin; after this the slide is fitted to the sight leaf and the stop screw inserted in the top right-hand corner. The slide catch is then fitted and the pin driven in. These parts must work freely when fitted in place.

Operation 7: Assemble Sear and Trigger.—This consists in simply putting the trigger in the sear slot, driving in the trigger pin and then inserting the sear spring. As all of these parts have been hardened, no fitting is necessary.

Operation 8: Fit and Assemble Retaining Bolt.—This consists in fitting the retaining and ejector bolt spring into the retaining bolt body, inserting the ejector and trying the fulcrum screw in the threaded hole.

Operation 9: Assemble Sear and Retaining Bolt to Receiver.—This consists in putting the sear over the fulcrum point on the receiver and then driving in the pin, and in doing the same with the retaining bolt, except that a screw instead of a pin is inserted. No fitting is necessary because all parts have been hardened.

Operation 10: Fit and Assemble Extractor and Extractor Collar to Bolt.—This operation consists first in expanding the extractor collar and placing it over the groove in the bolt, then locking the projections on the extractor collar into the corresponding locking grooves in the extractor and moving it back and forth to see that it operates freely.

Operation 11: Assemble Striker, Main Spring, Bolt Plug, Safety Lock and Cocking-piece to Bolt.—This consists first in putting the main spring on the striker; then the striker is held in a special fixture and the bolt plug forced on to compress the main spring. The cocking-piece is then put on and given a half turn, locking it in position. Before the cocking-piece is put on, however, the safety lock must be put in place in the bolt plug. This assembled member is then placed in the bolt and the bolt plug screwed into the end of the bolt and brought into proper alignment. As all of these parts have been hardened, no filing should be necessary.

Operation 12: Assemble Bolt to Receiver.—This operation consists simply in inserting the bolt in the receiver and running it back and forth a few times to see that it fits properly and that the locking lugs on the bolt agree with the cam surface on the rear end of the receiver and the cam-locking projections.

Operation 13: Assemble Magazine Floor-plate Catch, Spring, Platform and Floor-plate to Magazine and Trigger Guard.—This consists first in placing the spring over the magazine floor-plate catch; then this member is inserted in the hole in the magazine and trigger guard, and the retaining pin is driven in. The magazine spring is then slipped into the platform and floor-plate, the latter inserted, and the floor-plate locked in position.

Operation 14: Assemble Stock Mortise Band to Receiver and Receiver Assembly to Barrel.—This operation consists in placing the mortise band on the front end of the receiver and screwing the barrel into the receiver; a special fixture is designed for this purpose, the indicating points on the barrel and receiver being made to match up with each other.

Operation 15: Assemble Butt Sling Swivel in Block and Drive in Locking Pin.—This is accomplished in a special bench fixture provided with a lever for offsetting the ends of the swivel so that it can be inserted in the holes in the block. The retaining pin is then driven in.

Operation 16: Assemble Lower Band and Spin Over End of Swivel Screw.—This consists in inserting the swivel in the slot, inserting the screw, and screwing on the nut. The assembled member is then placed under a rivet spinning machine and the end of the screw spun over.

Operation 17: Press Rear Guard Screw Bushing into Stock.—This is accomplished under a special bench or foot press.

Operation 18: Assemble Miscellaneous Parts to Stock.—In this operation a clearance hole is first drilled for the retaining bolt fulcrum screw; then the hutt plate is located on the butt end of the stock, and the two screws are inserted. The butt sling swivel block is then placed in position and the two screws are inserted. The upper and lower band spring catches are then driven into the stock, the upper band nose plate put on and the retaining pin driven in.

Operation 19: Assemble Barrel, etc., to Stock.—This operation consists first in inserting the barrel, receiver and bolt assembly in the grooves in the stock in the proper position, then turning up the rear sight leaf and inserting the hand guard over it and under the stock mortise band. The lower band is then slipped over the stock and driven over the lower band spring catch, after which the upper band is inserted likewise and driven into position. The cleaning rod is then placed in the cleaning rod clearance hole in the stock and screwed down into the nut, which is a projection of the lower band spring catch.

TABLE XXXIX. ASSEMBLING AND TESTING OPERATIONS ON A MILITARY RIFLE

Oper. No.	Operation	Machine Used	Tool or Fixture	Hourly Product per Man
1	Barrel proof test	......	Spec. testing fixt.	10*
2	Tin seats on barrel for front and rear sight bases	Bench work	Bench fixt. Solder paste	80
3	Press on and sweat rear and front sight bases on barrel	Bench work	Bench fixt. Bunsen burner	30
4	Drill and countersink locking screw holes in sight bases	Two-spindle sensitive drill. mach.	Spec. fixt.	50
5	Fit and assemble front sight	Bench work	Bench vise, files, etc.	40
6	Fit and assemble rear sight leaf spring, leaf, slide and catch	Bench work	Bench vise, files, etc.	20
7	Assemble sear and trigger	Bench work	......	100
8	Fit and assemble retaining bolt	Bench work	......	60
9	Assemble sear and retaining bolt to receiver	Bench work	......	45
10	Fit and assemble extractor and extractor collar to bolt	Bench work	Bench vise, files, etc.	40
11	Assemble striker, main spring, bolt plug, safety lock and cocking-piece to bolt	Bench work	......	40
12	Assemble bolt to receiver	Bench work	Bench work, files, etc.	45
13	Assemble magazine floor-plate catch, spring, platform and floor-plate to magazine and trigger guard	Bench work	Bench vise, etc.	30 30
14	Assemble stock mortise band to receiver and receiver assembly to barrel	Bench work	Spec. assemb. fixt.	20
15	Assemble butt sling swivel in block and drive in locking pin	Bench work	Spec. assemb. fixt.	50
16	Assemble lower band and spin over end of swivel screw	Riveting mach.	......	45
17	Press rear guard screw bushing into stock	Spec. arbor press	Spec. fixt.	100
18	Assemble miscellaneous parts to stock	Bench work	......	30
19	Assemble barrel, etc., to stock	Bench work	......	25
20	Assemble magazine and trigger guard assembly to stock	Bench work	......	25
21	General inspection for action	Bench work	......	40
22	Test and align sights	Spec. testing mach.	Spec. cross-hair sighting rod and target	10*
23	Final firing test	Spec. testing mach.	Target	10*

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* Two men.

Operation 20: Assemble Magazine and Trigger Guard Assembly to Stock.—This consists in placing the magazine and trigger guard assembly in the opening in the stock and putting in the rear and front screws.

Operation 21: General Inspection for Action.—This consists in a careful inspection of all the working parts of the rifle to see that they work freely and without obstruction, and that every part has been assembled in its proper position.

Operation 22: Test and Align Sights.—There are several methods in use for testing the alignment of rifle sights. The

TABLE XL. EQUIPMENT AND OPERATORS REQUIRED TO TURN OUT 200 MILITARY RIFLES IN EIGHT HOURS

Name of Equipment	Size or Type	No. of Machs.	No. of Operators	No. of Non-producers
Cutting-off machines	No. 5	2	1	2
"Stiles" punch press (geared)	No. 5	2	1	2
"Stiles" punch press (flywheel)	No. 5	3	3	
Board drop-hammer	800 pound	8	6	
Board drop-hammer	1200 pound	3	2	3
Trimming press	No. 5	11	..	
Power forging machine	2-inch	1	1	
Lincoln type milling machine	11 by 36-inch	15	7	10
Lincoln type milling machine	7½ by 32-inch	65	20	
Hand milling machine	No. 6 Whitney	96	72	10
Profiling machine	No. 13 one-spindle	18	15	
Profiling machine	No. 14 two-spindle	18	15	4
Spline milling machine	Special	16	5	
Horizontal splining machine	Two-head	5	3	
Vertical bench shaving machine	Pratt & Whitney	9	7	
Oscillating milling machine	Hendey	1	1	
Broaching machine	No. 1 Lapointe	1	1	
Broaching machine	No. 3 Lapointe	2	1	
Broaching machine (duplex)	No. 3 Lapointe	2	1	4
Plain milling machine	No. 2	1	1	
Thread milling machine	Internal	1	2	
Thread milling machine	External	2	2	
Horizontal radial drilling machine	No. 1 Rockford	1	1	
Butt welding machine	No. 2-A	2	1	
Turret lathe	1-inch	13	10	
Turret lathe	1½-inch	8	6	
Hand screw machine with thread chasing attachment	⅝-inch	3	2	
Multi-spindle auto. screw mach.	1¼-inch	4	2	
One-spindle auto. screw mach.	No. 00 B. & S.	1	1	5
One-spindle auto. screw mach.	No. 0 B. & S.	1	1	
One-spindle forming and cutting off mach.	No. 00 B. & S.	1	1	
Screw shaving machine	No. 1	2	2	
Screw slotting machine	Special	1	1	
Engine lathe	14-inch	8	6	
Barrel turning lathe	Multi-tool type	9	2	
Double-head centering machine	Whiton	1	1	
Gun barrel drilling machine	Two-spindle	11	3	
Pistol barrel drilling machine	Two-spindle	3	1	5
Gun barrel reaming machine	Two-spindle	8	3	
Gun barrel chambering machine	Special	10	8	
Gun barrel rifling machine	Horizontal	21	5	
Cylindrical grinding machine	10 by 36-inch	4	3	
Disk grinder	Grinding wheel stand	1	1	
Vertical surface grinder	Blanchard	2	2	
Sensitive drilling machine	One-spindle	2	2	
Sensitive drilling machine, one with tap. att.	Two-spindle	9	7	
Sensitive drilling machine	Three-spindle	6	5	5
Sensitive drilling machine	Four-spindle	4	3	
Sensitive drilling machine	Five-spindle	3	2	
Sensitive drilling machine	Six-spindle	3	2	
Vertical drilling machine	One-spindle	1	1	
Bench bending machine	Special	1	½	
Bench tapping machine	Special	2	1½	
Polishing lathe	Bench No. 3	20	17	
Polishing lathe	Stand No. 3	20	17	3
Tumbling barrel	Abbott	1	½	
Sensitive drilling machine	Two-spindle	1	1	
Engraving machine	1-A Gorton	2	2	
Riveting machine	Grant	1	½	3
Marking machine	Noble & Westbrook	2	2	
Miscellaneous tools and fixtures	Bench vise Spec. fixt.	..	14	
Chronograph and fixtures	Special	..	18	
Inspecting fixtures and gages	......	..	..	24
Barrel straightening fixtures	......	..	6	
Browning oven	......	..	4	
Annealing furnaces	Barrel	1	1	
Annealing furnaces	......	3	3	
Pickling baths	......	6	6	
Cyanide pots	......	2	1	3
Hardening furnaces	......	4	4	
Niter baths	......	5	5	
Bluing furnaces	"American Gas"	2	1	

oldest is to hold a rifle in a machine rest and set the sights by actually firing loaded cartridges at a target located about 180 feet from the muzzle of the gun. This method of setting the sights, of course, has the defect that the inspector cannot always be sure that the axis of the barrel and the sights are parallel, because there may be some defects in the ammunition used. The latest and no doubt the most practical method of aligning the sight is shown in Fig. 67. This method of setting the sights makes use of a special sighting tube known as a "star gage," which is made from a bar equal in diameter to the bore of the rifle and drilled through from one end to the other. In one end a small peep sight hole is drilled, and in the other a larger hole, across which are two wires meeting at the center in the axis of the rod. This sighting device is placed in the bore of the barrel, the bolt mechanism being removed, and one operator sights it so that the cross wires coincide with the cross marks on the target which is placed at a distance of 75 feet from the muzzle of the rifle and illuminated. The other operator adjusts the machine rest until the cross wires in the sighting device and the target exactly coincide. The fixture is then clamped, and the front sight aligned with the target. When this is made to coincide with the target, a cold chisel is used to make a cross mark on the sight and sight base. This effectively locates the two members and at the same time holds them rigidly. By this method of sighting, it will be seen that the ammunition does not enter into the problem at all.

Operation 23: Final Firing Test.—Ten per cent of all rifles are tested by actual firing, the target being located 600 yards from the muzzle. The rifle is held in a machine rest designed to approximate the conditions it is ordinarily fired under as regards points of support, recoil, etc. At this distance nine out of ten shots must hit within a two-foot circle. The rifle is then given a general inspection and is finally packed ready for shipment.

In addition to the tests previously outlined, a military rifle must also pass through several other tests, *viz.*, an endurance test, dust test, rust test and defective cartridge test. Of course each barrel or rifle does not require to be tested, and generally one rifle out of a consignment decided upon by the government, and which differs in various countries, is tested.

Endurance Test.—The endurance test is made with several rifles, firing 5000 rounds in forty lots of 100 rounds each, and two lots of 500 rounds each. At various stages of the endurance test, the ballistic qualities of the rifle are tested by firing for velocity and accuracy, and the working of the mechanism is tested for rapidity of fire.

Dust Test.—The dust test is not specified by all the governments. The United States Government, however, requires the Springfield rifle to pass this test. It is handled in the following manner: With the breech-block closed, the rifle is subjected to a blast of fine sand for two minutes; first with the magazine empty and again with the magazine filled with cartridges. The surplus sand is removed after each blast by blowing or wiping and by tapping the butt and muzzle of the rifle on the ground. The rifle then must be capable of operating freely as a single loader and as a magazine rifle.

Rust Test.—Most modern military rifles are given what is known as a rust test. The rifle is first thoroughly cleansed, and all oil and grease removed by washing in hot soda water. The muzzle and chamber of the barrel are then corked and the rifle is immersed in a saturated solution of sal-ammoniac and then exposed to a damp atmosphere for forty-eight hours. The accumulated rust must not prevent operation.

Defective Cartridge Test.—In order to test the strength of the extractor, defective cartridges are fired from the rifle. Several cartridges are cut through at the head, others at the extractor groove, and others are split through their entire length. These are fired, and if the extractor removes them satisfactorily from the chamber, the rifle passes inspection.

TABLE XLI. EQUIPMENT AND OPERATORS REQUIRED TO TURN OUT 200 MILITARY RIFLE STOCKS AND HAND GUARDS IN EIGHT HOURS

Name of Equipment	Size or Type	No. of Machs.	No. of Operators	No. of Non-producers
Planing and jointing machine	16-inch	1	½	
Four-roll surface planer	24-inch	1	¼	
Trimming saw	One-head	1	1	
Equalizing saw	Double-ended	1	½	
Band sawing machine	36-inch	1	½	
Horizontal boring machine	Two-spindle	1	½	
Horizontal boring machine	One-spindle	1	1	
Horizontal boring machine	Two-spind. opposing	1	½	
Gun stock copying lathe	Special	8	8	
Semi-automatic gun stock lathe	Special	4	3	
Spotting machine	Spec. horiz.	1	½	
Inletting and bedding machine	Six-spindle	5	4	
Inletting and bedding machine	Five-spindle	2	2	4
Inletting and drilling machine	Four-spind. spec.	1	½	
Inletting and drilling machine	Three-spindle	3	2	
Inletting and bedding machine	Spec. hand guard	1	1	
Combination vertical profiler and trimming saw	Special	1	½	
Vertical shaper	Two-spindle	3	2	
Grooving machine	Special	1	¼	
Mortising machine	No. 1 special	1	½	
Shaping machine	Special horiz.	1	1	
Polishing lathe	Special	3	2	
Gaining machine	No. 1 special	1	1	
Oil dipping tank	Special	1	2	
Hand tools, etc.	......	..	5	
Inspection fixtures and gages	......	..	..	5

Machinery

EQUIPMENT AND OPERATORS REQUIRED TO TURN OUT AND ASSEMBLE 200 MILITARY RIFLES IN EIGHT HOURS

The problem of equipping a plant to turn out 200 modern military rifles in eight hours is an enormous proposition. In

the first place, to pass inspection a modern military rifle should go together without any hand fitting or filing. Consequently great care must be exercised in the laying out of the various operations, using the same bedding or locating points for holding and gaging the work. Tables XL and XLI give some idea of the equipment necessary. This includes such machines as punch presses, forging machines, drop-hammers, Lincoln type milling machines, hand milling machines, profilers, spline milling machines, drilling machines, etc., and the necessary equipment for turning out the stock and hand guard.

In making a total estimate of the production figures given in the preceding tables covering the operations on the sixty-two parts of a Spanish Mauser military rifle, it has been ascertained that the actual man-hours required to turn out a single rifle is sixteen. This does not include the labor on the bayonet, scabbard, or strap, which would probably increase the man-hours to seventeen or slightly more. For a plant of this size, the actual number of employes, not including the engineering and office force, would be slightly over 400 machine operators; fourteen foremen for manufacturing department; twenty-one sub-foremen; fourteen tool repair men; eleven clerks; twenty-five inspectors and chief inspectors; eight laborers; fifteen to twenty-five toolmakers (for upkeep of tools only). The majority of sub-foremen are producers, as they are over gangs and are working foremen setting up the machines and directing the work of other operators while their own machines are working. The total number of operations on a Spanish Mauser military rifle is in the neighborhood of 757, which includes machining, polishing, heat-treating, assembling, testing, etc.

The stock and hand guard can be turned out in 1½ man-hour, by using the special equipment outlined in Table XLI. In calculating the number of machines required to turn out any particular part, it is necessary to make allowance for breakdowns and for the time required to change over from one job to the next; both of these items vary with the type of machine. For instance, the time required to change over from one job to the next on a sensitive type drilling machine is much less than the time required to change over an automatic screw machine; and a Lincoln miller is likely to be out of order a much greater proportion of the time than a profiling machine. This makes it necessary to handle each case separately, so that the type of machine and other factors can be taken into consideration. To take care of breakdowns, from 10 to 25 per cent is added to all types of machines over and above the calculated number.

* * *

COPPERLESS MACHINERY IN GERMANY

The war has caused a great shortage of copper for other uses than those of martial character in Germany. Electrical firms in that country have been constructing transformers having zinc windings for some time past, and are now engaged in the production of generators and motors with windings made entirely or partly of zinc and commutators of steel.—*Electrical Review and Western Electrician.*

TESTING HARDNESS OF RIFLE PARTS

BY A. F. SHORE[*]

In order that a military rifle may stand up to the rough usage incident to service in war, it is necessary not only that it be strongly constructed, but also that the various parts be made from suitable materials of the correct hardness and elasticity. As the working members of the rifle are subject to considerable wear, it has been found necessary to heat-treat such parts as the receiver, bolt, trigger, sear, etc. It is doubtful if the hardness of these parts has ever been standardized. It does not require a very careful investigation to see that the working members of a military rifle are not subjected to the same conditions of service, and consequently should be of varying hardness and tensile strength. The rifle barrel is a good case in point. In the rifle barrel the stress caused by the explosion of the powder in the cartridge is greatest at the breech end, which calls for an enlargement of the barrel at this point.

Hardness of the Rifle Barrel

A satisfactory rifle barrel must meet two requirements: first, it must be capable of withstanding the enormous pressure exerted by the explosion of the powder in the chamber, which in the Springfield rifle is about 44,000 pounds per square inch; second, it must be capable of withstanding the erosive effect of the gases formed when the powder in the cartridge case is exploded. Erosion is caused by the heated explosive gases moving with high velocity under great pressure. These gases attack the walls of the bore, which are probably softened by the heat, and cut irregular channels in the metal, destroying the surface of the bore and rifling. Erosion is greatest at the seat of the bullet immediately in front of the cartridge case and extends forward into the barrel for several inches. Beyond this, the walls of the bore are practically unaffected. It is therefore evident that the hardness of the barrel is not as important a consideration as its ability to resist the pressure and erosive effect of the gases.

Many experiments have demonstrated the fact that alloy steels which can be employed satisfactorily to resist the breech pressure do not prolong the life of the rifle barrel because they are not capable of resisting erosion. It has also been demonstrated that plain carbon steel of the correct physical properties makes a much more satisfactory barrel than nickel steel or other alloys. A steel which has come into prominence for use in rifle barrels is known as "smokeless barrel steel." The various ingredients in this steel are: 0.40 to 0.50 per cent carbon; 1.15 to 1.30 per cent manganese; 0.18 to 0.25 per cent silicon; 0.08 per cent (maximum) phosphorus; 0.06 per cent (maximum) sulphur. This steel has a tensile strength of from 100,000 to 120,000 pounds per square inch, and an elastic limit of 60,000 to 75,000 pounds per square inch; reduction of area, 40 to 55 per cent; elongation in two inches, 20 to 30 per cent. The hardness of the barrel is not fixed by the hardness of the bullet jacket; the jacket has little or no effect in wearing

[*] President, Shore Instrument & Mfg. Co., Inc., New York City.

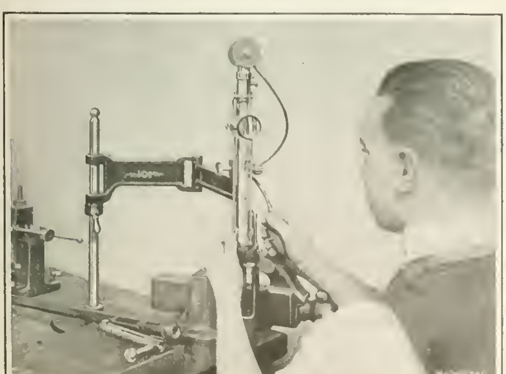


Fig. 1. Testing Hardness of Rear Cam on Receiver

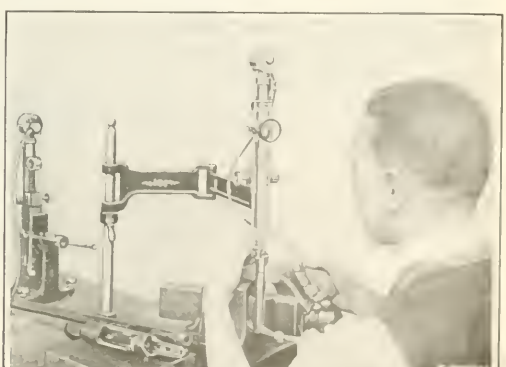


Fig. 2. Testing Hardness of Front End of Bolt

out the barrel. It has been demonstrated that a soft steel jacket wears the barrel less than a cupro-nickel jacket. The reason for this is that nickel, being softer than steel, causes fouling, which results in more wear than is caused by steel jackets with which fouling is eliminated. Therefore the two most important factors influencing the durability of a barrel are pressure and erosion. The hardness of rifle barrels varies between 40 and 50 under the scleroscope.

Hardness of the Firing Pin

The firing pin must be capable of indenting the primer but does not need the characteristics of a cutting tool. The primer, which is made from a copper alloy, strikes between 15 and 20 on the scleroscope. While the firing pin does not perform the function of a cutting tool, it nevertheless should be at least three times as hard as the primer, and for this reason should not strike less than 60. Increasing the hardness serves to strengthen the pin, so it is generally made to strike about 85. This increased hardness also gives the pin better wearing quality which is desirable because of the presence of grit and dust. Thus a hardness of 85 to 90 may be used, but this is not absolutely necessary.

Hardness of the Receiver Cams

The hardness of the cams in the receiver (see Fig. 1) should have a minimum of 60 to resist battering under ordinary hand pressure. These points on the receiver are also subject to wear due to the presence of grit when the rifle is in use on the battlefield. A receiver is generally made from a steel that can be heat-treated so that the exterior surface is hard and the core soft.

Hardness of Extractor

The extractor, which is used in extracting the cartridge from the chamber of the barrel, has a flexible or spring body which may have a minimum hardness of 55 to 60. The hook engages with a brass cartridge case which is 30 to 35 hard, but as no cutting is done, the well recognized hardness relation of three to one is not necessary. However, when a cartridge case sticks and the pressure on the brass is close to the cutting pressure, a hardness high enough to meet this condition prolongs the life of the extractor hook. The minimum hardness advisable is 75 and the maximum 85. The maximum requirement of 85 is due to the fact that the steel must be very tough, and toughness can only be obtained by drawing the temper down at least ten points. The higher hardness can only be obtained uniformly by the use of an 0.90 to 1.00 per cent carbon steel. The lowest carbon content allowable is 0.50 per cent.

Hardness of Gun Springs

Many tests have demonstrated that the minimum hardness for gun springs is 55 and the maximum 65 to 70. Below 55 the steel weakens rapidly, and the elasticity is too low to permit the desired flexure. The flexure of any steel spring is greatest at 85 hard, but only in alloy steels is there a sufficient factor of safety available at this hardness. Carbon steel springs take considerable permanent set before fracture when 70 hard, and are thus tough enough to resist violent shocks even though stressed very close to the elastic limit during service.

Hardness of Sliding Parts

Sliding parts which are exposed to continuous hand pressure need not be harder than other heat-treated steel having, say, a minimum hardness of 30 to 35. The principal advantage of having the higher hardness is in resisting wear due to grit. Even without heat-treatment, sliding parts exposed to continuous hand pressure usually outwear the bore. Parts exposed to violent shock or impact such as the bolt (see Fig. 2) should have a minimum hardness of 60 in order to prevent battering and upsetting.

Hardness of Casehardened Parts

In small casehardened parts which are not subjected to violent impact, the hardness may be as high as can be obtained by quenching without drawing. When these parts are subjected to considerable torsional stress, as is the case on the bolt and receiver, the casehardened surface should show a hardness of at least 85 when the temper is not drawn. This hardness is desirable principally because of the depth of case necessary to give such a hardness reading on the scleroscope, and upon which the resistance to battering would depend. As an example, mild steel, 21 hard, may be casehardened in cyanide to resist the file. When tested with the scleroscope it may show no more than 25 hard. The reason for this is that the hardened case is so thin that, though it resists the file, it cannot resist the battering impact of the scleroscope drop-hammer. It thus requires a hardness depth of at least 0.01 inch to give a reading of about 85 hard on the scleroscope. If the case is thinner than this and the core is perhaps not more than 25 hard, there will be a lower reading shown under the scleroscope because of the lack of support for the drop-hammer's impact. Hence in this instance, where only a slight depth of hardening is required, the scleroscope becomes a faithful detector of the depth of the hardened case.

* * *

OXY-ACETYLENE WELDING OF ALUMINUM

BY FOREMAN

The article by S. W. Miller which appeared on page 461 of the February number of MACHINERY shows that modern methods of autogenous welding have been developed to provide for welding aluminum alloys, a class of work which was formerly considered impossible. Personally, I think it would have been more appropriate if Mr. Miller had entitled his article "Oxy-Acetylene Welding of Aluminum Alloys," as the title used is rather misleading. In the article referred to it is stated: "Aluminum is seldom used in its pure condition, as it is too soft." While it is conceded that aluminum is unsuitable for many classes of work owing to its softness, this limitation applies only to the pure metal. At the present time there are undoubtedly a great many products made of pure aluminum, and these are extensively used in many lines of manufacturing. Pure aluminum is sold in the form of sheets, bars, strips, rods, tubes, etc.; in fact, the writer is acquainted with one manufacturer of aluminum who produces no less than 700 different drawn and extruded sections made from pure aluminum.

In his article Mr. Miller also makes the following statements: "The author doubts the advisability or necessity of using flux"; and, "It is frequently stated that it is impossible to make a sound weld in aluminum without a flux which will destroy the oxide." I agree most heartily with the latter statement, as it may be safely stated that a weld made in aluminum without the use of flux is not likely to result in the production of homogeneous metal. Consequently, it is advisable to use a suitable flux which will cause the oxide to melt or break down at the same temperature as the aluminum. This is obvious when it is explained that the melting point of metallic aluminum is 657 degrees C. and that of aluminum oxide is nearly 3000 degrees C. Therefore it is evident that welds made by mechanical puddling are not likely to result in the development of a homogeneous metal structure, as a portion of the oxide almost invariably remains in the weld and detracts from its strength.

In cases where such parts as automobile crank-cases and transmission cases are to be welded, I agree that sufficient strength can be obtained without the use of a flux, the reason being that these parts are usually made of an aluminum alloy and not from pure aluminum. When making welds in pure aluminum where a homogeneous structure of the metal is required, difficulty will sometimes be experienced, especially in the case of thin sections. Another troublesome case is where a weld must be made in a vertical position without the use of a flux. This is practically impossible; but the same welds can be readily made by using a suitable flux.

* * *

The proportions of a countersunk bolt head should be such that the diameter at the upper end of the conical head is equal to twice the diameter of the bolt. The length of the conical head should be five-eighths of the diameter of the bolt.

ELECTRIC WELDING FIXTURE

An electric welding operation of more than ordinary interest is carried on at the North East Electric Co.'s plant in Rochester, N. Y., in making the "North-East" electric starting and lighting outfit for automobiles. The operation consists of spot-welding a German silver relay contact to its brass holder. Fig. 1 shows the sheet metal parts separately and as they appear after making the two spot-welds necessary to join them. The parts must be located squarely before welding, and the holes in the two pieces must be in line. The fixture for holding the work was designed to meet these conditions, and as it is not practical to make two spot-welds simultaneously with one pair of electrodes, provision had to be made for moving the work to make the two welds separately.

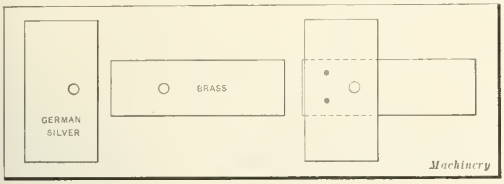


Fig. 1. Parts to be welded

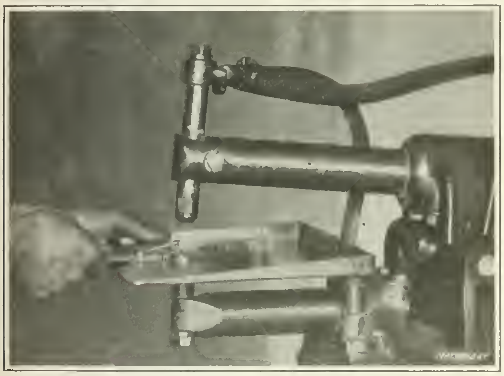


Fig. 2. Welding Operation

Referring to Fig. 3, it may be seen that the fixture is of the swiveling type; the first and second positions occupied in making the welds are shown in full and dotted lines, respectively. The brass brush-holder is first dropped into a shallow slot in the fixture, the rear end resting against a shoulder. The German silver part is next laid over the brass part and at right angles to it. The operator now presses down the spring locating pin that centralizes the parts and lines up the two holes. As soon as the finger pressure on the locating pin is released, it springs up out of the way until needed for the next piece. The foot-lever of the welding machine is depressed to make the first weld. The fixture is then swiveled to bring the second welding point into position under the electrodes, and the second weld is made, completing the job very rapidly. C. L. L.

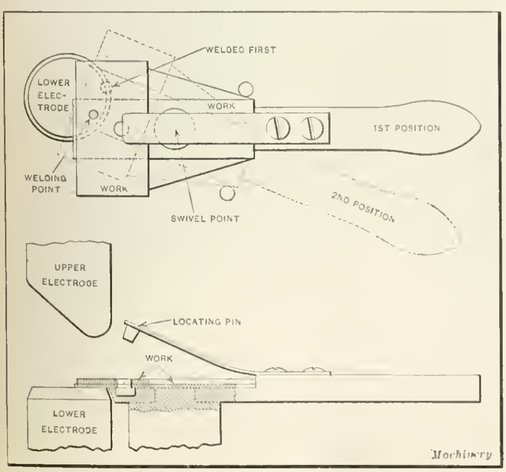


Fig. 3. Details of Welding Fixture

* * *

SAVING STOCK WITH STEEL TUBING

The Meisel Press Mfg. Co. of Boston, Mass., had several thousand special steel spinning rings to manufacture under contract. Fig. 1 shows one of these rings full size and gives the important dimensions. Several methods could have been used in making these rings, but it was decided to make them from Shelby steel tubing, doing the turning in an engine lathe with a Conradson turret attachment. It will be appreciated that a big saving in stock was secured by this method of manufacture. The extreme diameter of the rings was 4 7/16 inches, and the inside was 4 1/16 inches. The extreme thickness of the ring was 1/4 inch. It was required that these rings be turned to within 0.001 inch of the correct diameter. The tubing was held in the lathe chuck and supported by a steadyrest near the extreme end, as shown in Fig. 2. With the aid of the turret attachment, the outside diameter was turned to a diameter of 4 7/16 inches, over a length of about 10 inches. The inside was next bored to 4 1/16 inches diameter for a similar distance. Then the shoulder was formed on the end of the bar and one of the rings cut off. These last two operations were continued until all of the turned section had been worked up, at which time the steadyrest was moved along and a new length of tubing worked upon.

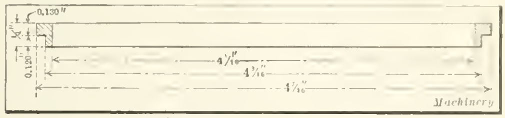


Fig. 1. Spinning Ring made from Shelby Tubing

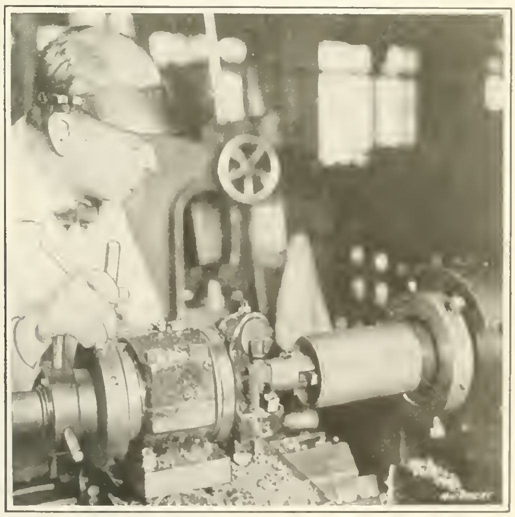
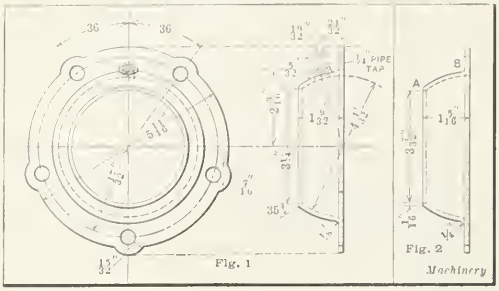


Fig. 2. Using the Conradson Turret to make Spinning Rings from Tubing

No heavy cuts were necessary, and the operation resolved itself into one of taking light cuts with practically no waste of stock. The production was 150 pieces per day of ten hours. Shelby steel tubing comes in so many sizes that it is possible to secure the required size for almost any ring job. C. L. L.

PRESS-WORK ON A UNIVERSAL JOINT COVER

BY ERNEST A. WALTERS*



Figs. 1 and 2. Universal Ball Cover and Condition of Work after finishing First Operation

The universal joint cover illustrated in Fig. 1 is one of two parts of a gasoline motor transmission. This part is made of 5/32-inch hot-rolled steel and is finished under the punch press in three operations. It must be of uniform strength at all points, and for this reason great care must be exercised in performing the press-work in order to avoid stretching the metal in a way that would lead to the rejection of the work when it reached the inspection department. As previously stated, the stamping is made in three press operations which have been worked out in a way which affords a very satisfactory rate of production.

Under ordinary conditions, it would take about nine operations to complete this stamping, these operations being about as follows: 1. Stamp out the round blank and perform the first drawing operation. 2. Re-draw to the proper shape and reduce the 1/4-inch radius under the flange to 1/8 inch. 3. Trim the work to the required diameter. 4. Perforate the bottom. 5. Perforate the hole in the wall where the boss is to be drawn. 6. Draw the boss. 7. Trim the bottom of the work and turn the edge to the required 35-degree angle, an engine lathe being employed for this purpose. 8. Perforate five 7/16-inch holes in the flange. 9. Re-strike the work in a press to flatten the flange and eliminate distortion caused by drawing the boss.

When the method of procedure outlined in the preceding paragraph is compared with the work of the dies which enable the entire piece to be finished in three operations, the saving in the cost of production will be readily appreciated. This is a good example of how it pays to expend the necessary amount of money in developing the proper method of doing work at the start, and in this connection it may be mentioned that a set of templets should be made for the punches and dies when they are new, so that the proper form of the tools is not lost as the result of wear. The occasional use of the templets enables both the punches and dies to be re-ground when necessary to preserve the required shape. For instance, it is important for the radii of curvature on both the punch and die used for performing the first operation on this job, to be held quite close to the original dimensions in order to obtain uniform stampings. To allow these radii to change from their original lengths through wear would naturally result in changing the dimensions of the stampings as well as their extreme diameters.

* Address: 219 W. Buena Vista, Highland Park, Mich.

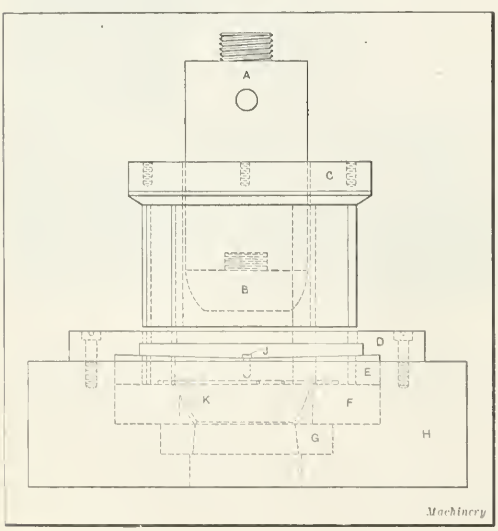


Fig. 3. Punch and Die used to bring Work to Form shown in Fig. 2

Fig. 3 shows the punch and die used for performing the first operation. Referring to this illustration, it will be seen that *A* is the drawing punch which is made of machine steel and provided with a high-speed steel point *B* which can be readily replaced when necessary. The blanking punch is shown at *C* and this punch also acts as a blank-holder while the drawing operation is in progress. The stripper provided to strip the steel from the blanking punch is shown at *D*. It will be evident that *E* is the blanking die and *F* the drawing die, while the perforating die employed to remove the bottom of the stamping is shown at *G*. These three dies are of the ring type; the drawing die is made of high-speed steel, while the blanking die *E* and perforating die *G* are made of carbon tool steel. The three ring dies described in the foregoing are held in the cast-iron die-holder *H*, as shown.

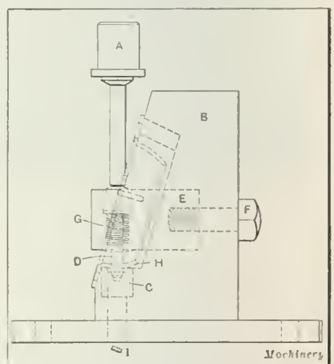


Fig. 4. Punch and Die for piercing 5/16-inch Hole and drawing up a Boss around it

A brief consideration will make it evident that the height of the drawing die must be maintained constant in order to insure the proper depth of the stamping. The gage pin *J* is provided to space the blanks properly. The way in which the bottom of the stamping is perforated is somewhat unusual. For this purpose, the punch must be set, so that it does not touch the sharp edges of the perforating die *G*, and at the same time close enough so that it will force out the bottom of the stamping. To avoid damage to the die, care must be exercised in setting up the tools, and after they are set up with all bolts and nuts properly tightened, there is seldom any need to make further adjustment. Literally speaking, the punch and die does not cut out the bottom of the stamping *K*, but rather crushes it out part way and then the bottom breaks away. The edge is clean and even all around and it is inclined at an angle of about 20 degrees which makes it easier to finish the third operation, *i. e.*, finishing the edge to the required angle of 35 degrees.

The second operation combines two ordinary operations, *viz.*, perforating a 5/16-inch hole and drawing out the boss at the same time. The thickness of the steel makes it possible for the 5/16-inch punch to go through without drawing the work to any appreciable extent, and when the shoulder on this punch comes into contact with the work, it draws the steel down into the die to form the required boss. Referring to Fig. 4, which shows the punch and die used for performing this operation, the punch is shown at *A* and the die or bushing holder at *B*. It will be evident that the die-holder *B* serves the additional purpose of a gage which locates the

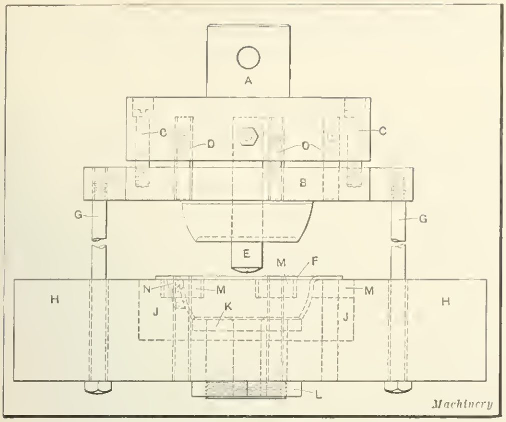


Fig. 5. Punch and Die for piercing Holes in Flange, beveling Bottom Edge of Shell and truing up Work

work in the desired position, and that the perforating and drawing die *C* is mounted in the holder *B*. The perforating and drawing punch *D* is seated in and guided by the extension block *E*, which, it will be seen, is held in place in the holder *B* by means of the cap-screw *F*. The spring *G* is employed to draw the punch back when it has reached the end of its stroke. It will, of course, be evident that the stamping is shown at *H*, and *I* illustrates the slug of metal which has been perforated from the wall of the stamping previous to drawing the boss.

The third operation provides for reducing the ¼-inch radius at the flange to ⅛ inch, and also flattening the flange to correct for any distortion which may take place in perforating the shell and drawing up the boss. This operation also perforates five 7/16-inch holes in the flange and bevels off the bottom of the stamping—which was left rough from the perforating operation—to the required angle of 35 degrees. Referring to Fig. 5, it will be seen that *A* is the punch which has the flattening stripper plate *B* attached to it by means of the screws *C*. The punches for perforating the five 7/16-inch holes in the flange are shown at *D*, and the punch is provided with a central guide pin *E* to preserve the required alignment. The stripper plate *B* has a motion of ¼ inch to provide for stripping the finished stamping *F* from the perforating punches *D*, the stripper being actuated by the stripper rods *G* which are properly adjusted in relation to the die-holder *H*. This die-holder is made of cast iron and supports the die *J* which is provided with a central plug or punch *K* that forms the 35-degree beveled edge at the bottom of the stamping. The bevel punch *K* is held in place by means of the nut *L* which engages the bottom of the die-block. The perforating dies *M* are dovetailed into the die *J* and can be easily replaced when necessary. It will be seen that clearance for the boss on the stamping is provided in the die at *N*, and this space also acts as a locating point in placing the stampings in the die.

* * *

The manufacture of the so-called lead pencils is carried on principally with machinery made by woodworking machinery builders that specialize in high-grade equipment. A lead pencil plant includes woodworking machinery, conveying machinery, gluing machines, hydraulic presses, and some special equipment. The cedar wood is worked up into strips about seven inches long and is then grooved and made ready for the "leads." The "leads" are made of a mixture of graphite and clay, the proportions being fixed by the required grade of pencil. The mixture is forced through dies in a plastic state by extrusion presses of the hydraulic type, and the extruded rods are cut into lengths and baked. It is true in lead pencil manufacture the same as in other lines, that there is little machinery that might be said to be machinery exclusively for the purpose.

RECTANGULAR PRESSURE VESSELS*

One of the problems that usually gives the machine designer trouble is the calculation of the proper plate thickness of vessels that are rectangular or square, instead of cylindrical in shape, and of the pressure that can safely be allowed in such a square vessel of a given thickness of material. In many types of water-tube boilers the square form is used for several details, such as headers, water boxes and mud drums, and not much trouble is encountered in the way of structural weakness, due to the presence of flat surfaces, because their cross-sectional dimensions are usually not large in comparison with the wall thickness.

With pressures higher than the usual, which are sometimes used for certain processes of manufacture, such as from 300 to 500 pounds per square inch, it becomes desirable to investigate the probable resultant stresses in the square headers and boxes due to internal pressure, so that some idea can be gained as to their safety, especially when they are subjected to the temperature of superheated steam. In the case, for instance, of a superheater header the temperature is a factor to be considered. Take the temperature of steam of 300 pounds gage pressure with a superheat of 100 degrees F. At this temperature, steel is blue hot, a condition in which it requires only about two-thirds of the effort to bend it that it takes when at normal temperature. It is also a widely known fact that a piece of steel which is strained by changing its form at a blue heat acquires an excessive brittleness.

From these facts it appears highly desirable that no deformations of the walls of a vessel take place while at a blue heat, or at least, that whatever change of form takes place due to working pressures be limited to a minimum, and consequently that the thickness of the walls be such as to afford a liberal factor of safety against elastic deflections.

The tendency of a square vessel, a cross-section of which is shown in Fig. 1, is to become round when subjected to internal pressure or in other words, such parts of the circumference as are flat tend to become curved, and the corners to straighten out, as shown in dotted lines. Referring to Figs. 1 and 2, two different sources of stress are readily recognizable, namely: the direct stress due to the tendency to separate as shown in Fig. 2, and the indirect stress, which is produced by the tendency of the vessel to assume a cylindrical form. The direct stress is easily calculated by means of the usual formulas for cylinders. In the case of the small dimensioned vessels with the comparatively thick walls under discussion it is well to use Lamé's formula for thick-walled cylinders in preference to the formula usually employed for boiler shells. The total tangential stress in the material of any cylinder is not evenly distributed throughout the thickness *t*

* Abstract from an article by H. J. Vander Eb, in "The Locomotive," published by the Hartford Steam Boiler Inspection & Insurance Co., April, 1915.

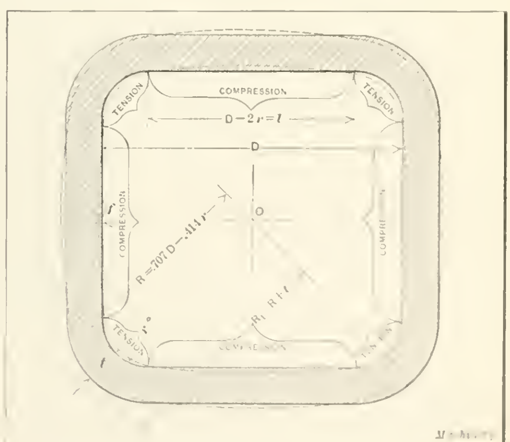


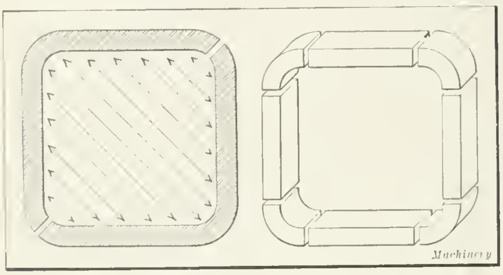
Fig. 1. Notation used in Formulas

of the material, but gradually diminishes from the inner skin of the plate toward the outer skin so that the maximum stress occurs in the inner skin of the metal.

Accordingly, let S represent direct stress in the inner skin of the material, and P, the internal pressure; then, referring to the notations in Fig. 1:

$$S = P\frac{(R_1^2 + R^2)}{(R_1^2 - R^2)} \qquad (1)$$

The stresses due to the tendency of the square vessel to become cylindrical are not so easily calculated. Considering what takes place when the internal pressure P is exerted on the walls of the vessel, we observe, as is shown in dotted lines in Fig. 1, that the flat portions bend outward, acquiring a deflection f, while the curved corners tend to straighten, or in other words, acquire a deflection which is in an opposite direction to the deflection f with regard to the center O of the cross-section. If we regard the curved corners as short curved beams, and consider a length of vessel of one inch, we can distinguish two groups of four beams, namely, four straight ones and four curved ones, the straight beams being the sides of the structure. When a simple beam is subjected to a uniformly distributed load, the fibers on the load side



Figs. 2 and 3. Diagrammatical Views showing Stress Distribution

of the neutral axis are compressed or shortened, and those on the other side stretched.

Because of the fact that the four side and corner beams form one continuous structure, but bend in opposite directions from each other, it follows that for elastic deflections the shortening of the inner fibers of one set of beams is equalized by a corresponding elongation in the inner fibers of the other set of beams, or expressed differently: speaking with regard to the total inner surface of a square vessel, it is an obvious law that the sum of all elongation equals the sum of all contraction in that surface, so long as the elastic limit of the material of the vessel is not exceeded by the attendant fiber stresses. Hence if we can calculate the shortening of the inner fibers of one straight beam of the given length $D - 2r$, due to a given pressure load, we may take this result as being equal to the elongation of the inner fibers of one curved beam of the length $\frac{1}{2}\pi r$. It is not the purpose of this article to attempt a complete mathematical analysis of the true stresses as they exist in the different parts of the square structure under discussion, which is extremely complicated, but rather to give a formula for making a safe approximation of the probable maximum stresses.

In the following formula, let:

S_1 = total unit fiber stress in the metal of the inner skin of the curved beam;

P = internal pressure.

The other symbols used in the formula are indicated in Fig. 1.

$$S_1 = P\left(\frac{R_1^2 + R^2}{R_1^2 - R^2} + \frac{l^3}{5.02\,t^2\,r}\right) \qquad (2)$$

The theory of this discussion, like all theories where the flexure of beams is involved, becomes void as soon as the stresses resulting from the pressure load exceed the elastic limit of the material. It is therefore necessary in all cases to figure the probable maximum stresses in the straight beam first, in order to see whether this is still within the elastic limit, and also to compare this stress later with the stress found for the curved beam from Formula (2). The maximum unit stress in the straight beam is:

$$S_2 = P\left(\frac{3\,l^2}{4\,t^2} + \frac{D}{2\,t}\right) \qquad (3)$$

The allowable pressure on the vessel should then be based on the weakest part, whichever of the beams is found stressed the highest.

With these formulas, the all important radius of the corner fillet is duly taken into account. From the theory of curved beams this is very essential, since in this form of beam, when of rectangular cross-section, the location of the neutral surface does not coincide with the center of gravity of the section as it does in straight beams, but its distance from the concave side of the beam is proportional to $\frac{t}{r}$. For $\frac{t}{r} = 0$, which is radius = infinity, or a straight beam, the distance of the neutral surface from the outer fibers is $\frac{t}{2}$. For a curved beam of a microscopically small radius, which is a sharp corner, the neutral surface and the concave outer surface coincide, which makes the stresses in the concave side infinitely large. Between these limits the following values for the distance of the neutral surface to the concave side of curved beams obtain:

$\frac{t}{r}$	Sharp corner	10	5	1	½	[illegible]	Straight beam
Distance	0	0.317 t	0.358 t	0.443 t	0.466 t	0.492 t	½ t

The fiber stresses in the metal of the concave side of the beams vary inversely as these distances. This shows clearly the importance of having an ample fillet radius at the corners of rectangular vessels.

Example:—A square header has a side dimension of 7¼ inches, an internal fillet radius of 1 inch and a thickness of ⅝ inch. What is the maximum fiber stress at 300 pounds gage pressure? Referring to Fig. 1, the following values appear:

$D = 6$ in.; $r = 1$ in.; $l = 4$ in.; $t = 0.625$ in.

$R = 0.707 \times 6 - 0.414 \times 1 = 3.828$ in.

$R_1 = 3.828 + 0.625 = 4.453$ in.

Then from Formula (3), maximum fiber stress in straight beam:

$$S_2 = 300\left(\frac{3 \times 4^2}{4 \times 0.625^2} + \frac{6}{2 \times 0.625}\right)$$
$$= 300\ (30.7 + 4.8) = 10{,}650 \text{ pounds per square inch}$$

This is well within the elastic limit of the material.

From Formula (2), maximum fiber stress in curved beam:

$$S_1 = 300\left(\frac{4.453^2 + 3.828^2}{4.453^2 - 3.828^2} + \frac{64}{5.02 \times 0.39 \times 1}\right)$$
$$= 300\ (6.65 + 32.67) = 11{,}800 \text{ pounds per square inch.}$$

With material of an ultimate tensile strength of 60,000 pounds per square inch, this header would have a factor of safety of over 5.

* * *

SHAFTS FOR TORSIONAL STIFFNESS—CORRECTION

The statement in the next to last paragraph in the article "Shafts for Torsional Stiffness," on page 794, May number, should read as follows: "For shafts of medium carbon or machine steel, divide the figures by 0.98; for bronze, divide by 0.81; for phosphor-bronze, divide by 0.83; for maple, divide by 0.526; for hickory, divide by 0.513. The errors in this paragraph as it appeared were the use of the term "multiply" instead of "divide."

* * *

The receipts from the national forests by the U. S. Treasury during the fiscal year ended June 30, 1915, amounted to nearly $2,500,000—an increase of more than $40,000 over the receipts during the previous year. The timber sales amounted to $1,164,000 and the receipts from the water power to about $90,000.

THE INSPECTION DEPARTMENT*

ITS RELATION TO THE MANAGEMENT OF A MANUFACTURING ORGANIZATION

In any manufacturing company, consideration of the inspection department should begin with a study of the relation of that department to the management of the company and to the various departments of the organization. These relations must be positively fixed and thoroughly understood. In many cases, the inspection department is not rendering the service of which it is capable nor operating at maximum efficiency, on account of lack of cooperation between it and the other departments. It is, of course, the primary function of the inspection department to inspect and pass upon the material submitted to it, approving that which meets the requirements laid down and rejecting that which fails to come up to the adopted standard. At the same time, this department is in a position to render valuable assistance to the sales and purchasing departments as well as to the engineering and production departments, if the spirit of cooperation exists throughout the whole organization.

To Whom should the Inspection Department be Responsible?

In the majority of manufacturing corporations, the inspection department is under the authority of the factory manager or superintendent. In other words, that branch of the organization which builds the apparatus decides whether that apparatus is properly built. It is unnecessary to point out the inherent weakness of this arrangement. The judgment of the inspector may continually be biased by the fact that he is a part of the factory organization and is responsible to the factory management. It is therefore evident that the highest standards of quality and workmanship hardly can be maintained continuously if the members of the inspection department are in any degree subject to the control of a factory superintendent or any other executive who is directly responsible for the factory production and has no connection with the engineering or sales organizations. This statement should not be understood as expressing a doubt in regard to the loyalty or honesty of purpose of any factory official. We must recognize the fact, however, that defects, due to drawings or specifications, are often disregarded by inspectors if they know that no criticism can be attached to them by their superiors on account of the latter's approval of the apparatus, especially when a rejection would prevent meeting a promised date of delivery.

In a smaller number of shops, the inspection department is under the control of the chief engineer. With this arrangement, the judgment of the inspector is likely to be biased by the fact that any defects in the finished product, due to improper specification of materials or any failure of the apparatus to function properly, might be considered as reflecting on the abilities of the engineering department. The inspector will often hesitate to reject a device if he thinks that the objectionable feature may be attributable to his superior officer, as it would imply a difference of opinion that might reflect discredit on the inspector's judgment. Moreover, there is often a tendency among young and subordinate engineers to refuse to recognize slight defects in a design for which they are personally responsible, and to severely criticize an inspector who points out what he considers a defect in such apparatus. Therefore, it will be seen that in most cases the executive head of the inspection department should be as free from control of the engineering department as from the manufacturing department.

The only logical plan of organization is that in which the head of the inspection department, whatever may be his title, is responsible directly to the general manager of the company or the chief executive in control of the factory output. He should report to the same officer as the works manager or the chief engineer. At the same time, he must be in full sympathy with all other departments. He must command the respect of the other department heads and be ready to cooperate with them to further the interests of his company.

The executive head should exercise a most thorough control over all the activities of the department. To that end, there should be no recognized paths of communication between this department and the heads of the other departments, except through his office. The strict enforcement of this rule is essential to the efficient working of the department and to the avoidance of misunderstandings and duplication of effort. This requirement, if rightly understood, will not be interpreted as limiting the useful activity of any member of the department, but will be recognized as a necessary feature in the conduct of inter-department business.

The Duties of the Chief Inspector

The executive head of the inspection department should be thoroughly familiar with general engineering practice and standards. He should be well informed on all shop methods, including foundry and machine shop practice, and be thoroughly versed in the use of testing machines and gages. He should, if possible, be conversant with chemical laboratory methods and apparatus, so as to be able to direct intelligently that part of his organization. Moreover, he should be familiar with the uses of the factory product and the conditions under which it is to operate after it has passed beyond the control of the factory. He must have absolute control of every inspector in the plant and be held responsible for the quality of material and workmanship of all that the plant produces.

In the majority of manufacturing corporations all dealings with the customers are conducted by the sales department exclusively, which is the logical arrangement. For this reason, complaints on the part of the customer are made directly to the sales department and usually reach the shop through a more or less tortuous channel. There is sometimes a tendency on the part of the sales department to assume that all of these complaints are justified, to criticize the shop for turning out an unsatisfactory product, and especially to blame the inspection department for failure to prevent the issuance of the material in question.

In justice to all concerned, including the sales department, all such complaints should be referred to the executive head of the inspection department for a personal investigation and report, and action on the part of the sales department, except so far as it relates to the replacement of material urgently needed, should be deferred until the report is in hand. This report may entirely change the attitude of the customer with relation to the alleged defective material, as it may clearly show that its failure to meet his expectations was due to no fault of the manufacturer or of the apparatus involved. The trouble may have been due to injury in shipment, rough handling after receipt, failure to install or to apply it properly, lack of proper maintenance on the part of the customer or his employes, or to a misconception of the capacity or function of the apparatus itself. Any errors on the part of the factory or inspection department must be freely acknowledged and any steps to prevent their recurrence should be fully explained. An unbiased report, based on all the available facts, rendered by the head of the inspection department to the head of the sales department, may be invaluable to the salesman in his negotiations with the customer.

Cooperation with other Departments

The inspection department exists for the mutual protection of the manufacturer and the customer. The salesmen should be informed in regard to the methods and practice of the inspection department, as this knowledge may be of great service in promoting friendly relations with a prospective or actual customer. The customer is often much interested in the means employed to insure accuracy in the manufacture of the apparatus he proposes to use. The head of the inspection department should therefore make it his duty to advise the sales department of any change in procedure or equipment that might be of interest to that department in its dealings.

The relations of the inspection department to the engineering department are most important, especially in the influence that may be exerted on the designs for new ap-

* Abstract of a paper read by Fred B. Corey, of Pittsburg, Pa., before Section D of the American Association for the Advancement of Science at the Philadelphia meeting, December 30-31, 1914.

paratus and the improvement of the old. In many places, new drawings, when completed and before their final approval, are submitted to a committee (variously known as "mechanical design committee," "limit committee," "standard committee," etc.) to determine if the limits set by the designers are such as can be met commercially in the factory, and to decide if any changes are desirable on account of methods to be used in the foundry, machine shop or elsewhere. The head of the inspection department should be one of the most important members of this committee; in some instances he is chairman. His principal duty in connection with this committee is to advise if the dimensions, tolerances and limits called for on the drawings are satisfactory for the various fits and if the quality of finish called for will be satisfactory to the inspection department. Thus the work of the inspection department should begin even before the designs are approved for manufacture.

The internal organization of the inspection department and the means and methods best adapted to carry out the details of its work are matters that will depend to a great extent on the management and operation of the larger manufacturing organization of which it forms a part. A plan of organization that may be highly efficient in one factory may be deficient in meeting the needs of another shop producing a different product or producing a similar product by widely different methods. The organization of inspectors that is perfectly suited to a factory having a large output of a few well standardized articles would be wholly unable to cope with the situations arising in a smaller factory producing a great variety of articles, but making each in comparatively small numbers. It is obviously absurd to try to apply big-shop methods to a small shop, and the converse application, while far more usual, is no more logical. Such matters must, therefore, be subjects of careful investigation and study in each individual plant.

* * *

One of the leading manufacturers of gear wheels, designs these with webs for the smaller sizes and spokes for the larger. The points at which webs cease to be used and spokes are applied are given by the table below.

Diametral Pitch	Diameter, Inches	Diametral Pitch	Diameter, Inches
12–10	5	4–3	12
9	6	$2\frac{1}{2}$	14
8	7	2	16
7–6	8	$1\frac{1}{2}$	26
5	10		

STRAIGHT KEYS AND THEIR STRENGTH VALUES*

BY PERCIVAL K REED†

Tables have been published at different times giving the proper width of straight keys to use with shafts of various diameters; these cover the range of general practice in machine construction, and are sometimes expressed in the form of an approximate ratio relating to the shaft diameters. The length of the bore of gear hubs or like members, in which the keys are located, is not so well defined, as the conditions of construction may vary it from three-fourths to four or five times the shaft diameter. Thus, while the strength of the shaft is constant for a given quality of material, and varies as the cube of the diameter, it is quite evident that to select a key of a width directly proportional to the diameter, without considering its length, would give a wide range of strength values for the same width of key in a shaft of given diameter. At times, this might result in serious failure, particularly where hubs of short lengths are used.

In the design and construction of machinery it frequently happens that an expensive train of mechanism must be placed in some inaccessible position. It will readily be understood that the failure of a key in such a train of mechanism would entail considerable loss in time and expense for dismantling and reassembling, and it is his ability to overcome trouble from just such conditions that enables the thorough and experienced designer to command a good salary. Under his instructions, such a mechanism would probably have been designed with considerable excess strength for each gear, shaft and key, with the single exception of some easily removable gear or other driving member at the external end of a shaft leading to the internal mechanism. Here the key should be designed to have a shearing fiber stress considerably higher than is generally allowed for safe driving, but still within the elastic limit of the material; this key will have sufficient strength to carry the rated load of this portion of the mechanism, but when some abnormal resistance is developed the key will be the weakest member and will naturally fail with a clean sheared fracture, thus sav-

* For other articles on the design of keys published in MACHINERY, see "Dimensions of Woodruff Keys," September, 1914; "The Square Key versus Rectangular and Tapered Keys," March, 1914; "Dimensions of Tapered Keys and Keyways," February, 1913; and "The Effect of Keyways on the Strength of Shafts," January, 1911.

† Address: 1541 North Felton St., Philadelphia, Pa.

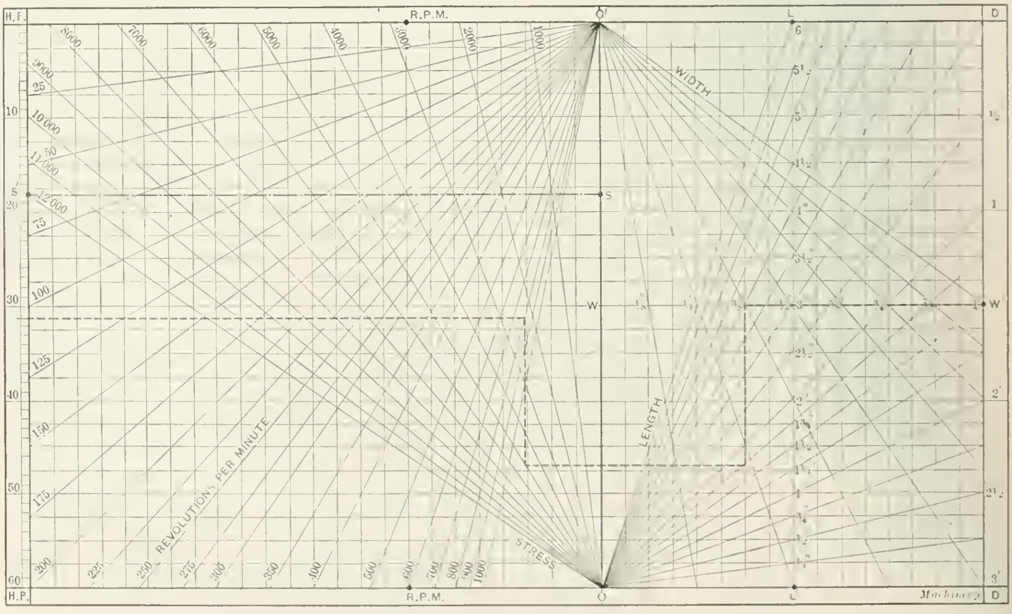


Chart for Use in determining or checking the Strength Values of Straight Keys

ing the more intricate portions of the machine from damage and materially reducing the time and expense required for making repairs. This is analogous to the application of the well-known principle of shear pins used for worm-wheel connections in feed-boxes, and is referred to in order to impress the reader with the importance of knowing exactly the strength of every key that is used, and of varying these values to meet the required condition, *i. e.*, to drive safely or to shear at a predetermined excessive load.

To assist in determining these values quickly and with a reasonable degree of accuracy, when due consideration is given to the six varying conditions of width and length of the key, diameter and revolutions per minute of shaft, horsepower to be transmitted, and allowable fiber stress in the key, the writer has arranged the accompanying chart, whereby the proper relation of these six elements may be obtained when a certain number of them are determined by considerations of design. To illustrate its use, let the chart first be applied in checking up the strength of a key in a 2-inch driving shaft turned down at the keyed portion to 1½ inch in diameter; the velocity is 800 R. P. M., the key is ⅜ inch wide by 1¾ inch long, and is intended to safely transmit 30 horsepower at a maximum fiber stress in shear of 5000 pounds per square inch. The method of procedure is as follows: First, find the shaft diameter D of 1½ inch at the right-hand side of the chart. Then move horizontally to the left until the line intersects the diagonal line indicating the proper key width W of ⅜ inch. Then move vertically until intersecting the diagonal line indicating a key length of L of 1¾ inch. Next pass horizontally into the left-hand chart until intersecting the line which represents a stress S of 5000 pounds per square inch. Then again move vertically to intersect the speed line for 800 R. P. M. By moving to the left from this point, the resultant horsepower will be found. The value obtained is 31.25 horsepower, thus showing the key to be well selected for the required duty, with a slight excess of strength.

When using the chart to determine an unknown element, when the remaining five are either known or assumed, it is only necessary to move forward from the first element and backward from the last element in the proper sequence, and the point of intersection of the projected horizontal and vertical determinant lines in the field of diagonal lines of the unknown element will determine the value of this unknown element. Should the combination of elements be such as not to conveniently lend themselves to projecting and intersecting on the chart, a nominal shaft diameter of 1 inch may be used, and the resulting horsepower multiplied by the actual diameter will give the proper value of the key. As a matter of fact, any one element may be reduced to unity and the resulting horsepower corrected in like manner by multiplication; also, if in finding an unknown element the duty is higher than the scope of horsepower of the chart, some portion of the duty, as one-half the actual horsepower, may be used. If the result is finally corrected by multiplying by the reciprocal of whatever reduction factor was used, proportionate values of the unknown element will be obtained.

For those who may be interested in the principle underlying the laying out of the chart, it may be explained as follows. Let:

W = width of key;
L = length of key;
D = diameter of shaft;
H.P. = horsepower;
R.P.M. = revolutions per minute;
S = shearing stress in key in pounds per square inch;
P = total pounds stress in shear across key area;
$A = WL$ = shearing area of key.

The stress considered is one of direct shear, which is the usual case for well constructed keys as proved by a close examination of actual cases of failure.

$$P = \frac{2 \times 63{,}000 \times \text{H.P.}}{D \times \text{R.P.M.}}$$

$$P = AS = WLS$$

$$WLS = \frac{126{,}000 \text{ H.P.}}{D \times \text{R.P.M.}}$$

$$\text{H.P.} = \frac{WLSD \times \text{R.P.M.}}{126{,}000}$$

It will be noted that the horsepower varies directly as the product of the remaining five elements under consideration, divided by the constant 126,000. Substituting the values of the example referred to in connection with the chart, this expression will become:

$$\frac{0.375 \times 1.75 \times 5000 \times 1.5 \times 800}{126{,}000} = 31.25 \text{ H.P.}$$

This corresponds to the result indicated by the dotted line. The construction of the chart is based on the foregoing discussion, and is worked out as follows: The diagonal lines representing the key widths W are radial from point O', and are laid out to proportional distances from line $O'O$ along line WW'. The values of the diameters D of the shafts are indicated by horizontal lines spaced in proportional distances from line $O'D$. Therefore points of intersection of lines representing D and W will fall at proportional distances from line $O'O$ and represent the various expressions of DW. Likewise, since lines representing the lengths L of the keys, radiate from point O and are spaced at proportional distances from line OD' along line LL', the intersections of vertically projected lines from intersection points DW with diagonals representing the lengths L of the keys, will be at proportional distances from line OD' to the variable values of DWL. Projecting horizontally into the left-hand chart to intersect diagonal lines in the field of stress, which are radial from point O and spaced at proportional distances from line OO' along line SS', the intersections will fall at proportional distances from OO' to give values of the product $DWLS$. A vertical projection from any such point intersecting one of the diagonal lines of R.P.M., which radiate from point O' and are proportionately spaced along line R.P.M., will determine the horsepower, because the distance of intersection will vary from the top of the chart as the product $DWLS \times$ R.P.M. varies, and this product includes all the variable elements in the foregoing horsepower formula, each element as it varies directly affecting the horsepower, as previously noted.

The horsepowers have been indicated at the left-hand side of the chart on horizontal lines spaced at proportional distances from the top of the chart, so as to bring the calculated and plotted results in coincidence, corresponding to the formula, as has been shown by the example. Thus, since the equation is of the first degree, the chart must be approximately correct for all variables within the scope of its area.

When using the chart, it must be kept in mind that it concerns the key values only, and does not determine the relation between the strength of shafts and the horsepower to be transmitted, which is a different abstract problem that is not at present being considered.

* * *

RUSSIAN-AMERICAN TRADE JOURNAL

A journal devoted to Russian-American trade has been started by R. Martens & Co., Inc., 24 State St., New York City. The publishers believe that both Russia and America have much to gain from a better understanding of each other and from closer trade relations. It is the intention to publish in the journal material concerning Russia and the Russians that will be more interesting in a general way and more authoritative from the technical side than the information that is now obtainable in the English language. The journal will be issued monthly and will be sent without charge to all who are seriously interested in Russia and Russian trade opportunities.

* * *

German silver is known under probably a greater number of names than any other alloy. In addition to the name nickel-silver, it is also known as Chinese white silver or packfong, white copper, silveroid, Nevada silver, and electrum.

UNDER-CUTTING MACHINE WITH FINGER GUARD

BY DONALD BAKER*

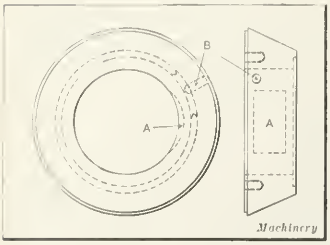


Fig. 1. Work to be under-cut at A

The piece shown in Fig. 1 is the timing ring of a fuse in which it is required to machine the under-cut *A;* and Fig. 2 shows an ordinary bench lathe equipped with a boring cross-slide, which is employed for performing the under-cutting operation. This bench lathe was originally used in the manufacturing department of a watch factory, but the addition of the fixture shown in place on the machine enables it to do this work very efficiently. Referring to Fig. 2, it will be seen that there is a stud *A* on the fixture, the end of which is hardened and ground to form a nose over which the work *a* is located, while the opposite end of the stud is threaded and screwed into plate *B;* the end of the stud extends back into the boring head and slide *C*. When plate *B* has been located in the proper position, it is secured in place by a dowel-pin *D*. This plate *B* also carries two studs *E* which act in conjunction with the swinging clamp *F* to hold the work in place on the nose of stud *A*. Clamp *F* is made of tool steel, and is hardened and drawn to a spring temper at points *G*. The clamp has been cut away at these points to give it sufficient spring to allow for slight differences in the thickness of the work, which may amount to as much as 0.010 inch.

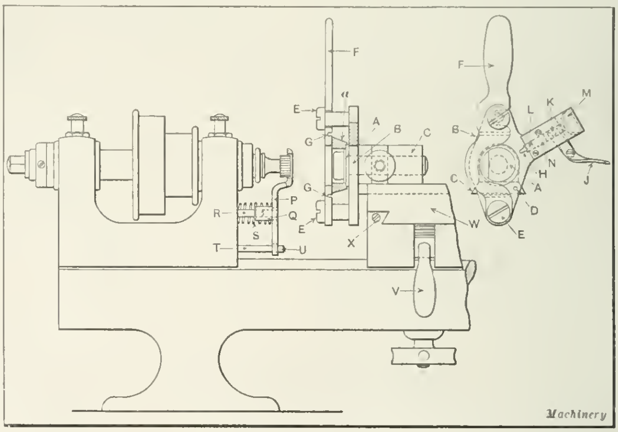


Fig. 2. Bench Lathe with Boring Cross-slide equipped for under-cutting Fuse Parts

The work is located in the fixture by a plunger *H*, which enters hole *B* (Fig. 1). The arrangement of this locating device will be understood from the front view of the fixture shown in Fig. 2 and the detail view Fig. 3, where it will be seen that the locating pin is operated by lever *J* which fits over pin *K* and forces back bar *L* that is a continuation of the locating pin. The drawing back of the pin is resisted by flat spring *M* that serves the additional purpose of a cover plate over the bar that carries pin *H*. Pin *N* enters a slot in the bar *L* and limits its movement so that it is impossible to break spring *M*. This is shown clearly in Fig. 3.

In operating this machine it was found that so little room had been provided between the cutter and the work that the workman was likely to hurt his fingers while putting the work in place in the fixture, even though the cutter was not rotating. To eliminate this danger and also to permit running the cutter continuously, the machine was equipped with a finger guard shown at *P*. This guard is made of a piece of flat stock with a ring which surrounds the cutter and projects past it for a sufficient distance to make it impossible for a man's hand to come in contact with the cutter while the guard is in its outermost position. Bushing *Q* is pressed into the lower part of the guard and is a sliding fit on pin *R*, while spring *S* holds the guard in its outer position. Pin *T* serves as a further guide for the guard, and crosspin *U* limits its travel. It will of course be evident that when the work is fed up to the cutter, lower stud *E* comes into contact with guard *P* and pushes it back against the resistance of spring *S* so that the cutter may enter the hole in the work.

The operation of the machine is as follows: Locating pin *H* is drawn back by means of lever *J* so that the finished piece may be removed from the stud *A* and a fresh blank substituted. Lever *J* is then released to allow the locating pin to drop into position in hole *B* in the work, after which clamp *F* is brought up into position over the work so that it is secured in place on the nose of the fixture. Movement of slide *C*, which is governed by a hand-lever, brings the work into position over the cutter, and guard *P* is moved back, as previously described. When the work has been brought to the limit of its forward travel, which is governed by a stop on slide *C*, the work is fed against the cutter by operating lever *V* which actuates cross-slide *W*, the movement of this slide being limited in either direction by stop screws *X*. The capacity of this machine is for from 3000 to 4000 pieces per ten-hour day, although under the best conditions as many as 100 rings have been under-cut in ten minutes.

* Address: 41 Grant Ave., Jersey City, N. J.

* * *

Engineering schools have successfully taught the laws of materials and forces and the methods of adapting these materials and forces to the use of man, but they have almost entirely disregarded the human element—a knowledge of which is absolutely essential for the proper utilization of any mechanisms which the engineer may contrive. If we would direct successfully the operation of any mechanism, we must have as complete knowledge of the men who are going to operate it as we have of the mechanism itself. * * * Without an intimate knowledge of the workman, a college graduate is too likely to assume, because the workman has not the same kind of knowledge that he has, that he is necessarily ignorant and a fit subject for contempt. A little association with him, however, soon dispels this idea, for the college man finds out that although the workman's knowledge may be quite different from the knowledge that he has, it is very extensive, and embraces subjects of which he is entirely ignorant. The workman has indeed a great deal of knowledge, much of which is far more practical and better suited to his needs than that which the college man can give him. The workman recognizes that the college man knows little about those subjects with which he is most familiar, and he is likely to have more contempt for the college man than the latter has for him.—*H. L. Gantt, in Industrial Leadership.*

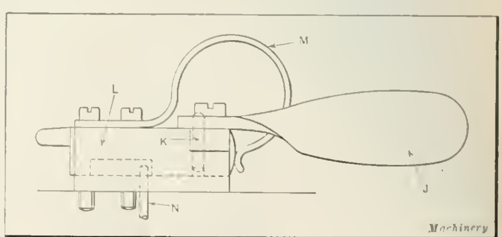


Fig. 3. Detail View of Mechanism for locating Work on Fixture

Tool System of Cadillac Motor Car Co.-I

by
Edward K Hammond

THE development of an efficient system for the purchase of tools and accounting for them after delivery to the shops is one of the difficult problems which the management of every large factory has to work out. There are various requirements to be fulfilled. In the first place, the men in all departments of the factory must be kept supplied with the tools and supplies needed to carry on their work. Second, the tools must be of the type and quality which will do the greatest amount of work for each dollar expended. Third, they must be purchased in a way that insures obtaining the most advantageous price. Fourth, a careful record must be maintained to see that they are not stolen or needlessly damaged. Fifth, accurate accounts must be kept of all tools delivered to each tool supply room in order that they may be charged up to the department using them, when worn out or broken.

After grasping the different phases of this problem, it will be evident that the man who can administrate the tool service department of a large factory must have a variety of qualifications. He must be systematic, for there are a multitude of details to attend to and records to maintain. It is important for him to be a trained mechanic in order to know which tools are capable of giving the greatest amount of service for each dollar spent. Last, though by no means least, he should possess a sufficient knowledge of accounting to see that all charges made against all departments and credits in favor of them are correct. The system used in the maintenance supplies and tool service department of the Cadillac Motor Car Co., Detroit, Mich., was worked out by A. D. Elmer to meet the requirements of this company's factory, but it is capable of application, with slight modifications, in any large manufacturing plant. This system represents scientific management at its best; that is to say, the routine work and accuracy of scientific methods of management have been applied in a way which has eliminated all unnecessary detail or features that would tend to retard the rate of production in the shops. We are indebted to George W. Walker, assistant to Mr. Elmer, for the material which forms the basis of this article.

For other articles on shop systems, see "Shop System of the American Machine & Foundry Co.," February, 1915, and articles there referred to.

Before entering upon a detailed description of the work of the maintenance supplies and tool service department, it will be well to give the reader an idea of just what relation this department bears to the manufacturing departments of the factory. Briefly stated, it may be said to constitute a central distributing station for all tools and supplies used in the performance of manufacturing operations on parts of Cadillac motor cars; although it is important to note that this department does not have jurisdiction over materials which enter into the construction of cars. But the handling of tools and manufacturing supplies is only a part of the work of this department. In addition, it acts in an advisory capacity to the purchasing department by specifying the classes of tools and materials which are to be purchased. The importance of this plan is that the head of the department is a trained mechanic and is able to order the type of tools or class of supplies which is best suited for the particular purpose to which it is to be put. The maintenance supplies and tool service department is held responsible for the quality of all tools and supplies which are delivered to the factory. For this purpose it has a corps of inspectors in addition to a fully equipped chemical and physical laboratory; and all tools and supplies are either inspected or tested before being accepted, so that positive assurance is obtained that their quality is satisfactory. The relationship of the maintenance supplies and tool service department to other departments of the factory is shown diagrammatically in Fig. 1.

The material handled by the maintenance supplies and tool service department is divided into three general classifications as follows: first, "long-lived tools," which are under-

stood to be tools which have a working life of considerable length; second, "short-lived or consumable tools," which is the name applied to a great variety of tools used for manufacturing purposes that are not capable of being used for any long period, drills, taps, dies, files and hack-saw blades being typical examples; third, "manufacturing expense supplies," which are such materials as sandpaper or sponges.

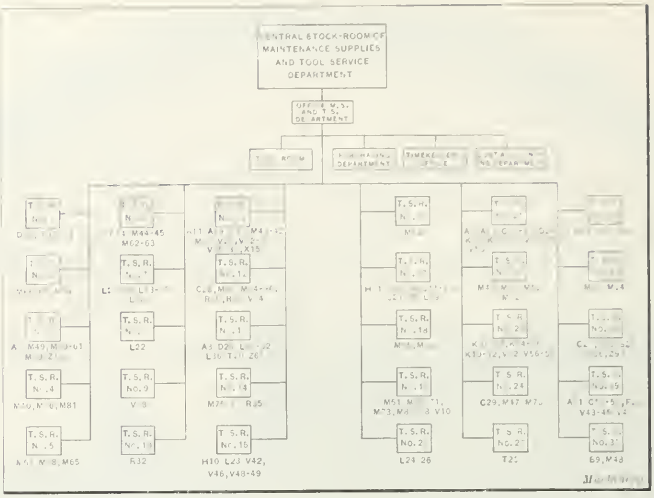
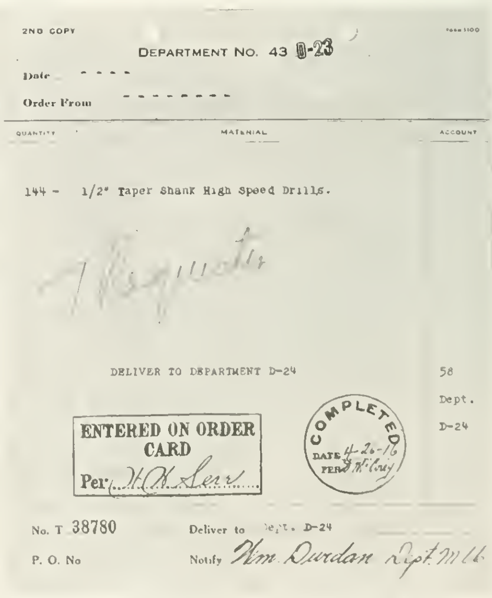


Fig. 1. Diagram showing Relationship of Maintenance Supplies and Tool Service Department to Other Departments of Factory of Cadillac Motor Car Co.

How the System is Operated

For the purpose of giving a detailed description of certain features of this system, we will assume that the foreman in one of the departments of the factory finds himself in need of a number of some type of tools which has not been previously used in the factory. To obtain such tools he must make application to the maintenance supplies and tool service department for them, explaining for what purpose the tools are to be used. This application will be turned over to one of the inspectors of the department, who is a mechanic of wide experience, and it is the duty of this man to decide, first, whether the foreman has need of the tools for which he has made a requisition, and second, whether the tools which he specifies are those best suited for the purpose. If the inspector reports favorably on the foreman's application, the maintenance supplies and tool service department will issue a "T-requisition" for the purchasing department, authorizing the buying of a specified number of the tools in question. In writing this T-requisition, use is made of the form shown in Fig. 2. Six copies are made out which are marked first copy to sixth copy, inclusive, but which are otherwise virtually the same, so that only one copy is illustrated. Attention is directed to the fact that in the lower left-hand corner of the form there are places for a T-requisition number and a purchase order number, but an arrangement has recently been made whereby the "T. No." is used as the "P. O. No." At the same time that the T-requisition is made out, an entry is made on a white order card, shown in Fig. 4, and the pink copy of the requisition is stamped "Entered on Order Card," to show that the order has been issued. This card also records the receipt of tools.

The use of the six copies of the T-requisition issued on the purchasing department is as follows: The first is sent to the purchasing department as authority to buy. The second copy is filed by the tool tracer in the maintenance supplies and tool service office on a file labeled "unfilled orders" until such time as the order has been completed, as explained subsequently. On the back of this copy the tool tracer records all correspondence, and notes progress being made in filling the order, which information is available to all interested parties. The third copy is held on the inspector's file until the tools are received, to serve as a notice that he has these tools to inspect, and after receipt and inspection of the tools the inspector's copy of the T-requisition is destroyed. The fourth copy is sent to the foreman of the department who ordered the tools to notify him that his order has been taken care of and will be filled in due course. It was stated that the form of all copies of the T-requisition is virtually the same, but in the case of the fourth copy which is sent to the foreman, information is given in regard to the clerks in the maintenance supplies and tool service department to whom written or telephone messages should be addressed in making any inquiries in regard to the tools in question. The fifth copy is given to the tool tracer whose duty it is to follow up the job represented by the T-order to be sure that satisfactory progress is being made in filling it. The sixth copy, which is sent to the cost accounting department, is filed by order number so that the invoice may be properly classified when the goods are received. For the drills called for on the order shown in Fig. 2, it will be seen that the invoice would be classified under account No. 58. The cost accounting department also makes out a cost card which is used for reference in pricing worn out tools when they are released, as will be explained later.


2ND COPY

DEPARTMENT NO. 43 B-23

Date

Order From

QUANTITY	MATERIAL	ACCOUNT
144 -	1/2" Taper Shank High Speed Drills.	

DELIVER TO DEPARTMENT D-24 — 58 Dept. D-24

ENTERED ON ORDER CARD
Per H. H. Lear

COMPLETED DATE 4-26-16 PER J. W. Coy

No. T 38780 Deliver to Dept. D-24

P. O. No Notify Wm. Durdan Dept M11

Fig. 2. Form used in authorizing Purchase of Tools and Maintenance Supplies; Size 7 by 8¼ Inches; Six Copies required, which are made out on Yellow, Red, Blue, White, Green and Pink Stock

Receipt of New Tools in the Factory

At the time that the new tools are delivered to the factory, the receiving department makes out five copies of the receiving slip shown in Fig. 3, three of which are sent to the maintenance supplies and tool service department together with the goods. The first copy is signed and returned to the receiving department, where it is filed according to date and name of the firm which supplied the tools, serving as this department's receipt for the goods which it has sent out. The second copy is kept with the goods until they have been inspected; and if they are found to be O. K. and the

copy of the receiving slip conforms with the inspector's copy of the T-requisition (Fig 2) the receiving slip is signed by the inspector and attached to the inspector's copy of the T-requisition. These slips, together with the tools, are then sent to the stock-room, where the balance in stock is added to the quantity received, and noted on receiving slip as indicated by the ninety in a circle in Fig. 3. This is used as a check against the balance which appears on the stock card. The stock-keeper then signs the receiving slip and notes the location of the tools in the stock-room under the space provided for remarks; and this second copy of the receiving slip, together with the inspector's copy of the T-requisition, is then handed to the tool tracer to notify him that the tools have been delivered to the stock-room. The tool tracer destroys the inspector's copy, attaches the pink copy to the receiving slip and hands them to the file record-clerk, who is then ready to close the order card, Fig. 4, and make the proper notations on the stock card, Fig. 5. He then stamps the receiving slip "Posted" and files it by the T-requisition number. The third copy of the receiving slip goes to the foreman of the department for which the tools were ordered, to notify him that these tools are in the stock-room. The pink copy of the T-requisition is stamped "Completed" and filed by the T-requisition number for future reference.


T 38781 REC'D FROM RECEIVING SLIP NO
DATE April 24, 1916
WT
PRO. NO. AM'T CHGS
POSTED Jos. Viehoff. Per.
NO. BOXES, PKGS., ETC. CAR INITIAL NUMBER
PURCH ORDER QUANTITY PART NO DESCRIPTION NET WEIGHT
T-38781 60 1/2" Taper Shank High Speed Drills
4
REMARKS Drawer 160
DELIVER TO DEPT D-24
O.K. F. M. Higby. H.S. Tuckett. 90

Fig. 3. Form used by Receiving Department for recording Receipt of Tools and Supplies; Size 8½ by 5 Inches; Five Copies required, which are made out on White Stock

How Different Classes of Supplies are Identified

For the purpose of keeping accounts, each different class of tools or maintenance supplies is charged to a different account and these accounts are all designated by numbers. Fig. 4 shows the card on which the order is entered at the time that a T-requisition is sent to the purchasing department, authorizing it to buy the supplies called for. It will be seen that the order card has spaces at the top for entering the name, description and size of the tool, and the account number to which it is to be charged; also, that the lower part of this card provides spaces for noting the dates on which the tools are received, the T-requisition number which goes in the column headed "Req. No.", the number ordered, number received and balance due. The column headed "Bal. Due" is filled out in cases where a considerable number of tools are ordered and where the immediate necessity for these tools makes it advisable to have them delivered in installments. In any case, this card shows the condition of the last order issued for tools of the particular type to which it refers. The stock card, Fig. 5, is the same as the order card except for the two spaces on the left marked "Min." and "Order." This refers to the the number of tools of this kind which must always be kept in stock, and when the number has been reduced to this minimum it means that an order must immediately be issued for the necessary number to bring the supply on hand up to the maximum quantity. It will also be noted that the location of this particular tool in the tool stock-room is entered beside the heading "Location." The arrangement of the card will be self-evident with the exception of the columns headed "In," "Out" and "Balance." Each time new tools are delivered to the stock-room the number received is recorded in the "In" column, and similarly each time tools are sent out to one of the tool supply rooms the number sent out is recorded in the "Out" column. By adding to or deducting from the previous balance number, the existing balance on hand is found and recorded in the column provided for that purpose.

A record of receipt is made on the stock card shown in Fig. 5 at the time the tools are delivered to the stock-room. The order and stock cards are kept in filing cabinets in the office of the maintenance supplies and tool service department. At the time that the receipt of new tools is recorded on the stock card, a corresponding entry is made on a stock bin card, shown in Fig. 6. Cards of this type are held in clips on each of the bins, and contain a record of the number of tools in the bin; the records on these cards also serve as a check on the records of the balance which appears on the stock cards. The manner in which this card is filled out will be evident after having read the description of the stock card.

How the Foreman Proceeds in Ordering Tools

The maintenance supplies and tool service department has a central stock-room to which all new tools and supplies are sent at the time they are delivered to the factory; and distributed around the plant are a number of sub-departments known as "tool supply rooms" which act as middlemen in the transfer of tools from the main stock-room to the different departments of the factory. The men in the factory go to the tool supply rooms for anything they need; and when

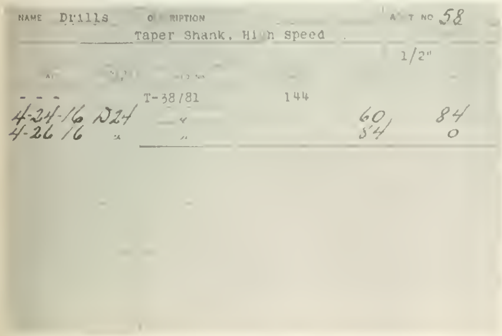

NAME Drills DESCRIPTION Taper Shank, High Speed A/C NO 58
1/2"
T-38/81 144
4-24-16 D24 60 84
4-26-16 84 0

Fig. 4. Form of Card used for recording Order and Receipt of Tools and Supplies; Size 6 by 4 Inches; One Copy made out on White Stock

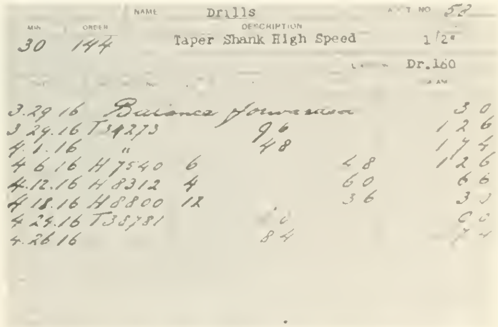

NAME Drills A/C NO 58
MIN ORDER DESCRIPTION
30 144 Taper Shank High Speed 1/2"
Dr. 160
3.29.16 Balance forward 30
3.29.16 T34273 96 126
4.1.16 " 48 174
4.6.16 H7540 6 48 126
4.12.16 H8312 4 60 66
4.18.16 H8800 12 36 30
4.24.16 T38781
4.26.16 84

Fig. 5. Form of Card used for recording Amount of Stock on Hand in Central Supply Room; Size 6 by 4 Inches, One Copy made out on Pink Stock

Form 1113

Name Drill Size 1/2"
Kind Taper Shank High Speed Location Dr 160
No. Classification 58

Date	Order No.	In	Out	Balance	Remarks
3-29-16	Bal. Forwarded			30	
3-29-16	T34273	96		126	K.G.
4-1-16	"	48		174	K.G.
4-6-16	H7540		48	126	T.S.R.#6 K.G.
4-12-16	H-8912		60	66	" #4 K.G.
4-18-16	H-8800		36	30	" #12 B.D.
4-24-16	T38780	60		90	F.P.
4-26-16	"	84		174	F.P.

Fig. 6. Form of Bin Card used to record Number of Tools in Bins; Size 5 by 3 Inches; One Copy made out on White Stock

the attendant finds that his stock of any tool is running low, which seldom happens due to automatic replacement each week of broken and worn out tools, as fully explained subsequently, he sends up to the central stock-room for more. In making requisition for supplies, use is made of the form shown in Fig. 7, which is made out in duplicate and sent up to the maintenance supplies and tool service department by a messenger. Both copies are handed to one of this department's inspectors, who passes upon the propriety of the requisition, and is found O. K., sends it to the stock-room where an order number is assigned to the delivery of tools, after which the proper entry is made on the bin card and the tools called for are handed to the messenger who takes them back to the tool supply room.

At the time that the tools are removed from the bin, a proper entry is made on the card held in the clip on this bin to show the balance which still remains on hand; and the requisition slip is stamped "Filled" on back. The first copy

C. P. 111 2-16

MATERIAL TRANSFER OK/BB.

STORE ROOM ACCOUNTS

Date April 18, 1916 No. H-8800

Quantity	Description	Price	Amount
36	1/2" Taper Shank High Speed Drills (30)		

From D-24 To D-31-T.S.R. #12

Stores Class 58 Stores Class 58

Signed H. McLaren

Fig. 7. Form used by Foreman in making Requisition for Tools and Supplies; Size 3 by 5 Inches; Two Copies made out on Yellow Stock

of the requisition is sent on to a requisition clerk who enters the item in the "Requisitions Filled" book. This book is maintained to be sure that all requisitions are properly accounted for, and does away with the possibility of lost requisitions. One copy of the requisition goes to the file record-clerk to make the proper entry on the stock card and figure the balance on hand; and finally, the requisition slip goes to the cost accounting department, where the proper adjustment of accounts is made and the slip filed by its order number. It will be noticed on this slip that there is a number 30 with a circle drawn around it, which represents the number of tools that remain on hand after the order has been filled. When the slip reaches the file record-clerk, he calculates the balance on hand from the data on the stock card and the balance obtained must agree with the number on the requisition slip; otherwise, an investigation will be instigated to determine the cause of the discrepancy.

When the tools are given to the messenger to take to the tool supply room, a list of the tools is made on the form shown in Fig. 8, to which has been assigned the same order number as shown on the requisition, and the messenger signs this form with the name of the foreman of the tool supply room to which the tools are going, together with his own initials. This form is filed in the maintenance supplies and tool service office by requisition number and serves as a receipt for the tools that have been sent out. At the time the tools are sent from the central stock-room to the tool supply room a slip of the form shown in Fig. 9 is made out and sent to the foreman to notify him that the tools he needs are in his tool supply room ready to be drawn out on the workmen's tool checks. When tools are received in the tool supply room they are entered in a book known as the "Incoming Commercial Tool" book, which shows date received, requisition number, quantity and description of the tools, and contains spaces to be used by the tool supply room man and clerk for checking when cards are put in the card file and spaces assigned on the check board.

The second copy of the requisition slip, Fig. 7, goes to the tool supply room record-clerk who makes an entry on cards

H-8800 Date April 18, 1916

Received from

DEPT. NO. D 24

36 - 1/2" - Taper Shank High Speed Drills

Sign here H. McLaren Per. D.M.

Fig. 8. Form used by Messenger in signing Receipt for Tools or Supplies sent to Tool Supply Room; Size 6 by 4 Inches; One Copy made out on Orange Stock

of the form shown in Fig. 10. These cards are made out in duplicate on red and white stock; the white copy is filed in the maintenance supplies and tool service department and the red copy in the tool supply room. On the day following the delivery of the tools, the second copy of the requisition slip is taken to the tool supply room, where the entry is made on a card, Fig. 10, to record delivery of the tools to the tool supply room. At the same time, the clerk checks the "incoming commercial tool" book to show that the proper entry has been made on the card, Fig. 10. Later the man who has charge of the check boards also checks the book to show that a space has been assigned to the tools on the check board.

Report to the Office

It has been explained that on the day after the tools are sent from the central supply room to one of the tool supply rooms, a clerk takes the second copy of the tool supply room

Form 903A

Commercial Tool Notice

Date April 18, 1916

Mr. Winne

This is to notify you that

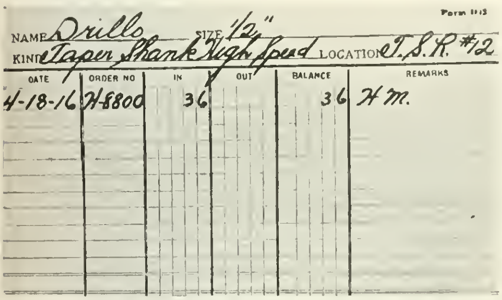
Amount	Size	Article
36	1/2"	Taper Shank High Speed Drills

~~Is~~ Are in Tool Supply Room No. 12

Signed A. W. Elmer B.D.

Fig. 9. Form used by Central Stock-room in notifying Foreman of Delivery of Tools to his Tool Supply Room; Size 5¼ by 4⅛ Inches; One Copy made out on Orange Stock

foreman's requisition slip and makes an entry on the card file in the tool supply room. It will also be recalled that the man in charge of the check board sees that a space has been provided for the tools so that they may be checked out to a workman. Similarly, if tools are removed permanently, the tool supply room records must show that such tools are no longer available. Each tool that goes out of a tool supply room is entered in a book known as the "Outgoing Commercial Tool" book which shows the date on which the tools were removed and the quantity and description of the tools, together with spaces to be used by the clerk to check when removing cards, check-board man to check when check board has been corrected and tool supply room man to cross-check when book and work are O. K. Once a week the books of each tool supply room are gone over by the man in charge to see that they are checked up to date. In reporting conditions



Form 1113

NAME Drills SIZE 1/2" KIND Taper Shank High Speed LOCATION T.S.R. #12

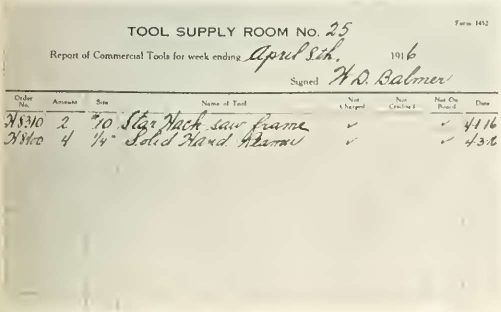
DATE	ORDER NO	IN	OUT	BALANCE	REMARKS
4-18-16	H-8800	36		36	H.M.

Fig. 10. Form of Card used for recording Transfer of Tools and Supplies from Stock-room to Tool-rooms; Size 3 by 5 Inches; Two Copies made out on White and Red Stock; White Copy filed in M. S. & T. S. Office and Red Copy in T. S. R.

found in each tool supply room, he uses the form shown in Fig. 11. It will be seen that the form used for this purpose provides a space for the number of the tool supply room to which the report refers, and spaces for the date and the tool supply room man's signature. In the space on the form, information is given concerning the order number, the number of tools, with their size and description, after which a check mark is placed in one of the three vertical columns at the right to show if a tool has been sent out without being credited, if it has come in without being charged, or if no space has been provided on the check board for the tools in question. In each case, the date of the transaction is recorded in the column at the extreme right. The making of these reports to the office enables the work of each tool supply room to be accurately checked up, and if it is found that any of the clerks show a tendency to be lax in their work, the necessary steps can be taken to overcome the difficulty.

Examining the Records to Guard Against Shortage

It has already been explained that a minimum number is assigned to each class of tools and supplies, and recorded on the stock card in the space assigned for that purpose. When



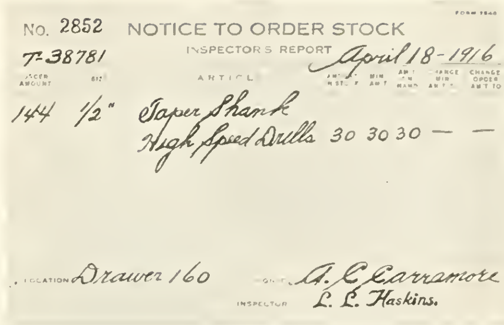
TOOL SUPPLY ROOM No. 25 Form 1452

Report of Commercial Tools for week ending April 8th, 1916

Signed H. D. Balmer

Order No.	Amount	Size	Name of Tool	Not Charged	Not Credited	Not On Board	Date
H8310	2	#10	Star Hack saw frame	✓		✓	4/16
H8100	4	1/4"	Solid Hand Reamer	✓		✓	4/3/16

Fig. 11. Form used by T. S. R. Foreman for recording Conditions of Files and Check Boards in Tool Supply Rooms; Size $8\frac{1}{4}$ by $5\frac{1}{8}$ Inches; One Copy made out on Pink Stock



No. 2852 NOTICE TO ORDER STOCK

T-38781 INSPECTOR'S REPORT April 18-1916

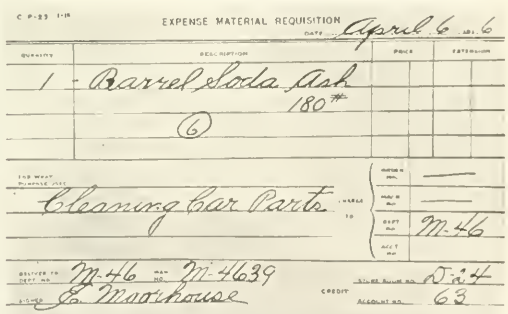
144 1/2" Taper Shank High Speed Drills 30 30 30 — —

LOCATION Drawer 160 A. C. Carramore

INSPECTOR L. L. Haskins.

Fig. 12. Form used by Inspector in calling for the Purchase of Additional Supplies; Size 6 by 4 Inches; Three Copies made out on Salmon, White and Yellow Stock

the file record-clerk, in the course of making deduction for tools sent out, finds that any article has reached the minimum amount he fills out the form shown in Fig. 12, one copy of which is passed to the inspector to determine whether or not the article is to be re-ordered. His knowledge of conditions in the factory is such that he can anticipate requirements and thereby control maximum quantities to carry in stock. If he finds that an order should go through, he O. K.'s his copy of the form shown in Fig. 12, and hands it to one of the stenographers to make out a form, Fig. 2, authorizing the purchasing department to buy more articles of this particular class. The form shown in Fig. 12 is made out in triplicate; the first copy is used by the stenographer, as previously mentioned, and is finally filed by the T-order number, which is written on the form shown in Fig. 2. The second copy is held by the record-clerk until the T-order has been written, after which it is destroyed. Before the first copy is filed, it is attached to the T-order form which has just been made out,



EXPENSE MATERIAL REQUISITION DATE April 6 1916

QUANTITY	DESCRIPTION	PRICE	EXTENSION
1	Barrel Soda Ash 180# (6)		

Cleaning Car Parts DEPT M-46

DELIVER TO DEPT NO. M-46 NO. M-4639 D-24

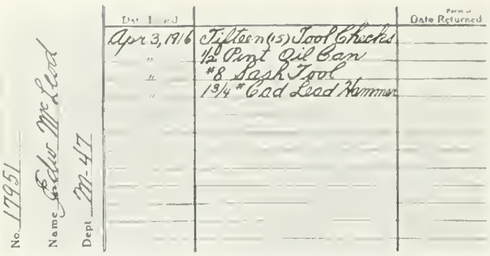
SIGNED E. Moorhouse CREDIT ACCOUNT NO. 63

Fig. 13. Form used by Foremen in making Requisition for Manufacturing Expense Supplies; Size 6 by 4 Inches; One Copy made out on Yellow Stock

and sent to the record-clerk who makes the necessary entry on the order card shown in Fig. 4. The third copy of the form shown in Fig. 12 is sent to the stock-room for the purpose of checking the balance recorded on the stock card against the number of tools actually in the bin, in order to be sure that these two coincide. The third copy is then returned to the office and filed by its card number 2852 for reference.

Method of Drawing Manufacturing Expense Supplies from Central Stock-room

The materials used in the factory which come under the classification "manufacturing expense supplies," that is to say, supplies which are rapidly consumed, are ordered out from the central stock-room on requisition slips of the form shown in Fig. 13. It will be seen that this slip provides for giving a description of the material, amount used, and cost, together with the purpose for which the material is to be used; and that spaces are provided for crediting the central stock-room


No. 17951 Name Edw McLeod Dept. M-47

Date		Date Returned
Apr 3, 1916	Fifteen (15) Tool Checks	
"	1/2 Pint Oil Can	
"	#8 Sash Tool	
"	1 3/4" Cad Lead Hammer	

Fig. 14. Form of Card used by T. S. R. to record Tool Checks and Tools given to Workmen; Size 7 by 3½ Inches; One Copy made out on Drab Stock

with this amount of material and charging it against the department in which it is actually to be used. Before any manufacturing expense supplies can be sent out from the central stock-room, the requisition must be O. K.'d by the inspector and an order number must be assigned by the stock-room for purposes of identification. When the requisition is filled, the messenger signs a receipt for it, as in the case where an order is filled for tools, the form shown in Fig. 8 being employed for this purpose. The transaction is entered on the requisition record book by order number and the requisition slip, Fig. 13, is sent to the stock record-clerk for adjustment of the stock cards, and then to the cost accounting department, where the proper adjustment of the accounts is made to cover the transaction.

Drawing Out Tools from Stock Supply Rooms

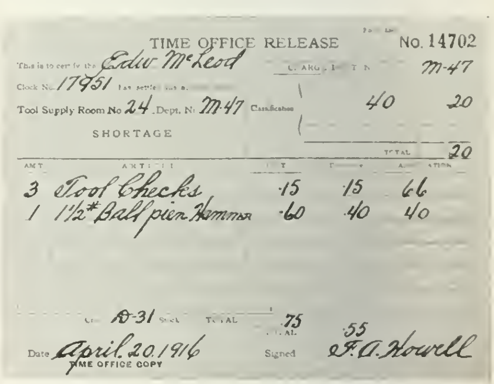
In the Cadillac Motor Car Co.'s shops, the usual check system is employed for lending tools to the workmen. When a man comes to work he is usually given fifteen tool checks, but this number would not be sufficient to enable him always to get the number of tools required for his work if he had to take out all tools from the tool supply room on check. For the purpose of partially overcoming this difficulty, it has been found advisable to lend each man a certain standard set of tools—according to the work for which he is employed—and have these recorded on a card instead of lending them to him against tool checks. For this purpose cards are employed of the form shown in Fig. 14, and it will be seen that on these cards the first entry is "Fifteen Tool Checks," together with the date on which they were given to the workman. Standard tools may also be lent to the man and entered on this card, and should it happen that he returns any of the tools before leaving the company, the date on which the tools were returned is recorded in the column provided for that purpose, such a record constituting a cancellation of his responsibility for the tools in question. These cards are an important factor in preventing the theft or loss of tools, because before a man can be paid off when leaving, he must first get his tool account O. K.'d by the foreman of the tool supply room which serves the department in which he was employed.

After the tool supply room foreman has gone over the tool account of a man who is leaving, he fills in a time office release form, Fig. 15. If the account is found to balance properly, the fact is noted, but should it happen that certain tools are missing these are noted in the space at the bottom. That part of the cost of lost tools which is to be charged to the employe is determined by the general foreman of the tool supply rooms, who notes it on the release, together with the account numbers of these tools. As a matter of fact, employes are seldom called upon to pay over half of the original cost of the tool; frequently it is less than this amount. In the upper right-hand corner of the form there is a space for noting the difference between the original cost of lost tools and the amount which the workman paid, this difference being charged against the department in which the tool was used. This form is made out in triplicate. The first copy is sent by messenger to the time office, the second copy is held by the tool supply room foreman until he gets credit for tool shortage on release and for future reference, and the third copy is held by the tool supply room general foreman as a memorandum to assist him in seeing that he gets proper credit for his tool supply room in case of shortage.

Weekly Replacement of Worn Out and Broken Tools

If a man has a tool out on check and breaks the tool or wears it down to a point where he finds that it is no longer giving satisfactory service, he takes the tool to the foreman of his department and gets him to sign a tool release slip which will enable him to return the damaged or worn out tool to the tool supply room and get another tool or his check in exchange for it. For the purpose of releasing tools in this way, the foreman makes use of the form shown in Fig. 16, and when this form is turned in, an investigation is conducted to see if the supply of this particular kind of tool has been reduced to a point where more should be ordered. This work is done by the foreman of the tool supply room, and after he has reached a decision he draws his pencil either through the word "yes" or "no," leaving an affirmative or a negative to express his decision in regard to the necessity of replacement. These damaged tools, together with the foreman's release slips, are placed in a box in the tool supply room, and once a week an inspector goes around to look them over and decide whether or not the damage in each case is of a nature which justifies discarding the tool. In doing this work use is made of the replacement checking list shown in Fig. 17; the name of the inspector and the foreman of the tool supply room work, and the name and size of each tool which is found to be damaged beyond repair is entered on this list, the tool supply room foreman signing in the column at the left and the inspector in the column at the right.

The tools are then sent to the tool salvage department of the central stock-room and an alphabetical list of the tools is made out from the slips, the form shown in Fig. 19 being used for this purpose. This form is made out in triplicate. The first copy is a record for the files of the maintenance supplies


TIME OFFICE RELEASE No. 14702

This is to certify that Edw McLeod M-47

Clock No. 17951

Tool Supply Room No. 24 Dept. No. M-47 40 20

SHORTAGE

TOTAL 20

AMT.	ARTICLE			
3	Tool Checks	.15	.15	66
1	1½# Ball pien Hammer	.60	.40	40

D-31 TOTAL .75 .55

Date April 20, 1916 Signed F. A. Howell

TIME OFFICE COPY

Fig. 15. Form used by Tool Supply Rooms in Issuing Tool Release to Employes who are leaving: Size 6½ by 4⅝ Inches: Three Copies made out on White, Buff and Pink Stock


Form 1324

COMMERCIAL TOOL RELEASE

T. S. R. No. 6 Dept. No. M-44

Release Check No. M-4461 on the following Articles:

AMT.	SIZE	ARTICLE	Amt. Chg'd to Room
3	1/8"	S. S. H. S. Drills	24

For use in D-31-32-33-34

Replace Yes ~~No~~

Date April 8-1916

Foreman B. E. Snow

Fig. 16. Form used by Foremen in giving a Release for Tools which have been broken or worn out: Size 5 by 3 Inches: One Copy made out on White Stock

and tool service department; this is also used in making a replacement of tools in the tool supply room or crediting the room with the number of tools which are not replaced. This first copy is given to an inspector for O. K., and then it goes to the stock-room foreman, who looks after sending out tools to replace the broken ones; then it is sent to the record-clerk in order that the card in his file and the tool supply room card, both of which are of the form shown in Fig. 6, may be corrected for any tools that may not have been replaced; this first copy is then filed in the maintenance supplies and tool service department by order number. The second copy is returned to the tool supply room, where it is checked against the original list shown in Fig. 17 to see that the tool supply room has received tools to replace those sent out in a broken or damaged condition. The third copy goes to the cost accounting department in order that the stock-room may be credited with the tools and a corresponding charge made against the department in which they were broken.

If it happens that the foreman of one of the tool supply rooms has reason to believe that any man in the factory has checks representing tools which he has broken or lost, it is the privilege of the foreman of the tool supply room to call upon the man for a settlement of his tool account. For this purpose use is made of the form shown in Fig. 18, the use of which will be apparent from the illustration. This practice of calling upon the men for an accounting at any time that it may be deemed advisable is a great help in doing away with disputes over the accuracy for charges for tools which may be made against a man at the time he leaves the company.

Records of Tools Lent to Outside Firms

The Cadillac Motor Car Co. follows the generally used practice of having certain classes of work done by outside concerns in order to benefit by the experience of specialists in unusual lines of manufacture. This is particularly true of

Form 1503

REPLACEMENT CHECKING LIST

CLOSING DATE April 6, 1916 T. S. R. No. 6 INSPECTOR G. A. Metcalfe

T. S. R. CHECK	SIZE	ARTICLE	INSPECTOR'S CHECK
6	5/16" × 18	Cad. Std. Plug Taps	6
12	1/4"	T. S. H. S. Drills	12
4	3/8"	Solid Hand Reamers	4
8	13/16" # 9	R. H. H. S. Solid End Mills	8

Fig. 17. Replacement Checking List used in Tool Supply Room to record Tools which Inspection has shown to be Unsuitable for Further Use; Size 8½ by 13 inches; One Copy made out on White Stock

Mr. W. Williams Clock No. D-2360 Dept. No. D-31

To avoid making a charge against you, please settle your account in TOOL SUPPLY ROOM No. 1 on the following articles.

This notice will expire April 16, 1916

Signed Chas. Winder

Date April 8, 1916 Dept. No. D-31.

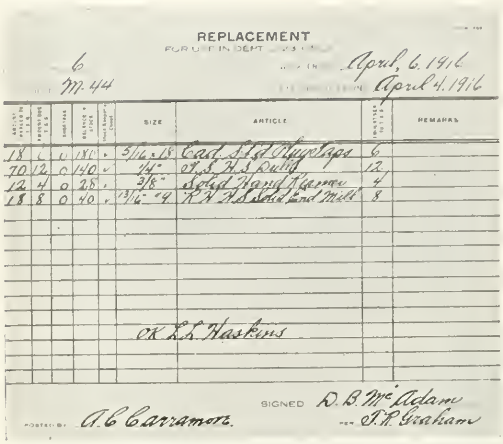
Fig. 18. Form used by Tool Supply Room in calling upon Workmen for Settlement of Tool Accounts; Size 5½ by 3 Inches; One Copy made out on Pink Stock

certain classes of special tool work, and for handling such work it is occasionally found necessary to lend tools for doing the work to these outside firms. Of course it is necessary to keep a record of tools which have been sent out this way, and such a record is maintained by issuing the form shown in Fig. 20. It will be seen that the upper part of the card is provided with spaces for the date and for the complete name and address of the firm to which the tools are to be shipped. The lower part of the form has spaces for descriptions of the tools; for the number to be shipped; and for the price, total value and classification of each kind of tool. After making out the order, it is checked by an inspector to see that everything is correct, after which the form is sent to the head of the maintenance supplies and tool service department for signature. The form is made out in triplicate, the first copy being sent to the manufacturing sales department, which looks after despatching the tools to their destination and rendering invoice, the second copy is held in the maintenance supplies and tool service department until the tools are returned, and the third copy is sent to the firm that does the work. If the tools are O. K. when returned, they are put in stock and credit is given to the firm who returns them.

The Repair of Commercial Tools

It will be recalled that when a workman damages a tool or wears it down so that he considers its use is no longer feasible, he takes the tool to his foreman and gets him to sign a tool release slip for it, which he turns in to the tool supply room with the tool in order to get his tool check or a new tool, as the case may be. It will also be remembered that at the end of each week these tools are gone over by the inspector and the foreman of the tool supply room, to decide whether or not they have been worn down so that they are no longer fit for service. It may happen that some of these tools will be considered capable of giving an additional amount of service after certain repairs have been made on them, and such tools, together with the tools that have been slightly damaged in the shops, are sent to the tool-room to be put back into condition for future service. The making of such repairs involves keeping a record for several purposes. In the first place, the tool supply room must know what tools have been sent out and when these tools should be returned; care must be taken to see that all tools sent out for repairs are finally returned; and it is also necessary to give the tool-room instructions as to the nature of the repair that is required, and to keep a record of the cost of the work. For this purpose the form shown in Fig. 21 is employed. It will be seen that there is a notation "Charge Time and Material to Order No. 63920," which is a blanket order number that is applied on all jobs involving the repair of commercial tools against the department which uses the tools.

Five copies of this form are made out, the uses of which are as follows: The first copy is sent to the maintenance supplies and tool service department with the work, where it is filed by the department order number. The second copy also accompanies the work and goes on to the tool-room, where it is filed as a record of the work which the tool-room did on this particular job. The third copy accompanies the work as far as the office, where it is held during the time that the



REPLACEMENT

6 April, 6. 1916

M-44 April 4. 1916

					SIZE	ARTICLE		REMARKS
18		0	180		5/16×18	Cad. Std Plug taps	6	
70	12	0	140		1/4"	S. S. H. S. Drill	12	
12	4	0	28		3/8"	Solid Hand Reamer	4	
18	8	0	40		13/16"×4	R H H S Solid End Mill	8	

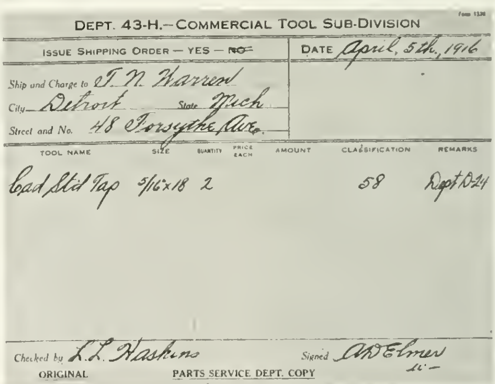
OK L. L. Haskins

SIGNED D. B. McAdam

POSTED BY A. C. Carramore — J. R. Graham

Fig. 19. Form used by Tool Salvage Department of Central Stock-room in making an Alphabetical List of Broken or Worn Tools; Size 8½ by 7¼ Inches; (Where a large number of Tools have to be recorded, the size of form is 8½ by 13 inches); Three Copies made out on White, Yellow and White Stock

job is in the tool-room; it simply serves as a reminder to the office that this work is being done and must be looked after to see that it is put through with the customary dispatch. The fourth copy is a receipt that is given to the tool supply room for the tools which they have sent out to be repaired; this copy is sent with the work to be signed by the transfer clerk in the maintenance supplies and tool service department, and is then sent back to the tool supply room, where it is filed until the article has been returned. The fifth copy, which is merely a memorandum of the transaction held by the tool supply room, is destroyed as soon as the receipt is returned.



DEPT. 43-H.—COMMERCIAL TOOL SUB-DIVISION

ISSUE SHIPPING ORDER — YES — ~~NO~~ DATE April, 5th, 1916

Ship and Charge to T. N. Warren

City Detroit State Mich

Street and No. 48 Forsythe Ave.

TOOL NAME	SIZE	QUANTITY	PRICE EACH	AMOUNT	CLASSIFICATION	REMARKS
Cad Std Tap	5/16×18	2			58	Dept D-24

Checked by L. L. Haskins Signed A. D. Elmer

ORIGINAL PARTS SERVICE DEPT. COPY

Fig. 20. Form used in authorizing Shipment of Tools for Use on Work done Outside Factory; Size 7¾ by 6 Inches; Three Copies made out on Drab, Yellow and Blue Stock

Twice a month a report is sent to the office of the maintenance supplies and tool service department showing the condition of each tool supply room as regards tools which have been sent out to be repaired, the form shown in Fig. 22 being used. It will be seen that the top of this form is similar to the one shown in Fig. 11, while the lower space provides columns for a complete description of the tools in question, the number which were sent out to be repaired, and the date of the receipt card for the tools which was sent down to the tool supply room at the time they were received in the tool-room. This report constitutes a check on the work of the tool-room in making repairs, and the distinction between its function and that of the weekly reports of the records kept by the tool supply room foreman should be carefully noticed.

In conjunction with a discussion of the question of handling worn out and damaged tools, the following description of the method of dealing with files is particularly important, owing to the rapidity with which this type of tool is used up. As in the case of other classes of commercial tools which are worn out, any workman in the shop who finds that his file has been worn down so that it will no longer give efficient service is required to take the file to the foreman of his department and get an order for the exchange of the worn out one for a new one. For this purpose use is made of the form shown in Fig. 23, which specifies the number, size and type of file which is to be given to the bearer; use is also made of this form when the man has occasion to draw out a new file from the tool supply room.

Buying Tools for Employes

Every manufacturer recognizes that it is good policy to encourage employes to provide themselves with a good set of tools. The Cadillac Motor Car Co. makes a practice of purchasing any tools which employes want in order that the men may get advantage of the company's wholesale rates from tool manufacturers with whom it has regular dealings. The cost of these tools is deducted from the workman's pay, and for making this adjustment use is made of the form shown in Fig. 24. It will be seen that the form has spaces for the plant number in which the man is employed, the date, and the name and time-clock number of the employe. Below are noted the tools which he has purchased and the price. The form is made out in triplicate; the first copy is sent to the timekeeper for deducting the proper amount from the employe's pay; the second copy is sent to the employe in order that he may check up the deduction; the third copy is filed by the maintenance supplies and tool service department as a record of the tools purchased for the account of employes.

Sets of Tools for Special Operations

For certain operations which call for the use of a number of tools, it is the practice to have the complete set of tools packed in a numbered box, and when a workman is assigned to such an operation he goes to the tool supply room and hands in a single tool check for a complete box of tools. The purpose of this plan is to avoid requiring a workman to give up a large number of checks so that he would be left with an insufficient quantity for obtaining other tools that he might require. On the inside of these boxes there is a list which shows the complete outfit of tools, and records of such sets are maintained on cards of the form shown in Fig. 25. One side of this card gives a list of special tools such as jigs, fixtures, boring-bars, etc.; and the other side of the card gives a list of the standard commercial tools such as drills, reamers and counterbores. When these sets of tools are not in use, the boxes are put away in racks provided for that purpose, and in order to avoid having a large number of commercial tools tied up in this way, such tools are removed from the boxes and added at the time that the set of tools is called for. This is easily done by the attendant in the tool supply room, who has merely to refer to

T. S. R. Commercial Tool Repair Order

Charge Time and Material

To Order No. 63920 Date April. 6. 1916

From T. S. R. No. 6 To Dept. No. D. 28

Amount 1 Name Hack-saw frame

Remarks: Supply new handle

H. G. Winters Transfer Clerk R. M. Bacon

T. S. R. FOREMAN

Used in Dept. No. M-44 Per F. Irving

FILE RECORD COPY

Fig. 21. Form used by Tool Supply Room in ordering Repair of Commercial Tools; Size 5⅞ by 3⅞ Inches; Five Copies made out on White, Blue, Drab, Yellow and Pink Stock

TOOL SUPPLY ROOM No. 4

Semi-monthly Report of Commercial Tools on Repair for two weeks ending April 14. 1916

Signed Chas. Winder

Order No.	Date of Receipt Card	Amount	Size	Name of Tool
63940	Mar. 30 1916	2	1 1/8"	Hand Expansion Reamer
64100	April 3, 1916	3	#730	B. & S. Dial Indicator
64106	April 2, 1916	4	3/4"	Pipe Reamer

Fig. 22. Form used by T. S. R. Foreman in recording Progress made with Repair Work on Commercial Tools; Size 8¼ by 5¼ Inches; One Copy made out on Pink Stock

ORDER FOR FILES

DEPT. No. M-67 DATE April 4 1916

TOOL SUPPLY ROOM No. 2

DELIVER TO BEARER CLOCK No. M-6740

Amount	Size	Kind	Number Letter
1	6"	Flat Mill File	60

Signed Geo. Elsey

Fig. 23. Form used by Foremen in authorizing Tool Supply Room to exchange Files for Workman; Size 5⅛ by 3⅛ Inches; One Copy made out on Drab Stock

the label on the box which gives the list of commercial tools required, together with the size of the tools.

An important factor in the purchasing of maintenance supplies is the placing of orders at such a time that advantage may be taken of the best possible price. In order to do this, it is necessary for the head of the department to keep closely in touch with the purchasing department on both present market conditions and the probable trend of the market. Should he see that the price of some commodity for which his plant has constant use is likely to advance, he will proceed to lay in a sufficient supply to last through the period during which producers may ask unusually high prices.

Another important feature is the ordering of the exact class of material best suited for the purpose to which it is put, and the examination of the material when received to be sure that it accurately fulfills specifications. To assist in this work the company maintains a fully equipped laboratory in which chemical and physical tests may be conducted to determine the nature of all supplies that are likely to be adulterated. The experience of these chemists has taught them to know just about what adulterants to look for, and in many cases some surprising results have been obtained. For instance, one would hardly expect that the services of a chemist would prove of any great assistance in the purchase of sponges, but experience has proved the contrary to be the case. Sponges are bought at a specified price per pound, and tests conducted on sponges which failed to give satisfactory service revealed the fact that they had been loaded with glucose; as a result the weight indicated that a durable commodity was being obtained, but when the sponges were dipped in water it resulted in washing away the glucose and leaving a flimsy structure that had little durability.

The accurate work of the chemical laboratory may be taken as typical of the entire service rendered by the maintenance supplies and tool service department. In its operation nothing is left to chance; methods have been devised which are the last word in accuracy, and the records of each transaction which are kept, aided by the multiple checks which are applied to be sure that the records are accurate, make the occurrence of errors a matter of extreme improbability. That the benefits resulting from the use of this system have paid many times over for the cost incident to its operation is shown by the reduction in expenditures for tools and maintenance supplies which is revealed by a comparison of inventories over a period of years.

* * *

DEFECTIVE AUTO APPLIANCES

American manufacturers excel in developing special appliances and methods of manufacturing, but unfortunately not all have the reputation of producing goods that are reliable. The automobile accessory business has grown tremendously during the past ten years and is now an important industry in itself, aside from the manufacture of motor cars. In the race to produce accessories cheap and insure a large profit, the strength of some of the tools furnished has been reduced to the danger point, the result being some deplorable accidents. For example, an automobilist recently was crushed beneath his car which he had jacked up in order to repair it on the road. The jack broke while he was under the car and the weight of the car fractured several ribs and caused serious internal injuries. If such accidents become numerous, it will be necessary for the legislatures of the states to make laws providing that all accessories, like jacks, which might endanger the lives of the users shall be subjected to inspection before being sold and used. Such a condition is a serious reflection on the intelligence and honesty of manufacturers. Any manufacturer putting forth a product which seriously endangers the life and limbs of the users under normal conditions is a dangerous member of society.

* * *

Make up your mind to know all there is to know about your job, and by the time you do, there is likely to be a better one waiting for you.

TIMEKEEPER

PLANT NO. 1 DATE April 6, 1916

DEDUCT FROM WAGES OF

NAME Arthur Engel CLOCK NO. D 2370

Amt	Article	Price	P. T. C. No.	Req. T. No.
1	#8-1" B. & S. Micrometer	$4.10		T-36170
1	#320 Starrett's 6" Rule	.45		T-36171

TOTAL CHARGE $4.55

CREDIT TOTAL AMOUNT OF P. T. C. —

AMOUNT TO DEDUCT $ 4.55

SIGNED D. B. McAdam

PER D.M.

No. 6376

Fig. 24. Form used to charge Employes for Tools purchased for them; Size 6 by 4 Inches; Three Copies made out on White, Pink and Blue Stock

6 3/8" Taper Shank High Speed Drills
6 #2 to 2 Magic Collets
6 #2 to 2 Magic Chucks

Fig. 25. Form of Card used for recording Commercial Tools required in Sets for Special Purposes; Size 6 by 9 Inches. One Copy made out on White Stock

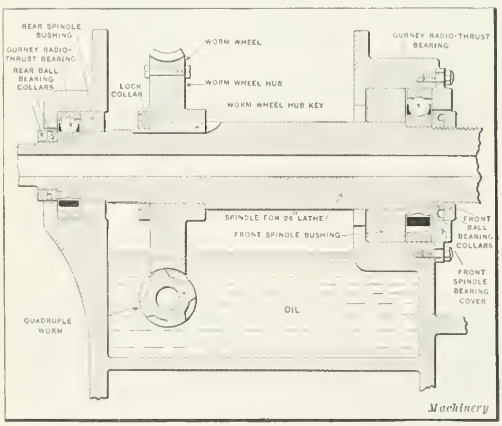
HART-PARR BALL-BEARING LATHE HEADSTOCK

The accompanying illustration shows a longitudinal section taken through the ball-bearing spindle of a projectile lathe built by the Hart-Parr Co., Charles City, Iowa. The lathe was illustrated and described in the May number, but these details of the headstock were not furnished in time to be used with the description.

The spindle is worm-driven, the worm being of the quadruple type, running in a bath of oil. A reservoir is provided in the headstock which holds from five to six gallons of oil, and the circulation induced by the worm and worm-wheel dissipates the heat through the oil and thence to the machine and the atmosphere. The spindle is mounted in Gurney radio-thrust bearings of the single-row annular type made by the Gurney Ball Bearing Co., Jamestown, N. Y.

The front end bearing next to the work is a Gurney 334 RT, having a bore of 6.693 inches, an outside diameter of 13.386 inches, a width of 2.244 inches, and fifteen 1⅞-inch balls. The rear bearing is a Gurney 322 RT, having a bore of 4.331 inches, an outside diameter of 9.449 inches, a width of 1.968 inch, and fourteen 1½-inch balls. These two bearings take both the radial and thrust loads in each direction, there being no other thrust bearing or thrust collar on the spindle. The mounting of these bearings on the spindle is simple; the spindle may be taken out by removing the two end plates that are bolted on. An important feature of these radial thrust bearings is that they are set up tight, there being no radial freedom whatever. This, of course, is quite different from the customary practice of setting up spindles in babbitt or bronze bearings. In plain bearings, sufficient radial freedom must be provided to allow for a film of lubricant between the spindle and the bearing.

It is claimed by some mechanical engineers that ball bearings when used on lathe spindles mark the work with annular waves, these being caused by the passage of the balls along the raceways in relation to the tool point. Some have gone so far as to suggest the use of a large number of small balls in order to reduce the distance between the balls to a minimum. But this expedient is unnecessary, as a properly constructed and designed ball bearing of sufficient capacity to carry the loads imposed on it will run perfectly smoothly when applied



Longitudinal Section through Spindle of Hart-Parr Ball-bearing Lathe Headstock

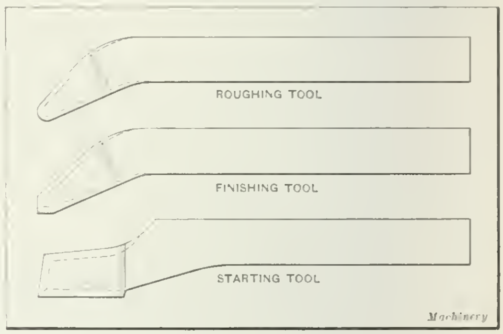
to a lathe spindle. In the case of the Hart-Parr lathe, it is claimed that the finish is so smooth that it is not necessary to grind the shells afterward.

It is stated by the lathe maker that the spindle drives the heaviest cut without chatter. Repeated tests have been made on steel projectiles mounted on a mandrel screwed to the spindle nose and without tailstock support, which have demonstrated that the combination of worm drive, heavy construction and anti-friction spindle bearings make remarkable production results possible. Cuts one-half inch deep with one-sixteenth inch feed in 0.50 per cent carbon steel were taken without chatter at a distance of 36 inches from the front bearing. A plain spindle subjected to such a test would doubtless have chattered, because the projected area of a plain bearing would not have been sufficient to prevent the oil film from being broken down and displaced. The metal-to-metal contact of the spindle and bearing under heavy pressure would cause excessive friction and chatter. This cause of chatter in machine tools is often unsuspected, the fault being laid to other constructive features.

* * *

WOODEN FORMS FOR FORGED TOOLS

It is much easier to whittle the shape of a forged tool out of a piece of wood with a jack-knife or chisel than it is to forge the same thing in a hand forge. However, a wooden tool would be less likely to work satisfactorily on some of the present-day alloy steels, and therefore could not be used for this purpose. Some years ago, however, the writer saw a group of



Wooden Forms for Forged Tools

tools in which the cutting portion which would ordinarily be ground was painted with aluminum paint and the shank of the tool which goes in the tool-holder was black. These tools were in the office of the foreman of a boring mill department in a large factory and excited the writer's curiosity to some extent.

It was found that in the development of the machines for certain classes of work, the tools did not work quite as satisfactorily as was desired, due to more or less variation in the forms which were forged by the blacksmith. A set of these wooden tools was therefore whittled out carefully and given the desired shapes in all cases. These were then mounted on a board and sent out to the blacksmith shop and used for reference when forging up tools of the required shapes, so that the offset angles and rakes were the same in all cases. It was a very easy matter for the blacksmith to set an angular gage on the wooden form and repeat the same thing in the steel as he was forging it. It was found that after this group of wooden tools had been installed in the blacksmith shop, the tools produced were much more uniform and could be depended upon to do the work as required. A. A. D.

* * *

MOUNTING GRINDING WHEELS

When a grinding wheel is brought to a machine for mounting, it should be inspected by some responsible person to see that the dimensions of the wheel—the diameter, thickness, hole, and if a cup or special wheel, the other measurements—are correct. Then the wheel should be sounded, that is, tapped lightly with a hammer to insure that it has not been cracked in transportation or handling. Special care is required to make sure that the speed of revolution is such that the surface speed of the grinding wheel is within the limit designated on the wheel tag. This is highly important, not alone because of the element of safety, but also because it is necessary for efficient production. At this time, too, the spindle should be looked over to make sure that there is no end play or looseness in the boxes. Vibration lowers production, increases wheel cost and tires the operator.—*Grits and Grinds.*

NEW METHOD OF BUILDING LATHES

BUILDING HEAVY LATHES WITHOUT MACHINE WORK ON THE BED CASTING

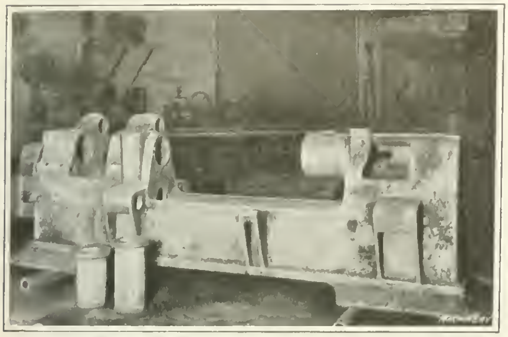


Fig. 1. Lathe-bed Casting ready to have Bearings and Ways assembled in Place. Note Headstock Spindle Bearings standing on Floor

THE use of jigs and fixtures in manufacturing machine parts has grown rapidly during recent years. This has resulted in increasing the rate of production and accurately controlling dimensions so that machine parts in general are made practically interchangeable with little hand work. But in machine tool building it has always been considered necessary to do a considerable amount of machine work on the frame castings, followed by hand scraping and fitting of bearings and similar parts where perfect fits and absolute alignment are required. This hand work takes much time and must be done by skilled mechanics; and at the present, when machine tool builders are overburdened with work and the supply of experienced men is far below the demand, these hand finishing operations are among the factors which seriously limit the output of machinery factories.

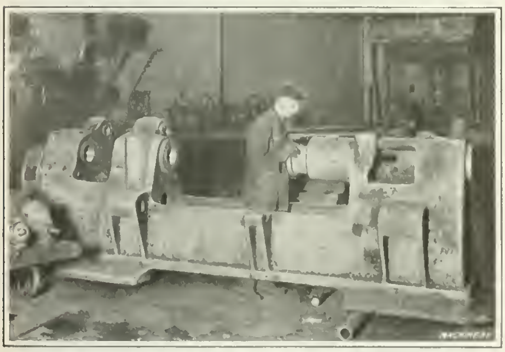


Fig. 2. Bed Casting with All Spindle and Shaft Bearings in Place. Note Truck Load of Parts at Left-hand Side of Machine

It is a matter of general knowledge that where castings are machined, the removal of the outer scale from certain sections of the casting allows the shrinkage strains in the metal to spring the casting out of shape. To overcome trouble from this source, the common practice is to take a cut over the surfaces to be machined and then set the casting aside for a sufficient length of time for it to become fully "seasoned" before the final machining operations are performed. Not only does such a method of procedure call for the expenditure of time and labor in machining, but it requires the castings to be held in the factory for a considerable period of time before they can be put into a finished machine. This is a severe drawback under conditions such as those which exist at the present time, when machinery builders are doing their utmost to secure the maximum production in their shops.

With the view of overcoming these difficulties, the Amalgamated Machinery Corporation, 72 W. Adams St., Chicago, Ill., has developed a method of lathe-bed construction, upon which patents have been granted, that virtually eliminates all machining and fitting operations, absolutely no machine work being done on the lathe beds. This result is obtained by the employment of turned and ground steel rods for the ways and cross-slides, that are supported in brackets provided on the bed and saddle castings. These rods are made of turned and ground 50 point carbon steel, and are sold under a guarantee that the error in alignment does not exceed 0.0005 inch in a length of eight feet. The headstock and tailstock are cast integral with the bed, and all spindle and shaft bearings are carried by iron bushings which are set in place in cored holes in the castings.

It will be evident that for such a construction to give satisfactory results, means must be provided for obtaining absolutely accurate alignment of all working parts, and this is done by means of an assembling jig which is dropped in place over the bed casting. This jig has brackets which fit snugly over the steel rods that form the ways, and close fitting bearings for mandrels that fit through the different spindle and shaft bearings. When all the machine members have been lined up in this way, a low melting alloy is poured into the annular spaces between the cored holes in the lathe-bed casting, and the machine members are held in these holes, so that when the molten metal has solidified, all parts are secured in

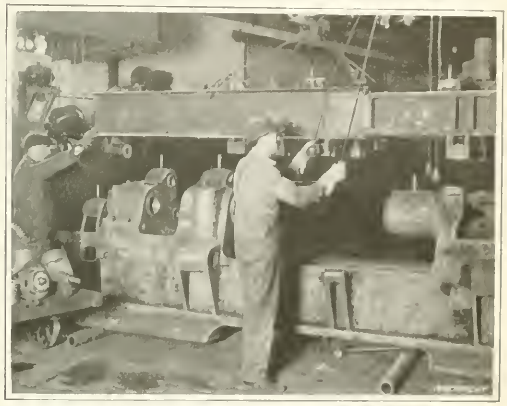


Fig. 3. Lowering Assembling Jig into Place on Casting. Note Bearings on Under Side of Jig for bringing Lathe Bearings and Ways into Alignment

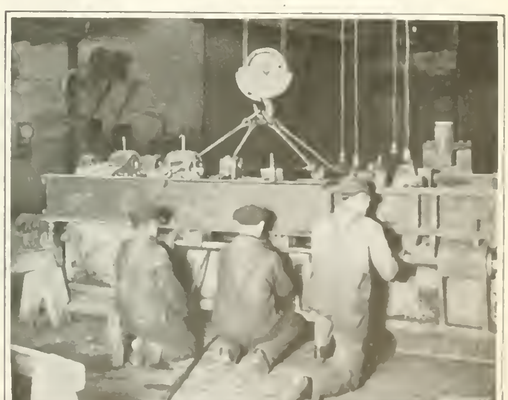


Fig. 4. Putting One of the Hardened and Ground Steel Rods into Brackets on Casting. Notice Method of Location from Bearings on Jig

Fig. 5. Pushing in Mandrel which locates Spindle Bearings in Alignment with each other and with Ways on Lathe Bed

Fig. 6. Pouring Clamping Metal. Attention is called to Arrangement of Clay to hold Molten Metal in Place until it solidifies

exactly the required positions. With this brief statement in regard to the general features of the type of construction, we are in a position to proceed with a detailed description of the method of assembling.

Arrangement of the Assembling Department

In the factory of the Amalgamated Machinery Corporation, the erecting department occupies bays which are of the required width to enable the machines to be placed crosswise and leave sufficient room to handle the work advantageously. Each bay is provided with a special form of overhead revolving jib crane; and at each assembling station in the bay two jib cranes are available for handling parts that are too heavy to be readily moved by hand. The bed castings are distributed on the floor, one to each space, and a complete set of parts to be assembled on a machine are brought to each station on trucks so that all the pieces are available for instant use.

In this connection it should be mentioned that the cast-iron bushings which carry the head spindle are babbitted ready for use at the time they come to the assembling floor. It is a well-known fact that the composition of babbitt metal is changed each time it is melted, as a result of the reduction in percentage of certain constituents through oxidation. This affects the physical properties of the babbitt and in cases where the metal is remelted a number of times, its character may have so seriously deteriorated that it will no longer be capable of giving satisfactory service. In the babbitted spindle bearings used by the Amalgamated Machinery Corporation, this trouble has been effectually overcome by sending the cast-iron bushings out to be babbitted by the company which makes the babbitt metal. The practice followed is to line the bearings at the time that the babbitt metal is first compounded, so that it is poured into the bushings at once and there is no danger of securing metal of an inferior quality as the result of deterioration due to the removal of certain constituents by oxidation.

Assembling the Lathe Bed

Reference has already been made to the fact that the bed casting has the headstock and tailstock cast integral with it; and one-piece bearings are employed for both the head and tail spindles. Fig. 1 shows one of the finished lathe-bed castings with the two headstock spindle bearings standing beside it; and in Fig. 2 the bearing bushings have been pushed into the spindle and shaft holes in the headstock, and a man is shown pushing one of the bearings into place in the tailstock. After this part of the work has been done, the assembling jig is lowered into place over the bed casting, as shown in Fig. 3, after which the turned and ground steel rods that form the ways are pushed into place in the bracket holes at the front and back of the casting. The assembling jig is provided with bearings which are carefully machined to fit around the steel bars that form the ways, so that they will be located in accurate alignment with each other; and similar bearings align mandrels which are a close fit in the spindle and shaft bearings in the lathe bed so that all bearings will be located parallel to each other and to the ways. These locating bearings can be seen on the under side of the jig in Fig. 3; Fig. 4 shows the jig in place on the lathe-bed casting; and in Fig. 5 one of the aligning mandrels is being pushed into place.

Pouring the Clamping Metal

After all the parts have been properly located in the cored holes in the lathe-bed casting, the assemblers are ready to pour in the molten metal which solidifies in the spaces between these parts and the bed casting to hold them in place. A brief consideration will make it evident that the metal which may be satisfactorily employed for this purpose must possess certain characteristics. In the first place, it must neither expand

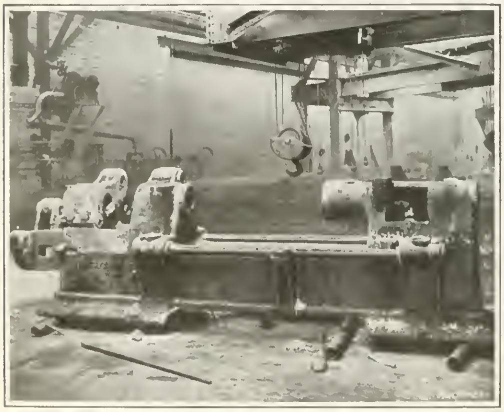


Fig. 7. Finished Lathe Bed as it appeared immediately after Removal of Assembling Jig

Fig. 8. Lowering Faceplate into Place ready to be heated and then shrunk onto Lathe Spindle

nor contract after being poured, as such a condition would result in either straining the casting or leaving the different machine members loose in their holes in the casting. The metal must also be of such a nature that it will not crystallize nor change its structure in any way as the result of vibration, and it must be tenacious enough to support adequately the load imposed upon it. The alloy used for this purpose was developed as a result of experimental work, and is a type metal of special composition. In order to take advantage of the peculiar properties of this metal, it must be poured at a certain specified temperature which was determined by experiment, as it has been found that a deviation of even 30 degrees above or below this temperature will result in expansion or contraction of the metal as it solidifies, which prevents obtaining satisfactory results.

To provide for accurately controlling the temperature of the metal, it is melted in pots heated with saturated steam, and an experienced metallurgist devotes all of his time to providing the assembling department with metal at exactly the required temperature. Melting pots are located at intervals down the side of the bays, and the ladles for pouring the metal are of different sizes which contain just the proper volume to fill the annular spaces without waste. The weight of each size of ladle has been carefully calculated, so that when the molten metal is poured into it from the melting pot, the ladle will absorb just enough heat to reduce the temperature of the metal from that of the melting pot, which is a little too high, to exactly the temperature at which it must be poured in order to avoid expansion or contraction while cooling.

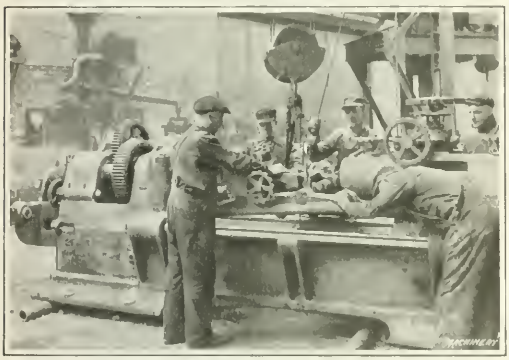


Fig. 9. Assembling Carriage onto Lathe Bed. Attention is called to Design of Carriage

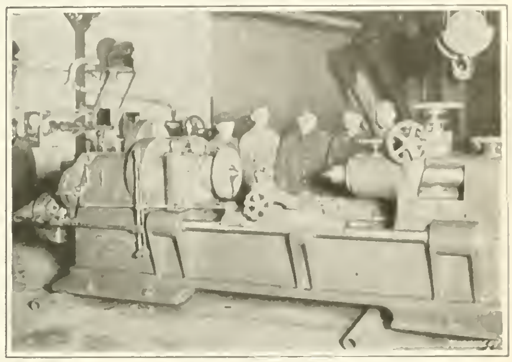


Fig. 10. Finished Shell Lathe, and Gang of Four Men and Foreman who assembled it in Six and One-quarter Hours

It will be evident that means must be provided for retaining the metal in the space which it is desired to fill, and these means are provided by packing clay around each end of the annular space; a small cup of clay is also packed around the cored hole through which the metal is poured into the annular space to be filled. This clay is mixed and cut into ribbons, in which form it is sent to the assembling department, so it may be conveniently handled. After the clamping metal has been poured, it cools and solidifies almost instantly because of the large mass of iron surrounding each pocket. It is stated that this cooling action is so rapid that a person can hold his hand on the outside of the casting or the inside of a bearing at the time the clamping metal is poured without burning it. As a result, there is no danger of distorting the babbitt bearing liners. After sufficient time has been allowed for the molten metal to cool and solidify, the assembling jig is removed from the casting and the strips of retaining clay are scraped away. The workman then goes over the machine with a file and removes any protruding metal, but he does not attempt to hammer down the metal, as this would result in introducing strains and possibly changing the structure.

Assembling the Lathe Carriage

The lathe carriage consists of two cast-iron shoes with grooves which fit over the ways on the bed. The cross-slide on the carriage is formed by two hardened and ground steel rods which are secured in place by the method which has just been described. Assembling jigs are provided for aligning the different members of the carriage preparatory to pouring the clamping metal. The work of assembling other parts of the machine is essentially the same as in any machine tool building establishment.

The Amalgamated Machinery Corporation makes four sizes of machines and four types of each size. In order to insure interchangeability, the assembling jigs for each size of machine are made from a master jig so that all dimensions are held constant. For example, on one size of machine there are seventeen assembling jigs in use, all of which are made from the master jig. This shows the importance of having a single standard which governs the dimensions of a given size of machine. The same thing is true of the jigs used for assembling both the carriages and lathe beds. The accuracy of alignment secured is shown by the fact that out of several thousand Amalgamated lathes which are in use, no trouble has been experienced from bearings running hot. Another interesting feature of the construction is the claim made that it is impossible to make one of these lathes vibrate in a way which will cause the tool to chatter. The explanation offered is that all important bearings float on a metal which tends to absorb vibration rather than transmit it from one machine member to another. Whether or not this is the correct explanation, the fact remains that it is impossible to operate the lathe in a way which will produce noticeable chatter of the tool.

Other Possible Applications of This Method of Construction

Although this method of construction was developed for building shell lathes rapidly without the employment of a great amount of skilled labor, it appears to offer possibilities of application in the construction of a variety of other classes of machinery and engines. In manufacturing small machines, it should be possible to provide for forcing the molten metal into the casting under pressure in much the same way that die-castings are made. This would insure obtaining a very dense metal, and would also enable the metal to be delivered from the melting pot the same as on die-casting machines. An idea of the rapidity with which the work of assembling can be done will be gathered from the fact that in the case of large lathes weighing approximately 20,000 pounds, the entire assembling operation can be completed by a gang of four men in $7\frac{1}{2}$ hours; such a gang of men assembles two complete lathes a day. Obviously such an achievement would be out of the question, were it necessary to employ hand work for scraping the bearings and ways to an accurate fit. E. K. H.

* * *

During the past five years, the average pay of the employes of one large manufacturing concern in Detroit, Mich., has increased 32 per cent. The wages of high-class mechanics, including toolmakers, die-makers, and first-rate machinists, have increased as much as 80 per cent. This rapid rise in wages in Detroit has been partly due to the competition of the motor car manufacturers.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Manufacturer Cannot Waive Agent's Warranty

(Oklahoma) The Oklahoma Supreme Court has held in the case of the International Harvester Co. v. Lawyer that the manufacturer of machinery may be held on its oral warranty, though the purchaser of the machinery later, at the request of the manufacturer, signed an order which expressly provided that the machinery was sold without warranty.

The facts of the case were that the plaintiff, Lawyer, purchased machinery from an agent of the International Harvester Co. in Oklahoma. The agent, in making the sale, warranted the machinery to be free from defects. He secured his authorization in making this warranty from the agency contract which existed between himself and the International Harvester Co. On delivering the machinery, the International Harvester Co. sent the purchaser a form of order containing a clause to the effect that the machinery sold was not warranted in any way. The machinery was found to be defective and plaintiff notified the agent, who, in turn, called the matter to the attention of the company and asked for an adjustment. The International Harvester Co. refused to adjust the matter, setting forth the stipulation as contained in the printed order. Suit resulted and the Supreme Court of Oklahoma on appeal held that the International Harvester Co. was liable for the warranty as made by its agent, and that the written order in no way relieved the company of its obligation to make good any defects in the machinery. The court said that the agent by authority of his agency agreement with the company had a right to warrant the machinery, which warranty could in no way be discharged by an act of the International Harvester Co. itself. *(International Harvester Co. v. Lawyer, 155 Pac. 618.)*

Transfer of Machinery for Benefit of Creditors

(Iowa) In the case of Stacy v. Brown-Hurley Co., Iowa Supreme Court, it has been held that a manufacturer who is badly in debt may transfer mortgaged machinery to one of his creditors as trustee, to manage and dispose of the same to the best advantage for the benefit of all creditors. The court further says that the trustee is not chargeable with bad faith though he induced a friend to take up the mortgages on the machinery and to hold the machinery with the expectation of realizing more than could be realized by a forced sale. An effort on the part of the trustee to secure to creditors as large a part of their claims as possible is considered commendable by the court. *(Stacy v. Brown-Hurley Co., 156 N. W. 695.)*

May Refuse Payment of Purchase Note

(Oklahoma) Where a manufacturer of machinery in making a sale accepts the purchaser's promissory note as part payment for the machinery, the purchaser may refuse payment of the note if it is later found that the machinery does not meet the warranty as to its fitness to perform the work for which it was sold. *(Murray Co. v. Palmer, 154 Pac. 1137.)*

Damages to Boilermaker

(Federal) The United States District Court in the case of In re the Anglo-Patagonian has held that a riveter and boilermaker, forty years old, who has been employed for fifteen years and making from twenty to twenty-five dollars per week, is entitled to $7000 damages for partial injuries received in the course of his employment. The injuries consisted of a fracture of the upper part of the arm, a broken ankle and partial paralysis of the right arm. *(The Anglo-Patagonian, 228 Fed. 1014.)*

Misdelivery of Machinery

(Massachusetts) Where neither the shipper of a crate containing machinery nor her agent, the expressman who delivered it to a steamship company for transportation, objected to the terms of a bill of lading which gave a different address for the consignee from that appearing on the crate, the steamship company could rely on the bill of lading issued as to the address and was not liable for delivery to the consignee as indicated therein. *(Porter v. Oceanic S.S. Co., 111 N. E. 864.)*

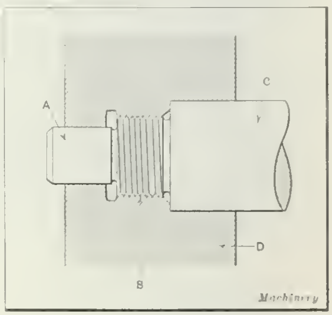
Operator of Crane Allowed Recovery

(New York) An interesting application of the Workmen's Compensation Law is found in Rist v. Larkin & Saugster, a New York Supreme Court case decided by Judge Kellogg on appeal by employers from an award of compensation to plaintiff. The facts show that the plaintiff was operating a crane on the Mohawk river, when the crane broke and he jumped into the river to avoid injury. He waded to shore, and as a result of that exposure contracted a heavy cold leading on to tuberculosis, and he has been disabled ever since. In part the decision reads: "We consider the claimant in the same position as if the accident had thrown him into the river, and, clearly, his being accidentally thrown ten feet into the water was an injury within the meaning of the act, and the disease following has been found to result naturally and unavoidably from that injury. He, at the time, was not physically disabled by jumping into the water, and it was not then quite clear what injury he had sustained, but it has developed that the injury was very serious." *(Rist v. Larkin & Sangster, 156 N. Y. S. 875.)*

* * *

CONCENTRICITY OF THREADED AND CYLINDRICAL WORK

When conditions in designing require the use of a construction similar to that shown in the accompanying illustration, difficulty is sometimes experienced in assembling on account of a lack of concentricity between the threaded part *B* and the plain cylindrical portions *A* and *C*. If the work is machined on centers in a lathe, the various parts will be concentric, but when made up on a turret lathe or screw machine as required in quantity production, there are two chances for error in machining: first, in the work *D* the tap for the hole may run out of truth unless it is piloted; and second, the die which is used to cut the thread of the screw *B* may not be started absolutely true with the other cylindrical surfaces, and may therefore cut a thread which is not concentric.



Concentricity of Threaded and Cylindrical Work

In order to obtain good commercial work of this kind, it is essential that the threaded portion be made a "free fit" in order to neutralize the variations caused by the running of the tap or die. The amount of freedom necessary depends on the diameter, pitch and the method of machining.

A. A. D.

* * *

RAILWAY RECORDS

Railway safety records were broken in 1916 when 325 American roads reported to the Bureau of Railway News and Statistics, in Chicago, that through the fiscal year to June 30, they had operated without a fatality to a passenger in a train accident. The roads reporting operate 161,948 miles of line. All American roads in 1915 operating over 250,000 miles of line reported 196 passengers killed in all railway accidents. In comparison, the latest report from Europe of 197,015 miles showed 700 passengers killed. This gratifying record of American railroads shows what has been accomplished by the "Safety First" movement. The movement is extending to every branch of industry and its effect will be to reduce the toll of useless killing and maiming and to make life and limb safer in all occupations.

SOME TOOLS USED IN MANUFACTURING THE CORONA TYPEWRITER

TOOLS AND DEVICES USED IN THE PRODUCTION OF A TYPEWRITER WEIGHING ONLY SIX POUNDS

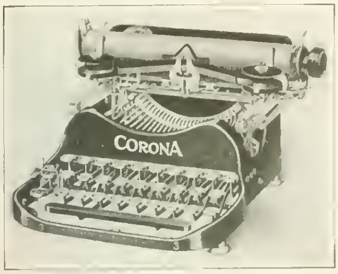


Fig. 1. Corona Typewriter—opened up ready for Use

Many difficulties are encountered in making a light, compact and practical typewriter; it is a case of constantly juggling compactness and practicability. How well the Corona Typewriter Co., Inc., of Groton, N. Y., has succeeded in overcoming these difficulties is evidenced by the reputation its machine is making, and the success is due, in a large measure, to its excellent manufacturing methods and tools, a few of which will be touched upon in this article. To appreciate the tools, it may be said that the Corona typewriter, which, in use, appears as shown in the illustration Fig. 1, folds into the compact size of 9 by 10½ by 4 inches, as shown in Fig. 2, and weighs but six pounds.

Dies for Blanking, Piercing and Forming Corona Typewriter Parts

Two of the dies for punching and partly forming the aluminum frame for the Corona typewriter comprise a most interesting set of tools; these are shown in Figs. 3, 4 and 5. The frame is made of aluminum, 0.162 inch thick, and before bending to the form of a square the frame blank is a little over thirty inches long. The blanking is done in an ordinary die that cuts the blank from strips that have been sheared to the right width for one frame, after which the frame goes to the die shown in Fig. 3 to have the forty holes pierced, and then to the die illustrated in Figs. 4 and 5, which performs the first bending operation. The subsequent bending tools are so simple that they will not be described here.

Fig. 2. Corona Typewriter—folded and ready for Case

The smallest of the forty holes in this frame is 0.076 inch diameter, which is quite small in comparison with the 0.162 inch thick stock. In addition to piercing the holes, the scallops, one on each side of the center, are clipped and the ends of the frame trimmed to length at this time. Fig. 3 shows the construction of this sub-press die and reproduces a sample of the pierced work. The die is made throughout of "Ketos" steel, and there are five sections, each of which carries a number of the holes. The forty punches are so inserted in the punch-plate that they may be quickly removed in case of breakage. They are guided by long bushings that are mounted in the stripper-plate. In addition, the large sub-press pins at the ends maintain the alignment of the die.

An interesting feature of this die is the method of insuring that the blank is correctly positioned before the punches come into action. There are five spring fingers A on the punch-plate that press the blank back against the gages just before the piercing punches enter the work. These "crowders" insure that the blank does not slip from its position against the gages. The end-trimming punches are piloted in the die, by using guide-shoulders on the punches.

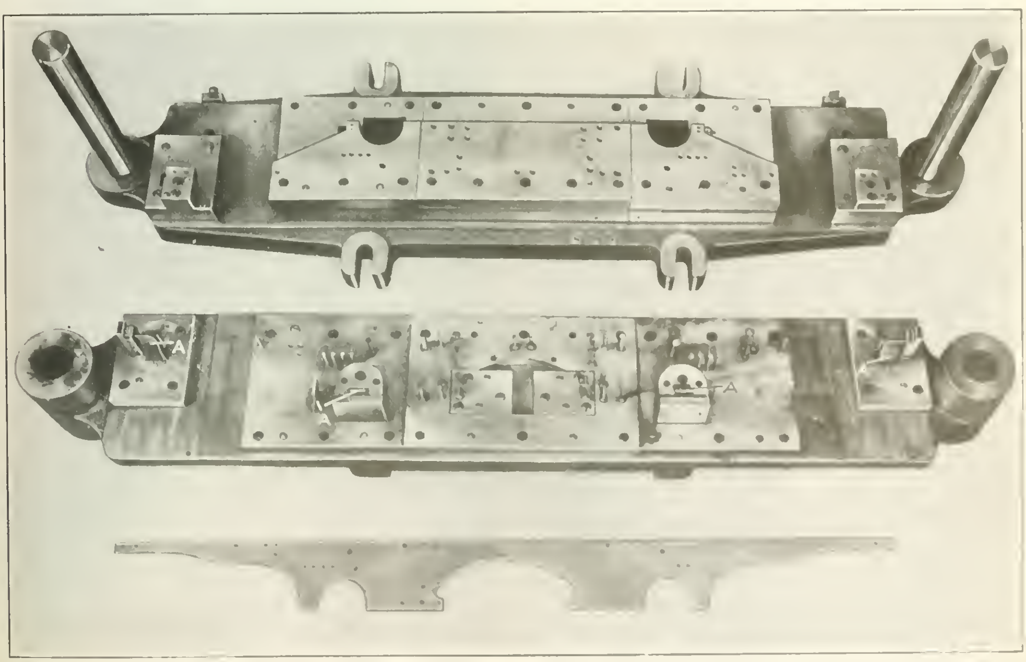


Fig. 3. Piercing Die for Typewriter Frame Strips

Figs. 4 and 5 illustrate the bending die that operates on the frame after it has been pierced. Fig. 4 shows the die and punch and the frame as it leaves the tools, and Fig. 5 illustrates the operation of the die. This shows the blank in position on the die and the bent frame on the punch in the position that it has taken after forming. Referring to the frame in Fig. 4, the bends made are the offsets *A*, the lugs *B* and the right-angle bends *C*. The center of the punch forms a long spring pad *D*. The frame blank is laid on the die, against

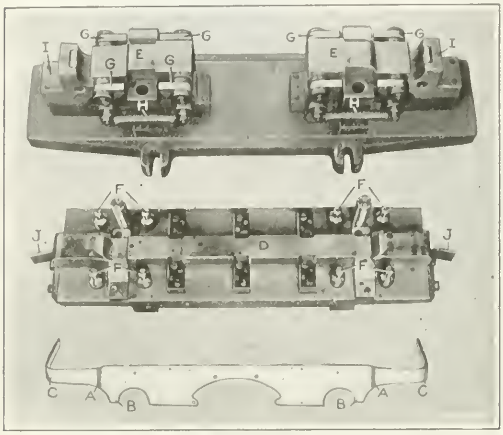


Fig. 4. Frame Bending Die and its Product

gages, one pair of which locates from the back and another pair engages holes to locate the blank endwise.

The first action of the die is to compress the spring pad *D*, thus gripping the punching firmly between it and the two die panels *E*, while the offset bends are being formed by the retreating spring pressure pad. The next action is brought about by the eight pins *F* that strike the short levers *G* in the die. These levers are really upper members of toggles upon which the die panels are supported. The toggles are kept normally straight by four spiral springs *H* that connect the middle joints

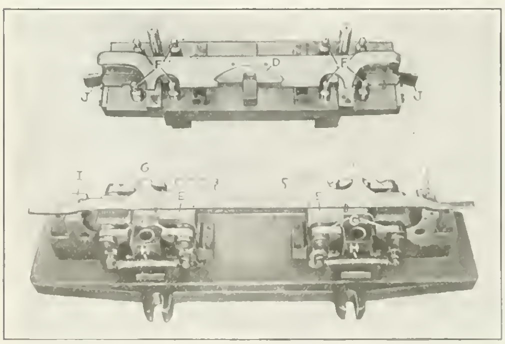


Fig. 5. Frame Bending Die, illustrating Operation

of each pair of opposed toggles. When levers *G* are depressed by the descending punches *F*, the toggles open, allowing the punch to carry the work and the die panels *E* down to the limit of the toggle opening. The ends of the frame are obstructed, however, in their downward path by form brackets *I* that bend them to a right angle. Rolls are inserted in these brackets to assist in bending the stock without marring. Lugs *J* prevent the frame ends from kicking forward when the bending operation is starting. At the time of making the offset bends, lugs *C* are also curled over. Two sub-press pins insure the die retaining its alignment. This die, while decidedly out of the ordinary in design, has worked out very successfully in practice.

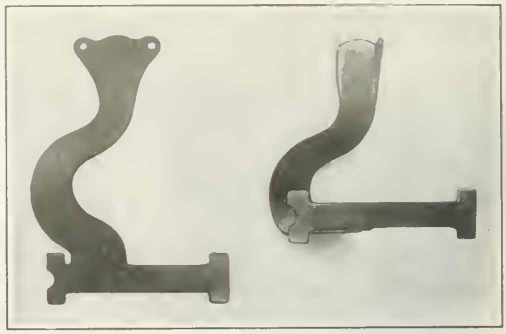


Fig. 6. Paper Finger Clip—before and after Bending

A complicated bending die for forming the paper finger clip shown in Fig. 6 is illustrated in Fig. 7. This die takes a blank punching, as shown at the left-hand side of Fig. 6, and bends it in one operation into the completed form shown at the right-hand side of the illustration. This clip is made from sheet steel, 0.018 inch thick. From Fig. 6 it will be seen that there is a compound bend to be made, consisting of turn-

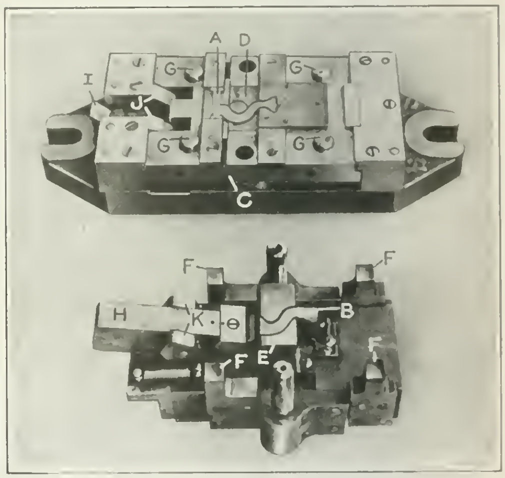


Fig. 7. Tools for bending Paper Clip

ing up the ears on one end of the clip, and making a double bend at the opposite end. On the die at *A* is one of the blanks ready to be bent, and on the punch at *B* is one of the completely bent pieces. The entire face of the die forms a pressure pad *C* that is supported on heavy spiral springs. At the center of the die is a smaller secondary pressure pad *D* supported

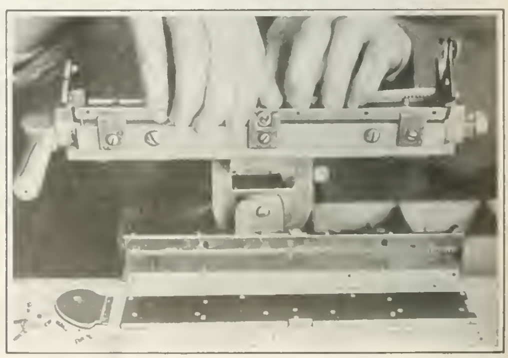


Fig. 8. Carriage Assembling—putting Parts on Under Side

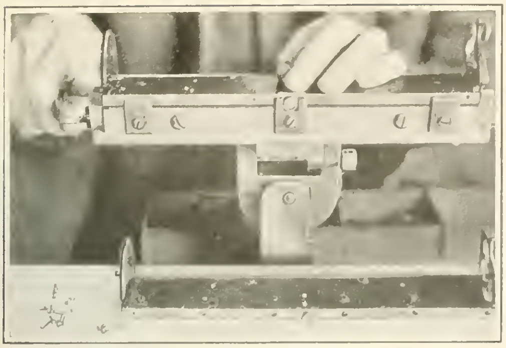


Fig. 9. Carriage Assembling—clamping End Plates

on much weaker springs than pad C. When the punch descends, the punch projection E forces the blank through the main pressure pad which acts as a solid die up to this point. In this manner the ears are thrown up and a right-angle bend is made at the wide end of the blank, as shown.

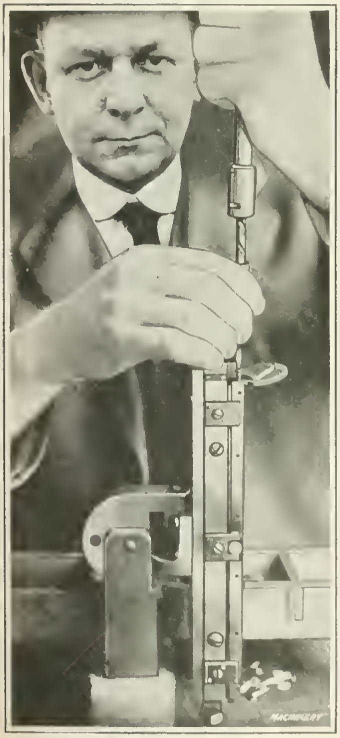


Fig. 10. Carriage Assembling—putting in End Plate Screws

At this point in the descent of the punch, posts F strike spots G on the main pressure pad, depressing it, and in conjunction with the punch and the secondary pressure pad D the blank is carried down to the limit of the descent. Punch E is undercut, as may be seen, and the main bend in the piece is made around the undercut section of the punch. A forming lever H bends the end of the blank around the "gooseneck" of the punch, being actuated by contact with inclined surfaces I and J as the punch descends. When the end of the lever strikes inclined surface I on the die, it presses the opposite end of the lever against the blank, holding it close against the punch, while die surfaces J bear against toggle surfaces K and force the lever and hence the blank inward around the under-cut section of the punch, leaving it on the punch, as shown in this illustration. This completes the bending operation and the piece is slid from the gooseneck shaped punch and dropped out of the die.

Fixtures for Assembling Corona Carriages

In Figs. 8 to 10 is illustrated the use of a fixture for assembling Corona typewriter carriages. The work to be done consists of assembling the back rail, rack, ball race, paper finger rail and two carriage ends to the carriage back plate. To do this requires the insertion of twenty-six screws from five different directions. Fig. 8 shows the beginning of the assembling operation, the fixture and some of the carriage parts. In the immediate foreground are some of the parts and directly behind is an assembled carriage. The various sizes of screws used are kept in a compartment box that may be seen just behind the fixture. The fixture may be used in the position shown, or it may be tipped 90 degrees to the right, left, front or back, by shifting the index pin at the center.

The first operation consists in loading the fixture with the parts that go on the under side of the carriage. These parts drop into respective grooves in the fixture. The first of these, which is shown being inserted in the foreground, is the carriage back rail. In the center is the rack, at the rear is the ball race, and on the further side is the paper finger rail, the two latter pieces being connected in Fig. 8. The carriage plate

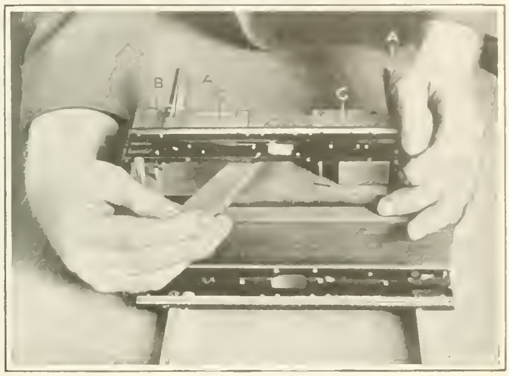


Fig. 11. Fixture for assembling Folding Arms to Carriage Bed Plate

is now slipped into place. Next, the end plates are located on pins in the guide brackets on the ends of the fixture.

Fig. 9 shows the clamping of the end plates in place, with the cam lever in the assembler's right hand. After this, the ten screws for attaching the rack and ball race are inserted, using a quick-acting screwdriver. The fixture is now thrown 90 degrees sidewise, bringing it into the position shown in Fig. 10, and the screws in the end plate are inserted. The fixture is then reversed 180 degrees and the opposite end plate screws are driven in, which completes the assembling operation.

The designing of this fixture was the result of efficiency studies on this particular operation, which previous to the installation of this fixture was a laborious operation, taking

Fig. 12. Counterboring on a Multiple Spindle Drilling Machine

eighteen minutes. With this fixture in use, the operation is completed in less than five minutes.

The assembling of the two folding arms to the carriage bed plate was formerly a troublesome operation because of the difficulty of making them square with the bed plate. A fixture was made to facilitate this operation, and from Fig. 11 the method of operation may be easily followed. In front of the fixture one of the assembled carriage bed plates may be seen, and it will be noticed that each of the folding arms is attached with two screws. At the farther side of the fixture are two arms or gages carrying pins for locating the two arms to be attached. These arms are placed on pins on the gages *A* and are located at the sides by gage-blocks, one of which is shown at *B*. By throwing over the central cam lever, two jaws *C* are moved against the sides of the folding arms and grip them tightly while the four screws attaching the carriage bed plate are driven in. While the primary object in designing this fixture was to provide an assembling method that would produce the best work, its use increased production 100 per cent over hand assembling.

Fig. 12 shows a counterboring operation that is performed in an unusual way on a multiple drilling machine. The pieces are aluminum carriage ends, which are blanked from 3/16 inch stock and at the same time have two holes pierced in them. The operation to be performed is the counterboring of these two holes. A jig that holds eight pieces is used, and the work is done on a multiple spindle drilling machine, using sixteen spindles. Two men are employed on the job, one of whom loads a jig full of work while the machine operator is counterboring the work in a second jig. Handled in this manner, the machine is kept working all the time and the production is very rapid. C. L. L.

* * *

CALCULATING CHANGE-GEARS FOR HOBBING SPIRAL GEARS

BY GEORGE ALLINGTON

The following method of calculating change-gears required for hobbing spiral gears on the No. 12 Barber-Colman gear-hobber, reduces what has formerly been regarded as a somewhat tedious problem into a direct process which gives extremely accurate results. The usual method is to substitute in Formula (1) a certain value for the feed which will cancel into the available change-gears for the indexing, and then substitute in Formula (2) the same value for the feed which must cancel into the available change-gears for the feed motion. The following method was developed with the view of eliminating slight errors in the gear ratios that it is usually necessary to employ in order that these cancellations may be made in Formulas (1) and (2). Any feed used in hobbing spur gears, that is suitable for the work, can also be used for spiral gears; and by employing Table II the proper index gears may be quickly determined without resorting to the method of cancellation. The following are the formulas referred to:

For index gears:

$$\frac{30}{N \pm \dfrac{FS}{P}} = \frac{\text{drivers}}{\text{driven gears}} \qquad (1)$$

For feed gears:

$$\frac{F}{0.075} = \frac{\text{drivers}}{\text{driven gears}} \qquad (2)$$

where N = number of teeth in gear to be cut;
F = desired feed;
S = sine of angle of spiral;
P = normal circular pitch = $\dfrac{3.1416}{\text{diametral pitch of hob}}$.

The minus sign is used when the spiral gear and hob are both right-hand or both left-hand; and the plus sign is used when the spiral gear is right-hand and the hob left-hand or *vice versa*. The proper feed to use depends upon the nature of the work, the material and the angle of the spiral; and the larger the spiral angle, the smaller should be the feed per revolution of the gear blank. Table I covers a range of speeds which is sufficiently wide for hobbing all ordinary commercial gears. Should a finer feed be desired, change-gears for the new feed may be calculated from Formula (2), employing the cancellation method as explained in the following example.

In order to explain the use of this method of determining change-gears for the hobbing machine, it will be of interest to carry out a problem taken from actual practice. Suppose it is required to determine the proper index and feed gears to use for hobbing a left-hand 20-tooth spiral gear of 7 diametral pitch (0.4488 inch normal circular pitch), which has a spiral angle of 17 degrees, 34 minutes, using a right-hand hob. Assuming that it is desired to use a feed of 0.0625 inch per revolution of the gear blank, we determine the index gears by substitution in Formula (1):

$$\frac{30}{20 + \dfrac{0.0625 \times 0.30182}{0.4488}} = \frac{30}{20.04203} = \frac{\text{drivers}}{\text{driven gears}}.$$

$$\begin{aligned} \text{Log } 30 &= 1.4771210 \\ \text{Log } 20.04203 &= 1.3019421 \\ \hline \text{Log ratio} &= 0.1751789 \end{aligned}$$

Two, four or six gears may be used in the indexing train, and from Table II, which gives the logarithms of various gear ratios that may be employed on the No. 12 Barber-Colman gear-hobbing machine, we select a pair of gears the ratio of which is such that the logarithm of this ratio is as nearly as possible equal to the logarithm of the ratio obtained from Formula (1). Reference to Table II will make it evident that the gears which come closest to this value have 45 and 30 teeth, respectively, the logarithm of the ratio of these gears being 0.1760913. But the difference between this logarithm and the logarithm of the ratio obtained from Formula (1) is too great, and so it becomes necessary to use four gears in the index train. To determine the proper gears to employ for this purpose, the following method of procedure is employed:

$$\begin{aligned} \text{Log of required ratio} &= 0.1751789 \\ \text{Log of ratio 54:37 from table} &= 0.1641921 \\ \hline \text{Difference} &= 0.0109868 \\ \text{Log of ratio 40:39 from table} &= 0.0109954 \\ \hline \text{Log of error} &= 0.0000086 \end{aligned}$$

In this way we find that an index train consisting of gears with 54, 37, 40 and 39 teeth will give the required result. Probably it will have been observed that the preceding result was obtained by selecting from the table of gear-ratio logarithms two values whose sum is nearly equal to the gear-ratio logarithm obtained from Formula (1). A few trials are sometimes necessary to reduce the error to a point where it may be safely disregarded. There are other gear-ratios which have a value very close to 1 to 1, and if the first ratio selected, *i. e.*, the ratio 54 to 37 in the preceding case, is as large as possible, the probability of the difference of the logarithms lying close to the value of a second gear-ratio logarithm which may be found in the table will be materially increased.

It will be recalled that it was decided to use a feed of 0.0625

TABLE I. RATES OF FEED AND FEED GEARS FOR BARBER-COLMAN NO. 12 GEAR-HOBBING MACHINE

Feeds per Revolution, Inches	Driver	Driven	Driver	Driven	Feeds per Revolution, Inches	Driver	Driven
0.01500	24	60	36	72	0.06000	48	60
0.01875	24	72	36	48	0.06429	48	56
0.02000	24	72	48	60	0.07000	56	60
0.02333	24	72	56	60	0.08034	60	56
0.02500	24	..	..	72	0.08750	56	48
0.03000	24	..	..	60	0.09000	72	60
0.03750	36	..	..	72	0.09375	60	48
0.04125	33	..	..	60	0.10000	48	36
0.04500	36	..	..	60	0.11250	72	48
0.05000	48	..	..	72	0.12500	60	36
0.05454	24	..	..	33	0.15000	72	36

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TABLE II. AVAILABLE RATIOS FROM INDEX GEARS FURNISHED WITH NO. 12 BARBER-COLMAN GEAR-HOBBING MACHINE, AND LOGARITHMS OF GEAR RATIOS

Driver	Driven	Log Driver/Driven	Driver	Driven	Log Driver/Driven	Driver	Driven	Log Driver/Driven	Driver	Driven	Log Driver/Driven	Driver	Driven	Log Driver/Driven	Driver	Driven	Log Driver/Driven
60	59	0.0072993	59	54	0.0384582	48	40	0.0791812	48	37	0.1130395	58	40	0.1613680	72	43	0.2238640
59	58	0.0074240	47	43	0.0386294	54	45	0.0791812	39	30	0.1139433	48	33	0.1627273	57	34	0.2243960
58	57	0.0075531	45	41	0.0404286	59	45	0.0806559	56	43	0.1147195	54	37	0.1641921	56	33	0.2296741
57	56	0.0076869	33	30	0.0413926	47	39	0.0810333	43	33	0.1149546	57	39	0.1648103	58	34	0.2319491
49	48	0.0089549	54	49	0.0421977	41	34	0.0813050	60	46	0.1153935	60	41	0.1653674	41	24	0.2325727
48	47	0.0091433	43	39	0.0424039	58	48	0.0821868	47	36	0.1157954	72	49	0.1671364	57	33	0.2373610
47	46	0.0093401	41	37	0.0445822	40	33	0.0835461	59	45	0.1176395	59	40	0.1687920	59	34	0.2393731
46	45	0.0095453	40	36	0.0457575	57	47	0.0837770	54	41	0.1196099	49	33	0.1716822	72	41	0.2445486
41	40	0.0107239	60	54	0.0457575	45	37	0.0850108	45	34	0.1217336	58	39	0.1723634	60	34	0.2466724
40	39	0.0109954	48	43	0.0477727	56	46	0.0854302	49	37	0.1219944	45	30	0.1760913	59	33	0.2523381
37	36	0.0118992	37	33	0.0496878	72	59	0.0864805	57	43	0.1224064	36	24	0.1760913	43	24	0.2532573
34	33	0.0129650	46	41	0.0499739	60	49	0.0879546	40	30	0.1249387	72	48	0.1760913	72	40	0.2552725
60	58	0.0147233	45	40	0.0511525	49	40	0.0881361	48	36	0.1249387	60	40	0.1760913	54	30	0.2552725
59	57	0.0149771	54	48	0.0511525	59	48	0.0896108	72	54	0.1249387	54	36	0.1760913	60	33	0.2596374
58	56	0.0152400	34	30	0.0543576	48	39	0.0901766	60	45	0.1249387	59	39	0.1797874	72	39	0.2662679
56	54	0.0157942	41	36	0.0564814	37	30	0.0910804	58	43	0.1299595	56	37	0.1799863	56	30	0.2710667
49	47	0.0180982	49	43	0.0567276	58	47	0.0913301	54	40	0.1303338	72	47	0.1852346	45	24	0.2730013
48	46	0.0184834	56	49	0.0579919	57	46	0.0931171	46	34	0.1312789	46	30	0.1856365	57	30	0.2787536
47	45	0.0188854	47	41	0.0593140	72	58	0.0939045	49	36	0.1338936	60	39	0.1870867	46	24	0.2825466
45	43	0.0197440	39	34	0.0595857	41	33	0.0942700	45	33	0.1346986	57	37	0.1876732	58	30	0.2863067
43	41	0.0206846	54	37	0.0602959	46	37	0.0945561	56	41	0.1354041	37	24	0.1879905	72	37	0.2891308
41	39	0.0217193	46	40	0.0606978	56	45	0.0949755	41	30	0.1356626	56	36	0.1918855	47	24	0.2918867
60	57	0.0222764	45	39	0.0621479	30	24	0.0969100	59	43	0.1373835	72	46	0.1945747	59	30	0.2937307
59	56	0.0226640	43	37	0.0652668	45	36	0.0969100	33	24	0.1383027	47	30	0.1949766	60	30	0.3010300
39	37	0.0228629	57	49	0.0656788	60	48	0.0969100	47	34	0.1406190	58	37	0.1952263	48	24	0.3010300
57	54	0.0234811	56	48	0.0669468	59	47	0.0987541	54	39	0.1413292	57	36	0.1995724	72	36	0.3010300
36	34	0.0248236	48	41	0.0684573	54	43	0.0989253	57	41	0.1430910	54	34	0.2009149	49	24	0.3099849
49	46	0.0274383	54	46	0.0696360	49	39	0.0991315	46	33	0.1442439	59	37	0.2026503	72	34	0.3258536
48	45	0.0280287	47	40	0.0700379	58	46	0.1006702	60	43	0.1446828	48	30	0.2041199	72	33	0.3388186
46	43	0.0292893	40	34	0.0705811	72	57	0.1014576	56	40	0.1461280	72	45	0.2041199	54	24	0.3521826
60	56	0.0299633	40	39	0.0716932	43	34	0.1019896	48	34	0.1497623	58	36	0.2071255	56	24	0.3679768
58	54	0.0310342	39	33	0.0725507	57	45	0.1026624	58	41	0.1506441	60	37	0.2099496	57	24	0.3756637
43	40	0.0314085	58	49	0.0732319	47	37	0.1038962	34	24	0.1512677	39	24	0.2108534	72	30	0.3802112
40	37	0.0338583	57	48	0.0746337	60	47	0.1060534	47	33	0.1535840	49	30	0.2130748	58	24	0.3832168
39	36	0.0347621	56	47	0.0760901	46	36	0.1064553	57	40	0.1538149	54	33	0.2138799	59	24	0.3906408
37	34	0.0367228	43	36	0.0771660	59	46	0.1080942	43	30	0.1563472	59	36	0.2145495	60	24	0.3979401
49	45	0.0369836	49	41	0.0774122	72	56	0.1091445	56	39	0.1571234	56	34	0.2167091	72	24	0.4771213
36	33	0.0377886	72	60	0.0791812	58	45	0.1102155	59	41	0.1580681	60	36	0.2218488	..	..	....
..	..	....	36	30	0.0791812	..	..	....	49	34	0.1597172	40	24	0.2218488	..	..	....

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inch per revolution of the gear blank. Substituting this value in Formula (2), we have:

$$\frac{F}{0.075} = \frac{0.0625}{0.075} = \frac{625}{750} = \frac{60}{72} = \frac{\text{drivers}}{\text{driven gears}}.$$

Checking this calculation for error, we have:

$$\frac{30}{20.04203} = \frac{1.496854}{1}$$

$$\frac{54}{37} \times \frac{40}{39} = \frac{1.496881}{1}$$

$$\begin{array}{r} 1.496881 \\ 1.496854 \\ \hline 0.000027 \end{array} = \text{error in index ratio.}$$

It will be recalled that the index constant of the No. 12 Barber-Colman gear-hobbing machine is 30; therefore, the actual error in indexing has a value of:

$$\frac{0.000027}{30} = 0.0000009 \text{ inch.}$$

With the exception of the gear-ratio logarithms, the preceding calculations were made for five-place logarithm tables. Slightly more accurate results would be obtained with seven-place tables, and for this reason the results presented in Table II were carried out to the seventh decimal place. The gear-ratio logarithms are calculated by subtracting the logarithm of the driven gear from the logarithm of the driver, and Table II includes all possible combinations of gears which may be obtained from the change-gears supplied with the No. 12 Barber-Colman gear-hobbing machine. As each special gear which is added to the list admits of introducing a number of new combinations, it will be evident that the table of gear-ratio logarithms can be extended to include a sufficient range of four gear combinations to obtain any ratio that may be desired for hobbing all gears that come within the range of the machine. The six gear combinations are obtained by a further application of the same principle employed in selecting four gear trains; and the sum of any three-ratio logarithms must very nearly equal the value of the logarithm of the required ratio.

* * *

IMPORTANT POINT IN JIG DESIGN

In the design of jigs for two pieces which are to be fastened together by means of bolts or screws, it is important to drill the work in such a way that the tendency of the drill to run out of its true path will not cause serious trouble. An example of this kind is shown in the accompanying illustration in the two halves of a bearing *A* and *B*, which are bolted together through the holes *C* and *D*. In designing a jig for pieces of work of this kind, it would be necessary in order to obtain the best results to start drilling from the surfaces at *G* and *H* and from *E* and *F* If this were done, the holes would match perfectly at the points of junction of the two pieces, and although there might be some variation at the outer ends of the holes, this would not cause trouble in alignment. A. A. D.

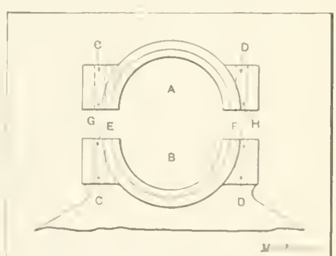


Diagram Illustrating an Important Point in Jig Design

* * *

For drawing temperatures between 650 degrees F. and 1000 degrees F., lead or a mixture of two parts of potassium nitrate and three parts of sodium nitrate may be used.

STRENGTH OF OXY-ACETYLENE WELDS*

BY S. W. MILLER†

With regard to the strength of welds, the author knows of no comprehensive tests that have been published, and does not believe that any investigations that have been made are complete enough to warrant accurate conclusions, particularly when modern welding practice is considered.

Cast Iron

In the case of cast iron, it is well known that the weld is stronger and less brittle than the original material; that is, as far as any ordinary cast iron is concerned. An explanation of this is to be found in what may be called the "anatomy" of the weld. It is finer grained, and inasmuch as the welding rods have to be made of good material, it is generally of a better quality than the original casting. It is therefore hardly necessary to discuss in detail the strength of cast-iron welds.

Steel

With regard to steel the situation is very complicated. There are so many different kinds of steel, and they are used for so many different purposes and are subjected to so many kinds of strains that it is impossible to lay down any general rule as to the strength of welds in this material. It has been claimed that oxy-acetylene welds are brittle and hard, although they may have greater tensile strength than the original material. It is true that in the early days of oxy-acetylene welding, when torches did not give as nearly a neutral flame as they do at the present time, many welds were burnt, and were therefore brittle and hard. At the present time, however, any weld of this kind shows that the welder either had a poor torch or did not know how to handle it. Hardness and ductility are relative terms, and a weld in a very soft, ductile, low-carbon steel may be harder than the original material, while a weld made with the same welding wire in a much harder steel of higher carbon may be softer than the original weld. In the former case, the original material may be more ductile than the weld, while the opposite may be true in the case of a harder original material. Again, the effect of the heat on the added material will be approximately the same in both cases. It is not true, however, that the effect of the heat will be the same on the original material in both cases. In the case of the soft ductile steel, the tensile strength of the weld will undoubtedly be higher than that of the original material, while in the other case the tensile strength will be less, and it may even happen, in the second instance, that the material just next to the weld will be so badly damaged by the heat that the test piece will break there, and not in the weld or some distance away from it. In the case of the higher carbon steels, there is still another action, in that the material next to the weld and in other places, where the heat is high enough, is decarburized. The extent of this decarburization varies with the intensity of the heat and the time to which the piece is subjected to it. A higher temperature and longer continued heating remove more carbon. This action is not due to anything except the heat and the presence of the oxygen in the air, and would occur with any method of heating. Another thing that occurs with very high carbon steel, such as tool steel, is the burning of the original metal in the vicinity of the weld. This applies particularly to tool steel, and an examination of many specimens microscopically indicates that it is not possible to weld high-carbon steel without burning it. Of course, it is possible to secure a union that may be strong enough for certain purposes, but the material next to the weld will not be sound, and no method of annealing or heat-treatment will cure steel that is really burnt.

Fig. 1. Test Specimens showing Ductility of Welded Joint

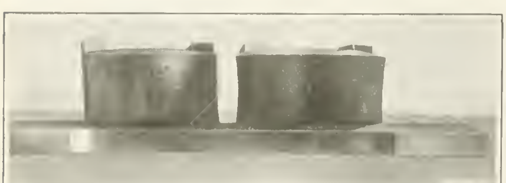


Fig. 2. View from above of Test Specimens shown in Fig. 1

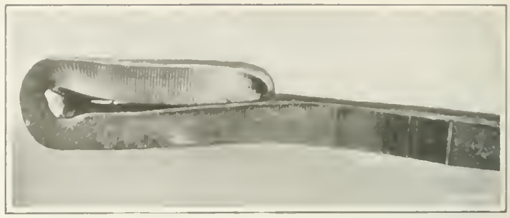


Fig. 3. Test Specimen bent Cold, showing Ductility of Weld

Ductility of Steel Welds

With regard to the ductility of steel welds, Figs. 1 and 2 show some test pieces, nearly full size, before and after bending, the weld being made in the center of the test piece. It certainly cannot be claimed that such welds are brittle or lack ductility. Fig. 3 shows, full size, a similar weld made in the same material and flattened cold. This also shows that a properly made weld is ductile. In the particular cases shown, the test pieces broke about 2½ inches from the weld, but the material from which they were made was a very low carbon steel of 47,500 pounds tensile strength; hence, it would naturally be expected that such material would not break in the weld. With steel of about 55,000 pounds tensile strength, a welded test piece will usually break in the weld, giving a tensile strength of about 52,000 pounds. The elongation in such cases may run as high as 20 per cent, that of the original material being in the neighborhood of 32 per cent. The elastic limit will be about 33,000 pounds, against 35,000 pounds in the original. So much depends on the material with which the weld is made, on the method of making it, and on the heat-treatment after it is made, that it is impossible to give any specific results. All the published tests that the author has seen are, in his opinion, deficient in essential information. For example, in one report of some tests made about two years ago, calling the average of the original pieces 100 both for tensile strength and elongation, the average for the welds untreated in any way was only 85 for tensile strength and 22 for elongation. The author's belief is that these welds were in some way improperly made, as he has never obtained such low figures as these. The lowest results given are for tensile strength, about 80 per cent of the original, and for elongation, 9.3 per cent of the original. The latter very low result indicates clearly that there was a wide variation in the actual condition of the different welds which should not exist. It is admitted that there will be some variation, but the author has repeatedly obtained results with a maximum variation of 10

* For other information on oxy-acetylene welding, see "Oxy-Acetylene Welding Practice," March, 1916, and articles there referred to.

† Address: Rochester Welding Works, Rochester, N. Y.

per cent in elongation, 6 per cent in elastic limit and 5 per cent in tensile strength. As has been stated before, it cannot be claimed that any weld is as good as the original material; and particularly in the case of steel, which is generally used in places where great strength and high physical qualities are required, care should be taken and good judgment used in selecting the method of joining. There is, above all, one thing that should be carefully considered, and that is, whether a welded piece is to be subjected to alternating stresses or shock. This is the worst condition to which a weld can be subjected, and it is well known that a piece of over-annealed steel will not stand these stresses nearly as well as a piece that has been properly refined by correct heat-treatment.

Strength of Welds in Non-ferrous Metals

With regard to the strength of welds in other metals, the author is not acquainted with any conclusive published tests, and is unable to give any results. However, in a general way, if the welds are made carefully with a good torch and the proper materials, the results will usually be satisfactory, as in most cases such metals as brass, bronze, aluminum and copper are not subjected to great stress, although, of course, there are exceptions to this; so that a weld in these materials will usually be amply strong, even if not equal in strength to the original material. One point, however, should be noted, which is that in the case of brass and bronze castings subjected to pressure, it is good practice, if indeed not absolutely necessary, that the whole piece be annealed at the proper temperature in order to relieve the cooling strains caused by welding. What this annealing is depends upon the alloy, and no definite instructions can be given. The time and temperature of annealing and the rate of cooling all have their effect, and have to be determined in each case.

* * *

MACHINERY CLUB OF CHICAGO

The Machinery Club of Chicago was organized May 1 with 154 charter members. The purpose of the club is to bring together at least once a week the salesmen and heads of the different machinery houses in Chicago. The club meets each Monday in the restaurant of the Chicago & North Western Railway terminal, in the midst of the machinery district on the West Side. The officers of the club are as follows:

President, Clyde W. Blakeslee, Chicago manager, Abrasive Material Co.

First vice-president, E. P. Welles, president and general manager, Charles H. Besly & Co.

Second vice-president, H. A. Stocker, president, H. A. Stocker Machinery Co.

Third vice-president, E. L. Essley, president, E. L. Essley Machinery Co.

Treasurer, A. L. Beardsley, Chicago manager, Cleveland Twist Drill Co.

Secretary, D. F. Noble, credit man, E. L. Essley Machinery Co.

The directors are Robert E. Cuthbertson, manager, Manning, Maxwell & Moore; F. L. Peterson, manager, Hendey Machine Co.; Hiram N. Cudworth, Chicago manager, Norton Grinding Co.; Herbert E. Nunn, western sales manager, Cleveland Automatic Machinery Co.; George M. Pearse, western representative, Brown & Sharpe Mfg. Co.; and E. L. Beisel, Chicago manager, Gardner Machine Co.

The resident membership fee is $5, and the annual dues $5; the non-resident membership fee is $2 and annual dues $3.

* * *

MONTHLY MEETING OF A. S. M. E.

The final meeting of the season 1915-1916 of the New York section of the American Society of Mechanical Engineers was held at the Engineering Societies Bldg., Tuesday evening, May 9. The subject for discussion was a report upon efficiency tests of a 30,000 K. W. (40,000 H. P.) cross-compound steam turbine, by Henry G. Stott and W. S. Finley, Jr.

The New York section will not discontinue its activities, however, through the summer; it has planned to make excursions to nearby points of mechanical and engineering interest about every two weeks through the season. The first one of these excursions was made to the Essex Station of the Public Service Corporation of New Jersey, Saturday afternoon, May 20.

GRAPHITE AS A LUBRICANT

BY C. H. BIERBAUM*

The rate of increase of the use of graphite for lubricating purposes is nothing less than surprising. Concerning the general increase of the consumption of graphite, *Mineral Industry*, 1914, says, "Fifteen years ago 75 per cent of the world's supply was used for crucibles and 4 per cent for lubricants; now 30 per cent goes into lubricants and 50 per cent into crucibles." The world's total supply of graphite for 1913 was somewhat in excess of 100,000 tons; 30 per cent of this amount, or 30,000 tons, accordingly, stands as the world's consumption of graphite for lubricating purposes for the year 1913.

The constantly increasing use of graphite for lubrication is the more surprising when we consider the impurities which many of the best lubricating graphites now on the market still contain. These impurities have rendered their use, if not absolutely harmful, at least undesirable, for it is always difficult to say, concerning any particular grade of lubricating graphite, how much of the pure graphite is necessary to counteract the effect of the impurities, and in many grades the nature of the impurities is such that their harmful effects cannot be counteracted by the pure graphite. This condition is clearly shown by the photomicrographs reproduced herewith. Fig. 1 shows the surface of a cut tooth of a bronze gear in a new Lobee pump, and Fig. 2 shows the surface of a tooth after the pump has been in service for a month. This pump was used for pumping a mixture of graphite and water against a head of two pounds per square inch. The mixture had the consistency of cream; that is, it was made up of substantially equal parts of water and air floated lubricating graphite. It should be noted that the streaks in Fig. 2 run at right angles to those in Fig. 1. Fig. 1 shows the milled surface as left by the gear cutter; this appears smooth to the naked eye but under the microscope shows slight streaks, as illustrated. Fig. 2, on the other hand, shows distinct cutting due to an abrasive, and in Fig. 3 the abrasive is shown magnified on the same scale (one hundred diameters). This material is practically pure quartz or white sand, and it is of interest to note the extreme variation in the size of these particles. In amount, it represents substantially 3 per cent of the total weight of the graphite from which it was taken. However, it does not represent all of the impurities which this graphite contained; it is only a portion that was washed out from the rest and constitutes the more abrasive part.

It is evident that these impurities have made many enemies of graphite, but nevertheless beneficial results have been obtained by its use in spite of its drawbacks. All criticisms of graphite can be traced directly to its impurities. The impurities in lubricating graphite may be divided into two classes: the harmful and the inert—that is, those that have a positive abrasive effect and those that act neither as abrasives nor lubricants. Artificial graphite may be made very high in carbon, but since it is a by-product of the electric furnace process of making silicon carbide, it is likely to contain traces of this, which is very objectionable, as silicon carbide is one of the most abrasive substances known. In the natural graphites the objectionable impurity most commonly found is silica, or common sand.

The harmfulness of the impurities depends also on the size of the particles. If the size of the arbrasive particles in a graphite is greater than the average thickness of oil film, their abrasive effect will be greatest in a bearing running under uniform pressure. On the other hand, in a reciprocating bearing under high duty, where the oil film is alternately broken and restored, all the different sizes or particles of the abrasive material may come into play, and it is in the latter class of bearing that pure graphite is most essential and that abrasive impurities are most harmful.

Among the many impurities in the natural graphite we find some that are not, by nature, abrasive, but are highly undesirable and injurious to bearings. To illustrate, let us take the particle of so-called flake graphite shown in Fig. 4, where we have alternating layers of mica and graphite held together in a manner capable of sustaining considerable compression. Let

* Vice-president, Lumen Bearing Co., Buffalo, N. Y.

us imagine stopping an engine at night with a layer of these laminated particles between a heavy crankshaft and a babbitt or lead bronze bearing; the inevitable result will be "pock-marking" of the bearing surfaces. The effect on a reciprocating bearing would be equally undesirable; and it will be readily seen that the jamming effect produced in a ball bearing by the use of this graphite would be ruinous. Yet this is a fair representation of the structure of Ticonderoga flake graphite or the micaceous graphites. For lubrication, the graphite should be such as to permit an infinite divisibility while in contact with bearing surfaces. The very thin layer of graphite between the layers of mica in the material shown in Fig. 4 possesses this property when completely separated from the mica; that is, if this micaceous graphite were ground fine enough and then had all the mica and other impurities completely eliminated the resulting product would be a very high grade of amorphous graphite.

Fig. 1. Section of Tooth of Bronze Gear not subjected to Abrasive Action—Magnification 100 Diameters

Fig. 2. Section of Tooth of Bronze Gear after being subjected to Abrasive Action—Magnification 100 Diameters

The degree of fineness to which the graphite should be ground is also of importance. It should be uniformly fine enough to practically maintain suspension in the oil or grease, so as to permit of the application of the lubricant without undue difficulty due to settling, and it should be fine enough to enter properly between the bearing surfaces without clogging; this will allow it to flow freely in the oil film between the bearing surfaces. For all ordinary lubrication with the lighter grades of machinery oil, none of the graphite particles should be coarser than 0.0003 inch; grades of graphite used with greases or heavy oils would be satisfactory if ground considerably coarser, owing to the correspondingly thicker oil film which exists with these lubricants. Excessively fine grinding solely for the purpose of securing permanent suspension in the oil is not desirable for the following reasons: First, it is a physical impossibility to keep mechanically divided pure graphite permanently suspended in a pure lubricating oil; and second, the larger the particle of graphite in the oil film of a bearing, the more efficient is the lubrication secured.

There being a positive capillary affinity between graphite and the oils, it is possible to grind the graphite so fine that it will remain in a suspended conditiou for a time, but in this fine state of subdivision the particles would, by the Brownian action, or vibration, be brought in contact with each other, coalescing and forming larger and larger masses. These larger particles, then, would tend to settle, through the action of gravity. This action is clearly illustrated in the photomicrograph shown in Fig. 5.

The friction of a bearing is not reduced owing to the presence of floating graphite in a perfect oil film, but upon the destruction of the oil film when the bearing surfaces approach each other and the graphite comes into play. Now it is evident that as the bearing surfaces approach each other, the largest particles are intercepted first while the smallest particles will flow freely from between the bearing surfaces. If the largest particles are 0.0003 inch and the smallest particles 0.000005 inch, it is obvious that the larger particles will allow the bearing surfaces to approach each other to within 0.0003 inch, whereas the smaller particles will allow these surfaces to approach each other to within 0.000005 inch. When we consider that the mass of a particle 0.0003 inch in diameter is more than 200,000 times that of a particle 0.000005 inch in diameter we will appreciate the folly of grinding graphite to such a degree of fineness. It has been found that grinding finer than 0.000005 inch is necessary to produce permanent suspension, and even under those conditions the effects shown in Fig. 5 are produced.

The carbon content of a graphite is not an indication of its lubricating value, for the reason that the percentage of amorphous carbon in some varieties is comparatively high. Amorphous carbon, or carbon not completely graphitized, can best be classified as an inert impurity; its presence always shows extreme blackness. This is true of another common impurity, hydrogen, or a hydro-carbon; this also is black, whereas the purest graphite is a dark steel gray when mixed with a clear oil. The chemical laboratory can only give valuable information on the subject of the graphites when the work is done by an expert or specialist.

Impurities such as mica, silicon, calcite, feldspar, iron oxide, alumina, clay, and the like, to the amount of over 13 per cent, have been removed from some of the best lubricating graphites now ou the market by the Bierbaum process. Graphite purified by this process is used in the lubricating compound called "Lesoyl."

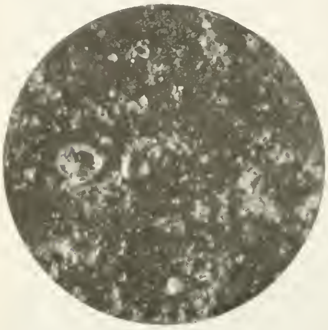


Fig. 3. Photomicrograph of Graphite containing Quartz Particles magnified 100 Diameters

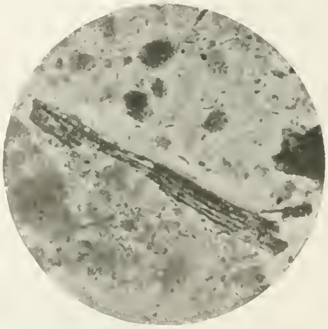


Fig. 4. Flake Graphite having Alternate Layers of Mica and Graphite—Magnification 100 Diameters

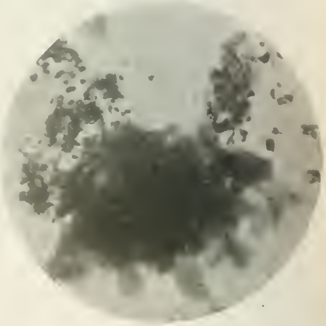


Fig. 5. Photomicrograph showing Coalescence of Particles of Graphite—Magnification 1600 Diameters

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

ESTIMATING THE COST OF MACHINE WORK

It is indeed refreshing to find the much lampooned household plumber justified by so good an authority as your own columns. If the implication conveyed by the editorial on page 780 of the May number, concerning "Estimating the Cost of Machine Work," is in point, and if the plumber can show as good reasons for his traditional vagaries as can the small manufacturer for not estimating and bidding on small jobs, then the knight of the soldering iron must indeed find full extenuation at your hand.

In the first place, the present is an inopportune time to raise this question of estimates, because so much work, particularly special tool work, has been done and is being done on an hour rate basis. So long as orders are freely given on that basis, why estimate? To do so appears to be a needless and futile expenditure of time. Prior to the present pressing times, bids could be secured on orders of almost any kind and size, but according to my observation the small shops were those which would "make a price," while larger shops would exact the hour rate basis—possibly impelled to do so because of early experiences which they have survived, and possibly because a well established reputation enabled them to enforce the exaction.

The nature of the illustration offered by your correspondent leads to the assumption that he refers to small jobs involving a single piece or device, or work of such restricted extent as to neither involve nor warrant special manufacturing equipment.

In cases judged to be akin to the example presented, the drawings or prints and other specifications are frequently inadequate. Replete with such archaic expressions as "running fit"; "absolutely straight"; "absolutely square," they call for further information. Two of the first questions which invariably arise are, "How accurate? What are the tolerances?" Shafts and bearings are depicted, dimensioned as of the same size, with no clue as to the running speed or other conditions from which to guess suitable relative sizes. Round holes are shown with no indication of their ultimate function or the precision of their size or relation: should they be merely drilled; or drilled and reamed; or must they be bored with regard alike to accuracy of spacing and parallelism? Were a substantial order in view, one might well afford to make a trip, or write, or otherwise ascertain definitely what is required, and further revise the drawings to a manufacturing basis so as to distinctly impart to the workmen just what they were to perform and within what degree of accuracy. But to undertake the same procedure for every small job submitted by a prospective customer would consume time that could be better devoted to securing more profitable orders. Indeed, to what extent could a contractor realize on the extra effort? Will your "engineer of wide experience" pay me or anyone for making a painstaking estimate; or will he give his order to Jones who bids $30 less on the basis of a guessed weight and an estimated (?) cost per pound? Unless your engineer is an abnormal altruist, Jones will secure the order if he is a responsible party, even if he is believed to have bid in on a losing basis.

But even if the drawings are entirely adequate, with full information expressed in terms readily intelligible to the workmen, there are two other principal factors to be considered in the production of any piece—the individual factor or personal equation of the workman, and the individuality of the piece to be made.

In some respects the personal equation is the least certain and least dependable. Among experienced, competent workmen there is a distinct difference in their rates of mental and bodily action, and consequently in their individual rates of performance. These rates are further varied by the condition of bodily health at any given time. Temperament is not confined to artists. An exceptionally good workman will sometimes utterly "fall down" on a job, due to temporary bodily infirmity or mental disquietude. A price may be based upon the rate of performance of a rapid worker, and when the work comes to hand it must be given to a slow worker. Therefore, in work of duplication, i. e., making a single piece or set of pieces from a drawing or from a sample piece or set, the personal equation has a stronger bearing on cost and price than does the cutting capacity of a machine tool. In the case of reduplication, *i. e.*, the making of a multiplicity of pieces or sets, the cutting capacity is of greater importance, first because the employment of special tools renders the personal rate more uniform, and again, in making an extended number of parts there is opportunity to substitute a more rapid worker for a slow one, which substitution is usually impracticable on the small job.

The individuality of the piece to be machined is an important consideration. If it is a casting of complicated form—or even of apparently simple form—it is not an unknown occurrence to be obliged to materially modify or to entirely remake a pattern. Apparently simple operations sometimes develop unforeseen difficulties. After a casting has been half or two-thirds machined, a spongy spot or a deep blow-hole develops at a point where it cannot be tolerated. One surface or portion of a casting machines freely and another portion develops hard spots which cause a reduction in the rate of cut, or entirely prevent further machining. A piece of steel may likewise develop some flaw after the machining has proceeded substantially. In any of these cases the foundry or the steel mill may replace the defective material, but neither will reimburse the contractor for his fruitless work. The cost of doing that work over may materially curtail or entirely cut out his estimated profit.

In the case of extended manufacture, the cost of the pattern change will be spread over the entire lot; the variation of the labor cost from the estimated figure may be taken care of; the cause of the spongy iron and of the blow-holes will probably be located and its effects will be corrected. In short, the contractor has steerage way which he has not in the case of a small job. In any estimate there is a factor of guesswork, as evidenced by the fact that every experienced contractor includes some allowance for contingencies—a factor of safety, as it were. There seems to be only one sane way in which to estimate on such small jobs, and that is to allow a factor of safety that will be ample to care for the possible accumulation of all these variable factors, i. e., guess at the probable outcome of the work.

With reference to the three prices quoted in the example presented, there seems to be a note of reproach at their disparity, and the statement is ventured that only one of the prices can be correct. To my mind all of the prices may have been correct, and again all of them may have been wrong. From a purely commercial viewpoint, the lowest price was the only correct price if it were made by a responsible party. As your correspondent gives no figures showing what the work actually cost at the factory, there remains the possibility that none of the prices sufficed to cover the cost and yield a profit, in which case none of them would be correct.

Costs and prices vary materially between different shops, and their correctness—better, their propriety—is to be determined usually by the conditions prevailing in the shop doing the work, rather than by the acceptability of the price to the buyer.

A concern that buys its castings pays a higher price for

them than does the concern that makes its own castings—usually. A concern that buys substantial regular tonnage of medium and heavy weight castings usually enjoys a better price than does the concern that buys only light weight castings and in relatively small quantities.

Operations in one shop may be such that the job can be carried along with other work at a *pro rata* expenditure of time, whereas in another shop the work must proceed by itself and sustain the cost of "straight time" unshared by any other work. One shop may be able to use some rig that has been used for a previous order and that materially facilitates the prosecution of the work, while another shop may have no such time-saver at its disposal, or may have only meager facilities of any kind. Different establishments have diverse views as to what constitutes a reasonable profit, and some are not satisfied with a reasonable profit. Equally diverse is the allowance for contingencies.

A very small shop frequently has an insignificant overhead burden, because the proprietor himself works, besides keeping his books and attending to his correspondence. Almost everything received beyond his actual expenditures for rent, wages and material is net profit. The medium sized and large shop usually has a substantial charge for overhead that must be embodied in any estimate.

The fact that tenders vary is no indication of essential error in an estimate, but rather that conditions may be different in different shops, and that it may be advantageous to place the order with one concern rather than with another. There is always the further possibility, due to the ambiguities above indicated, that the drawings submitted may have been differently interpreted by different persons, one proposing to do much closer work than another.

Is it not fair to infer from the fact that your correspondent has for so many years been unable to interest "small manufacturers" in estimating, that those small manufacturers may be better acquainted than he with the pitfalls that are to be encountered in prosecuting such small contracts? Possibly some of them have memories of experiences more "lamentable" than their disinclination to make such estimates?

By the way, if we as Americans are so unprogressive, who is more progressive? Your correspondent omits to point out who is ahead of us. Can he secure bids on such work from across the water or from across the border? If he is correct, then what do the advertisements for contract work mean that are carried by all metal trade papers, including MACHINERY? Some of these advertisers solicit a print or sample on which to base a proposition despite the asseveration concerning American progressiveness in the line discussed. Some of the advertisers are certainly located here in this country, but, of course, there is no conclusive evidence as to their nationality.

Providence, R. I. EDWIN C. SMITH

We have read the editorial in the May number on "Estimating the Cost of Machine Work," and wish to offer a few remarks on the subject from the standpoint of the shop, and especially of the small shop.

If the specifications of cylinder submitted were no more complete than the description, we do not wonder at the variation of estimates made, and if the specifications were more complete than this, it constitutes an exceptional case in specifications offered for estimates or quotations. In this particular case, were there any specifications of limits as to dimensions? Was the use to which the cylinder was to be put specified so that the required finish could be positively known? Was its use such that an absolutely clean surface was required, as would be the case in a hydraulic or air cylinder? Were the patterns that had to be made to be used for single castings only, or were they to be so made that they would stand up for continuous use? We could ask a number of other questions that should be known in order to make an intelligent estimate on the job.

Our attention was especially called to this case because within ten minutes after reading the article we were called on the telephone by someone fifty miles away and asked to quote on reboring a four-cylinder automobile engine, making new pistons, rings and piston pins. The person at the other end of the wire was quite "peeved" because we would not make a quotation on the job, although he was unable to give make of engine, bore, number of rings in pistons, amount required to be removed from cylinder walls, whether cylinders had open or closed ends, or any other essential information than that noted above.

The machine shop, and especially the small shop, is often asked to make estimates upon work with data varying all the way from motions made with the hands to complete blueprints. In many cases where estimates are requested from complete data, the request is not made with the intention of giving out the work but merely for the purpose of checking the manufacturers' own estimated cost. Frequently the estimator for the small shop is also the superintendent, foreman, sales manager, trouble man, time clerk and rate setter; he has duties in the shop which occupy a large part of his time and, therefore, does not have as much time to devote to these estimates as could be wished by the parties submitting them.

No lawyer would submit an opinion based upon the most careful statement of facts, gratis, nor would a physician furnish his estimate of the treatment necessary for any given ailment without compensation for his time and skill. We do not see why a machine shop should be called upon to furnish similar service without compensation.

In the case under discussion, the writer states that he sent the data to ten machine shops. It is a "cinch" that nine of them would get nothing for their estimate or quotation. We do not consider the variation of bids received for the work more than would be expected unless complete drawings and specifications were submitted and unless the shops to whom these were submitted were all equipped to do the work in the most efficient manner.

Moline, Ill. REYNOLDS PATTERN & MACHINE CO.

ELGIN WATCH SCREW THREADS

In the March number of MACHINERY a table was published giving the dimensions of standard screw threads used by the Waltham Watch Co. As the products of this firm and those of the Elgin National Watch Co., of Elgin, Ill., are the two best known in the United States, the accompanying table giving the dimensions of standard screw threads used by the latter firm appears to be a logical supplement to the table published in March. This table is taken from the Elgin material list issued in May, 1915.

TABLE OF ELGIN WATCH SCREW THREADS

Diameter, Inches	Diameter, Millimeters	Threads per Inch	Diameter, Inches	Diameter, Millimeters	Threads per Inch
0.0132	0.33	360	0.0428	1.07	120
0.0148	0.37	320	0.0448	1.12	110
0.0168	0.42	260	0.0468	1.17	110
0.0208	0.52	220	0.0488	1.22	140
0.0228	0.57	260	0.0488	1.22	200
0.0248	0.62	220	0.0508	1.27	110L
0.0268	0.67	180	0.0548	1.37	180
0.0288	0.72	220	0.0608	1.52	110
0.0308	0.77	180	0.0608	1.52	110L
0.0308	0.77	220	0.0708	1.77	180L
0.0368	0.92	140	0.0768	1.92	110L
0.0368	0.92	220	0.0772	1.93	80L
0.0408	1.02	120L	0.0892	2.23	80L
0.0408	1.02	200	......	....	...

Machinery

Note: "L" indicates left-hand threads.

New London, N. H. GUY H. GARDNER

PLUG GRINDING FIXTURE—CORRECTION

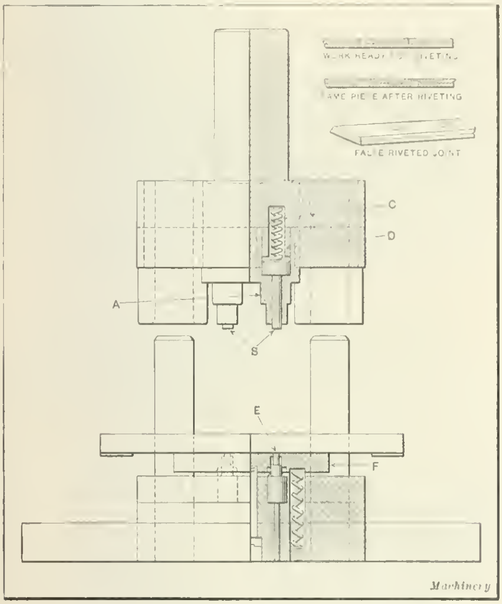
An error appeared in my letter, "Plug Grinding Fixture," in the May number. Beginning on the thirteenth line, the sentence should read as follows: "The work is gaged by placing a parallel on top of the plug, and the distance between the under side of the parallel and the surface of the magnetic chuck is measured by means of a gage block or distance piece."

Plainfield, N. J. J. B. MURPHY

FALSE RIVETING DIE

The term "false riveting" is used to denote a method of securing two pieces of sheet stock together by forcing metal from one sheet up into a hole punched in the other, and compressing this metal so that it is a tight fit in the punched hole. The following describes a punch and die for performing false riveting operations, and an example of false riveting is shown beside the illustration of the tool.

The upper member consists of a cast-iron punch-holder, which carries two steel riveting punches and guide pin bushings. Tool steel bushings *A* support the riveting punches *B* which protrude for a distance slightly greater than the thickness of the pierced stock, and are held out by compression springs *C*. Bushings *D* are driven into place and form abutments for the riveting punches. The lower member consists of a cast-iron shoe that supports a steel plate in which two punches *E* are mounted. *F* is the drawing plate which assists



Die used for False Riveting Operation and Examples of Work

in forcing the metal from the lower piece up into the hole punched in the upper piece.

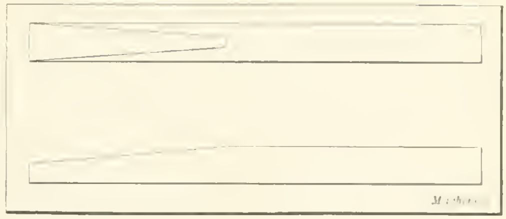
The operation of the punch and die is as follows: The two pieces of sheet metal—with the upper piece punched as shown in the top view—are properly located in the die by a gage. The upper member of the tool engages the work and forces it down onto punches *E* which force metal from the lower sheet up into the holes in the upper sheet. When plate *F* has reached the limit of its travel, pins *B* apply pressure from above and expand the metal in the holes in the upper sheet, thereby making a very tight joint.

For light manufacturing, this method will be found to constitute a very satisfactory means of making joints. It can be used in cases where the employment of ordinary rivets is out of the question, because their raised heads would detract from the appearance of the finish applied to the work. Where pieces are joined by false riveting, they may be nickel-plated and polished, after which the joint will be practically invisible. Tests made of false riveted joints have shown that the metal forced up into the holes in the upper plate will break before the rivets are pulled out of the holes.

Chicago, Ill. H. Field McKnight

SLIDING FIT FOR PILOT PINS

When it is required to provide a sliding fit for a pilot pin made of cold-rolled stock or drill rod, the following method



Reamer for finishing Holes to make Sliding Fit for Pilot Pins

will be found to give satisfactory results. First take a drill one size smaller than the stock and drill a hole in the usual way. Then take a piece of the drill rod that is to be used for making the pilot pin, and bevel off one side to form a reamer which is used for finishing the hole; this piece is then hardened and ground. By running this tool through the hole which is to receive the pin, a nice sliding fit will be obtained. When it is frequently necessary to machine holes for pins of standard sizes, it is a good plan to carry a number of these reamers in stock.

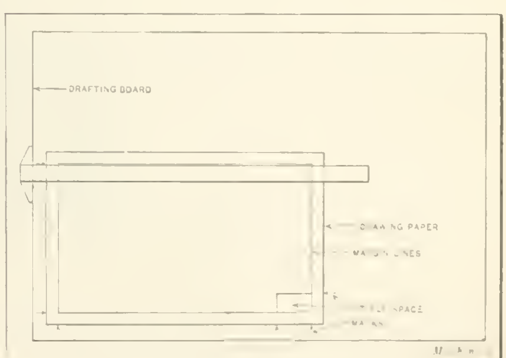
Milwaukee, Wis. W. E. Butler

DRAFTING-ROOM KINK

The following describes a method of saving considerable time for tracers and draftsmen through having reference marks on the drawing-board to facilitate laying out border lines and title spaces without the necessity of making measurements. Many draftsmen are not careful about ruling margin lines and the space for a title at the time they start work, and if the drawing is not laid out in this way to correspond to the printed tracing cloth, there is a probability that some of the details or views on the paper will extend beyond the border lines. Especially is this the case if an attempt is made to crowd all views and details onto a single sheet.

When such drawings come to the tracer and it is found that they cannot be traced direct on a standard sized sheet, it is necessary to shift the tracing cloth to get all the views inside the border lines and title space, and this naturally results in the loss of considerable time. But if the draftsman has his drawing-board marked off according to the plan shown in the accompanying illustration, it requires but a few seconds to draw in the border lines and title space before he starts work, thus obviating trouble for the tracer and saving time for the draftsman. The reference marks which indicate the locations of the different border lines and title space lines are marked on the drawing-board with India ink, or cut in lightly with a knife, being laid off to correspond with the standard printed tracing cloth used in making tracings. The illustration shows a board laid off for a single size of drawing, but it would be practicable to lay off a single board with reference marks for a number of different sized sheets.

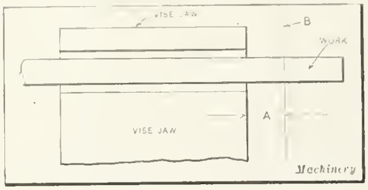
Chicago, Ill. James R. Allan



Rapid Method of laying out Border Lines and Title Space on Drawings

HACKSAW SETTING TO LENGTH

The accompanying illustration shows a useful kink for setting up a hacksaw machine for cutting off stock to a specified length. Its use saves the necessity of making several settings by the cut and try method. Referring to the illustration, it will be seen that the distance *A* from the edge of the vise jaws to the inside of the hacksaw blade is measured. In setting up the work in the vise, it is then a simple matter to set the end of the bar out from the edge of the vise a distance equal to the length of the piece to be cut off plus the distance *A* from the edge of the jaws to the saw blade.

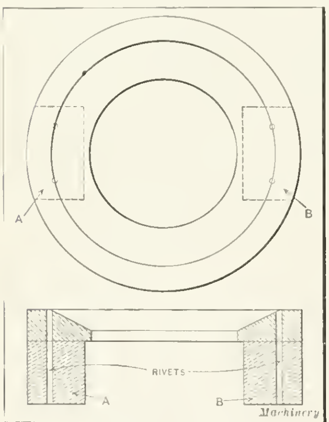


Method of setting up Work on Hacksaw to cut off Piece to Required Length

Worcester, Mass. C. H. Anderson

TO PREVENT BROKEN TOOLPOST RINGS

Lathe operators often have work to do that requires the tool to be turned around to a position at right angles to the faceplate or chuck, and rather than take the time to swing the compound rest around they simply turn the toolpost to the desired position and tighten the tool in place. With the tool turned around in this way, there is no support under the ring, and when the screw is tightened there is a tendency for the pressure to cause the ring to bend between the T-slots of the compound rest, which sometimes results in breaking it. After breaking several rings in this way, it occurred to the writer that it would be possible to fit two small blocks on the under side of the ring as shown at *A* and *B* in the accompanying illustration. These blocks are made the same width and thickness as the T-slot in the compound rest and are riveted to the ring as shown.



How to avoid breaking Toolpost Rings

Harvey Mead

HAND BENDING FIXTURE

Some time ago we received an order for 10,000 pieces of the form shown at *A*, and the small number of pieces called for naturally limited the amount of money which could be spent for tools. As a result, it was decided to employ some simple form of hand bending fixture, and the following describes the tool that was finally developed for the purpose. The blanks from which pieces *A* were formed were cut off from bar stock on a power shear, and each end was then bent up to an angle of sixty degrees as shown at *B*. After the blanks had been prepared in this way, they were brought to the bending fixture on which the coils were wound, care being taken to keep the bent ends in line with the plane of the coils. After the forming operation was completed, the work was fitted to a gage, and if it did not fit this gage properly the piece was straightened out with a small hammer. After obtaining a little practice in operating the bending fixture, the boy employed to do the work became quite expert and was able to wind the coils so that they did not require straightening, at the rate of 250 per hour.

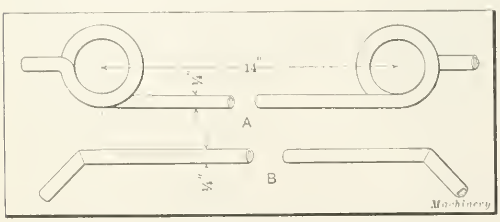


Fig. 1. Blank B with Ends bent to Angle of 60 Degrees and Finished Piece A

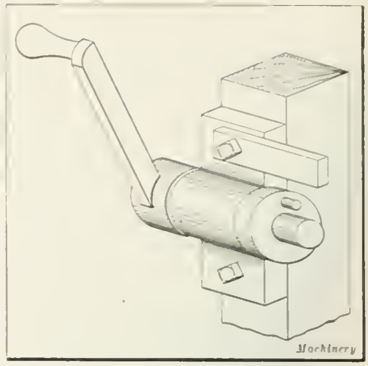
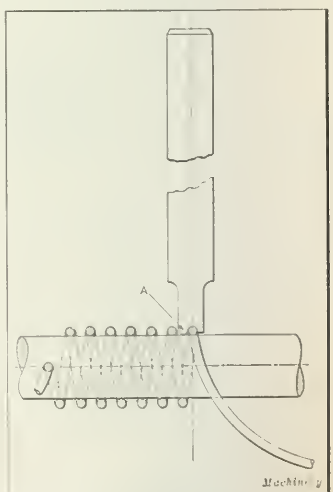


Fig. 2. Hand Bending Fixture used for making Pieces shown at A in Fig. 1

Memphis, Tenn. James Ellis

TOOL FOR WINDING SPRINGS

The following describes a method of winding medium and heavy helical springs for use on jigs and fixtures, without having to gear up a lathe to attain the required lead for the spiral. In addition to saving time, this method also makes it possible to wind springs of any lead, regardless of the change-gears which may be available. The spring is wound on an ordinary mandrel which is supported on centers and driven by a dog or chuck. The feed is disengaged and the winding tool is fed along by the spring as it is wound up on the mandrel. Provision may be made for winding a spring of any required lead by making the projection *A* proportional to the pitch. The lathe is driven at about the same speed as for threading, and the mandrel must be made of such a size that after the spring is removed, and unwinds slightly, it will be of the required size. The exact size of arbor to use is governed, of course, by the diameter of spring, and gage size of wire used.

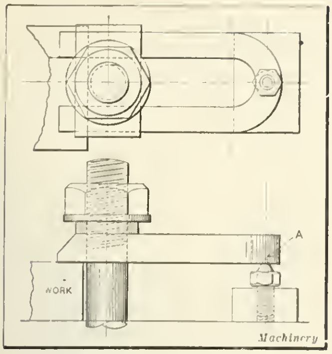


Method of winding Springs on Lathe without using Feed to control Lead of Spiral

J. B. M.

RAPID CLAMPING DEVICE

The accompanying illustration shows a method of clamping work for drilling, milling, planing and similar operations, which does away with loss of time in hunting up suitable



Plan and Elevation of Clamp and Jack

blocking to raise the back end of the clamp. It will be seen that the device consists of an ordinary horseshoe clamp and a bolt fitting in one of the T-slots in the table; but instead of using blocks to support the outer end of the clamp, a small jack is substituted, making the device quickly adjustable to any height within the range of the screw. Reference to the illustration will show that the clamp has a center hole drilled at *A* to receive the point of the jack screw.

Plainfield, N. J. J. B. Murphy

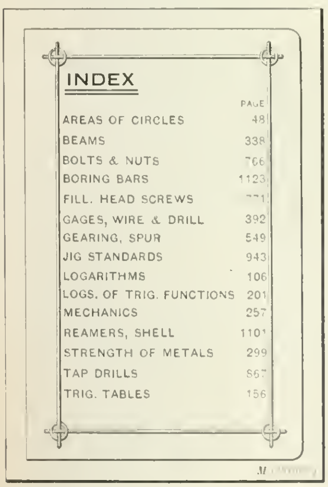
MONEL METAL PICKLING TRAYS

At the Pierce-Arrow Motor Car Co.'s plant in Buffalo, N. Y., where I worked out the pickling game on a large scale, we were at constant expense in replacing steel trays. Monel metal trays were later installed, and three years of constant use found these trays as good as new. Boiling sulphuric acid apparently had no effect on them.

Kenmore, N. Y. George B. Morris

ABBREVIATED INDEX FOR MACHINERY'S HANDBOOK

The average draftsman does not use textbooks enough to remember the page numbers of the common subjects or tables without actually learning them. An easy way of memorizing and in the meantime a quick way of finding the page numbers is to compile an abbreviated index of about twelve or fifteen of the most used sections or tables. The accompanying illustration reproduces the blueprint of an abbreviated index of the data in Machinery's Handbook which I use most. The blueprint is pasted inside of the front cover where it can be found instantly. The time spent in looking through the general index which this page saves amounts to a few hours in a year. Of course each user in compiling an abbreviated index will select the subjects to which he refers most.



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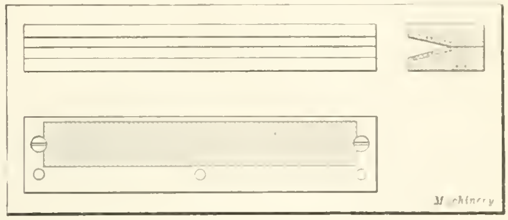
Reproduction of Blueprint Page, 4⅝ by 6⅞ Inches, carrying Abbreviated Index to Machinery's Handbook

Rockhampton, Australia. R. W. Williams

PENCIL SHARPENER

The average draftsman has occasion to use both conical and chisel shaped points on his pencils, and in order to get satisfactory results, the pencils must be sharpened at frequent intervals. The following describes a tool which enables pencils to be sharpened rapidly with either form of point. It consists of two ordinary hand files with the tangs broken off; slots are ground in each end of the files so that they may be held by screws, the files being held by two pieces of wood which are beveled in such a way that they may be joined at an angle. The files are screwed to these pieces of wood and the two pieces of wood are then screwed together. This pencil sharpener is mounted in a vertical position where the draftsman can easily reach it; and by drawing the pencil down the groove formed by the two files the point may be renewed very rapidly.

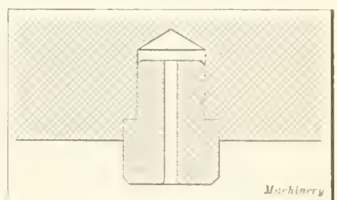


Pencil Sharpener for Drafting-room Use

C. C.

DESIGN OF JIG FEET

In the April number of Machinery, Donald Baker gives a method of putting in feet in a drill jig to avoid breakage and also to make their removal easy if this becomes necessary at any time. The writer has found that if the hole is counterbored as shown in the accompanying illustration, and the feet are sunk in a little below the surface of the casting, there is much less likelihood of breakage occurring because the foot is supported more strongly. The hole through the center of the foot is an excellent idea and can be applied to this style of foot as well as to that shown in Mr. Baker's article.

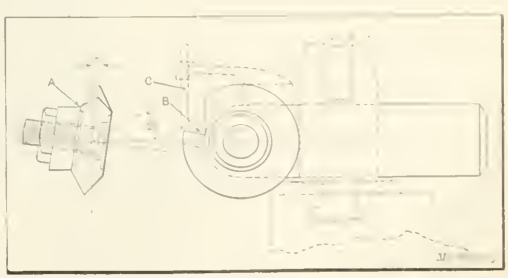


Design of Jig Feet

A. A. D.

HIGH-PRODUCTION TURNING TOOL

The illustration shows a lathe tool designed to eliminate loss of time in setting, when turning duplicate work to micrometer dimensions. This tool must be set in the usual way for turning the first piece, and then, no matter how often it is reground, it is only necessary to replace it with the cutting edge set to a height gage to keep the dimensions of the work constant. It will be evident that since the radial distance from the center of the formed tool to the cutting edge will always remain the same, the cross-feed screw need not be moved; and if the cutting edge is accurately set for height.



High-production Turning To[illegible] with Cutter bolted to Shank

the depth of cut can be kept accurate within about 0.002 inch.

The cutter is designed with a recessed face *A* in order that the bearing on the tool shank may be as large as possible, and thus prevent the cutter from turning under the thrust of the cut. At *B* is shown the method of using height gage *C* for resetting the cutter after grinding to bring the edge to the position that it formerly occupied.

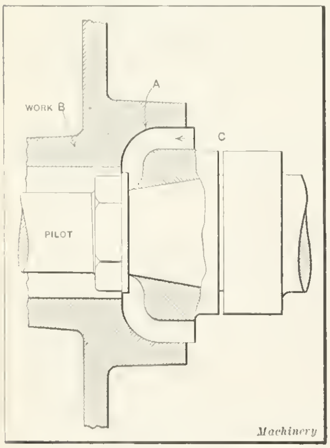
Plainfield, N. J. J. B. MURPHY

NUMBER OF TEETH IN END-MILLS

End-mills are frequently used for bottoming out holes or for similar work on turret lathes. Tools of this kind are necessarily fed in to the work by hand, by pressure on the spider wheel which controls the turret longitudinal feed. Considerable pressure is required to force a tool of this kind into the work and the number of teeth must be governed by the amount of surface which each tooth cuts.

Designers of tools frequently overlook this point and are inclined to make up the cutter as if for milling, with tooth spaces of ½, ⅝ or ¾ inch on the periphery. An end milling cutter, then, of 3 inches diameter with teeth ¾ inch apart might have, perhaps, twelve teeth. If the mill were designed for a form like that shown at *A* in the accompanying illustration in which the width of surface is about 1 inch, then all the teeth in the twelve-tooth mill would have $12 \times 1 = 12$ inches to cut, which would be equal to a forming cut 12 inches wide in the amount of pressure required.

The writer once tested out an equipment of tools under the conditions noted. The work *B* was held in chuck jaws on a turret lathe and the piloted end-mill *C* was fed into it by hand, using the spider wheel for the purpose. With the twelve-tooth mill mentioned, it was found impossible to use sufficient pressure to make it cut into the castings any appreciable amount, just a scraping action being apparent. It was difficult at first to see the reason for this trouble, but it seemed possible that too many teeth were in contact with the work. Every other tooth was therefore ground away, leaving only six. After this, the mill cut much better, but still took much more pressure than seemed desirable. Three more teeth were then taken out, after which the mill cut very well, and without requiring excessive pressure.

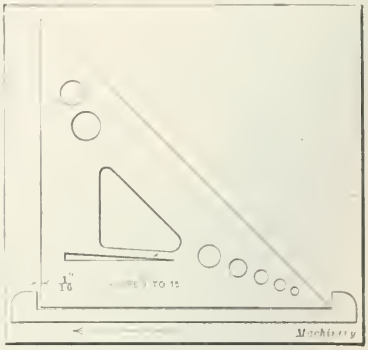


Work to be milled by End Milling Cutter

It will be fouud advisable in designing end-mills for work such as that shown, not to put in too many teeth. The total length of the teeth which are in contact with the work should not be more than 3 or 4 inches. If this idea is carried out, much better results will be obtained and the cutting qualities of the mill will be much improved. It will be found an improvement on face mills to nick the teeth in such a way that the nicks do not correspond on any two consecutive teeth. Recent developments along these lines favor the use of two-lip cutters for end cutting. These cutters are sometimes made of flat stock formed to shape and properly fixed in a holder. A. A. D.

A CONVENIENT FORM OF TRIANGLE

The illustration presented herewith shows how the usefulness of a transparent triangle can be greatly increased. The seven holes increase in size by intervals of 1/16 inch, the smallest being 1/8 inch in diameter, and are used for drawing fillets, rivet heads, or any small circles up to ½ inch in diameter. Center lines may be scratched through the centers of the holes to aid in centering, but they are not necessary. Similarly, the size of each hole can be graved on the triangle, but since they are arranged in order, the sizes are easily remembered. It is unnecessary to turn the triangle in any way to get the holes into working position for drawing a fillet or a circle; and this device saves the time required to set the compasses and to locate the center of a desired arc or fillet. Furthermore, for the smallest sizes of circles, a clearer and better line is obtained than it is possible to get with the compasses. The pencil is slanted so as to draw the circle as large as possible. This insures a true circle. To drill the holes in the triangle, clamp the triangle to a flat piece of iron so that the bottom edge of the hole will not burr. Run the drill very slowly, as a small amount of heat will soften the celluloid sufficiently to produce an irregular hole. Use a drill 1/64 inch larger than the nominal size of the hole; the circle that can be drawn will be about that much smaller than the hole.



Triangle arranged for drawing Small Circles, indicating Screw Threads and cross-sectioning Drawings

To slant the edge of the inside opening of the triangle is a well-known contrivance for drawing the convention for screw threads, but I have never yet seen a published statement as to what the proper slant or slope should be. A slope of one in fifteen, equivalent to an angle of 3 degrees, 50 minutes, is just right for ⅝ or ¾ inch U. S. standard bolts, and a close approximation for all sizes from ⅜ inch to 2 inches. A good homemade device for cross-hatching is also shown. It is made about the thickness of the T-square and 1/16 inch longer between jaws than the length of the edge of the triangle. Two different spacings may be obtained by rounding one corner of the triangle so that one edge will be 1/16 inch shorter than the other. The larger spaces will be obtained when this shorter edge is in the cross-hatcher. In use, the cross-hatcher is placed against the edge of the T-square and the triangle against it, as shown. With the wrist resting on the blade of the T-square, one finger on the cross-hatcher and another on the triangle, slide the cross-hatcher and triangle alternately along the T-square in the direction of the arrow, drawing a line after each move.

The following describes a method of making erasures on tracings that I have found to work out very satisfactorily:

Place a hard, smooth surface underneath the point at which it is necessary to make an erasure. A large amber triangle is just the thing for this purpose. Use a good grade of ink eraser, one that is entirely free from sand grains that cut the cloth. You will be surprised how cleanly you can erase in this way without roughening the cloth, even when the ink is on the dull side of the cloth. Yet this is only half the job. The cloth must now be resurfaced so that ink will not spread on it and so it will not absorb dirt at that point. With the triangle still underneath, glaze the cloth by smoothing it with the flat side of the blade of a large pocket-knife, applied with considerable pressure. It is best to have a knife that is dulled, and the point, and the corner on the blunt side, rounded so that the smoothing may be done rapidly with backward and forward strokes.

Connellsville, Pa. E. V. KAPLAN

SHARPENING AND RELIEVING HOBS

The following describes what I believe to be an improved method of sharpening hobs. Those who have had experience in this work know that it is difficult to sharpen hobs in which the gashes are at right angles to the threads and maintain accurate spacing of the gashes, unless a dividing head is employed. Fig. 1 shows a simple attachment for the tool grinder which is more convenient to use than the dividing head and enables accurate work to be done quite rapidly.

This attachment is fastened to the column of the grinder with cap-screws. The arrangement will be better understood by referring to Fig. 2, which shows the individual parts. The piece *A* is made of a piece of cold-rolled or machine steel, ½ by 1½ inch in size, which is bent to an angle of 90 degrees and twisted to the form shown; the elongated slots provide additional range. Piece *B* is made of the same material, and is fastened to *A* by means of bolt *C* and a nut and washer; the reamed hole at the end of piece *B* receives the shank of clamp *D*. This arrangement enables clamp *D* to be pivoted to any angle that may be desired, in which position it is secured by a nut and washer. The pin *E* is made of tool steel so that it may be hardened and ground to size. This pin is carried by clamp *D* and the tapered point is ground to an angle of 30 degrees to fit in the master on the arbor which supports the hob; pin *E* is secured in clamp *D* by a thumb-screw.

The arbor which supports the hob and master form is shown in the lower view, Fig. 2. The master is gashed at the same time that the hob is gashed, and as a result the use of this fixture insures the maintenance of accurate spacing of the gashes in the hob. It will, of course, be evident that sufficient spacing collars are placed between the master and the hob to afford the necessary clearance for the grinding wheel. In making the master, the blank is turned to a diameter equal to the pitch diameter of the hob plus ½ inch. The gashes are then milled to a depth of ½ inch, using a cutter with an included angle of 30 degrees. The gashing of the hob is done with a cutter of the same angle. In grinding a hob, the master is mounted at one end of the arbor and the hob at the other, after which the arbor is set up on the centers of the grinder. The pin *E* enters the gashes in the master, which provides for obtaining the required rotation of the hob in addition to indexing the work to secure accurate spacing of the gashes.

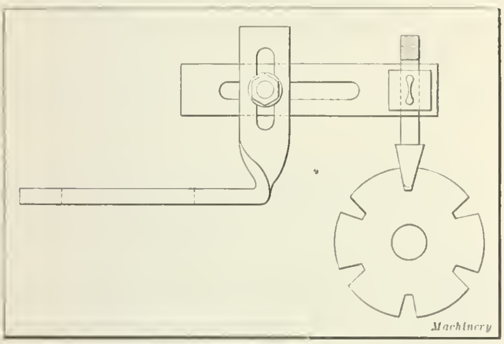


Fig. 1. Tool Grindor Attachment for uso in grinding Hobs

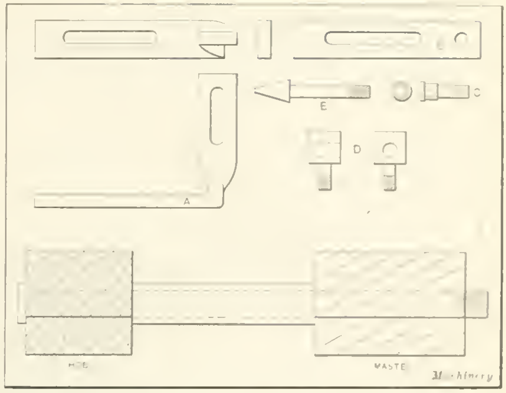


Fig. 2. Parts of Attachment shown in Fig. 1, and Hob and Master set up on Arbor

In making hobs, I have sometimes been called upon to turn the work out as rapidly as possible in order to fill a rush order from a customer. As the relieving of the teeth is the part of the work which takes the greatest amount of time, this appeared to be the most likely place to look for possible improvements in the method of manufacture. In order to explain the improvement that I hit upon, let us assume that a hob is to be made for generating a worm 8½ inches long with a normal pitch of 1 inch. We will make the hob 9 inches long and put nine gashes in it. For the purpose of discussion we will take three of these gashes and develop them into racks, as shown in Fig. 3. Here it will be seen that the lay-out is such that one tooth comes at the center of the hob, as shown in the top view. Now it is my contention that this center tooth is the only one which cuts on both sides, while the rest of the teeth only cut on the inner sides which have been marked by short arrows. Of course, it is impossible to have a center tooth produced by each of the gashes, and in the teeth produced by such gashes there will be two teeth at the center of the hob which will do a certain amount of cutting on both sides, this condition being shown in the two lower views in Fig. 3. Obviously, it is only necessary to relieve the sides of the teeth which take an active part in the generating action, and by following this method a material saving is effected in the amount of time required for relieving the teeth. This is particularly true in shops where the relieving is done by hand.

Springfield, Mass. PAUL J. VISCO

DEPTH GAGE FOR A TAP

In tapping stud holes in cast iron, where it is desired to have the studs go in to a specified depth, the holes may be easily tapped to just the required depth by placing a check-nut on the tap to act as an indicator. When this kink is used the tap is run in until the nut comes almost into contact with the surface of the work at which point the machine is reversed. This does not give such satisfactory results in tapping steel, owing to the long curly chips produced.

Worcester, Mass. C. H. ANDERSON

THE SQUARE CENTER

An article on the square center appeared on page 694 of the April number. We had occasion to make a 70-degree triangular center recently, and in calculating the proper angle to use in milling and grinding the triangular point, we discovered that there was an error in the figures given for the 60-degree triangular center in the article mentioned. Instead of being 26 degrees, 34 minutes, it should be 16 degrees, 6 minutes.

Galt, Ont. CECIL H. SMITH

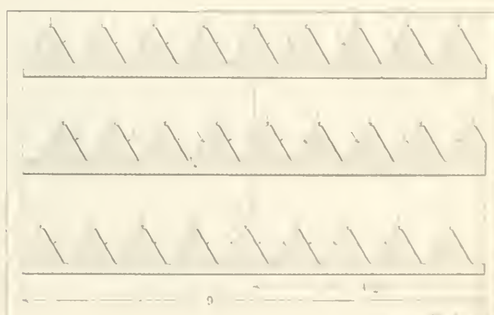


Fig. 3. Diagram showing Cutting Sides of Teeth of Hob, which must be relieved

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

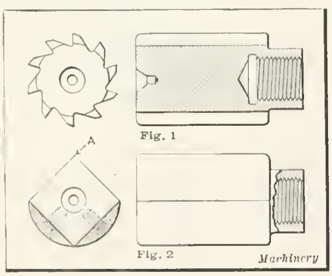
NUMBER OF CUBIC INCHES IN BRITISH IMPERIAL GALLON

B. T. A.—Please inform me how many cubic inches are contained in the British imperial gallon.

A.—The legal definition of the British imperial gallon is: "The unit, or standard measure of capacity, from which all other measures of capacity, as well for liquids as for dry goods, shall be derived, shall be the gallon containing *ten* imperial standard pounds weight of distilled water, weighed *in air* against brass weights, with the water and air at 62 degrees F., and with the barometer at 30 inches. Letting $w =$ the weight of a cubic foot of water under the above conditions, then, evidently, one gallon contains $\frac{1728 \times 10}{w}$ cubic inches. The main difficulty is to determine the weight of a given volume of water. According to several authorities, $w = 62.355$ pounds; in which case, the gallon contains 277.123 cubic inches. The value almost universally used is 277.274 cubic inches. For many years, the Bureau International des Poids et Mesures, of Paris, has been conducting experiments to determine the density of water, and as a result of these determinations, the most reliable value for the imperial gallon has been computed to be 277.420 cubic inches. The present legal equivalent is fixed by an Order in Council, issued in 1889, as 277.463 cubic inches, but this does not seem to be generally known. J. J.

REBORING BRASS WORKING BARRELS

O. C. I. W.—Owing to trade conditions, it is impossible for us to get brass working barrels from the makers at present, and in order to take care of our trade in Louisiana, we must devise some method of repairing worn barrels that come to our shop. Will you kindly advise us what type of reamer to use in reboring these barrels in an engine lathe? The barrels are the cylinders of oil pumps used for pumping from oil wells, and range from 2 to 2½ inches in diameter and from 4 to 5 feet in length.



Figs. 1 and 2. Reamers for repairing Worn Working Barrels

Answered by W. O. Platt, Oil City, Pa.

In the job shop days we repaired worn working barrels with reamers made to screw onto a shank long enough to reach through the barrel, and did the work in a long lathe, the barrel being held in the chuck and supported in steadyrests. The coarse-pitch type of reamer commonly used is shown in Fig. 1. It had about ten teeth and was shaped on the leading and following ends about as shown. If we wanted a very nice job, we followed with a square reamer, packed up with wood, as shown in Fig. 2, to fill the barrel; the square edge *A* gave a scraping cut. This square reamer was used also when it was merely necessary to smooth out a worn barrel.

TO FIND A STRAIGHT LINE EQUAL IN LENGTH TO A GIVEN CIRCUMFERENCE

J. L. M.—Is there any easy and accurate method for finding geometrically a straight line equal in length to the circumference of a circle?

A.—There is, of course, no exact geometrical construction, and it has been proved that an exact construction is impossible. However, the following method is very rapid of execution and also very accurate. Referring to the diagram, draw a diameter *AB*; through one end *B*, draw a perpendicular line *CD*, which will, of course, be tangent to the circle at *B*. Through the center *O*, and with the aid of a 30-degree triangle,

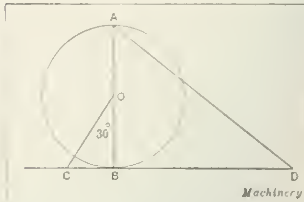


Diagram for constructing Line Equal in Length to Circumference of Circle

draw *OC*, making an angle of 30 degrees with *AB*, and intersecting *CD* in *C*. Then make *CD* equal to three times the radius *OA*, draw *AD*, and *AD* will be very nearly equal in length to one-half the circumference of the circle. The length of *AD* is readily calculated. Thus, letting the radius $= 1$, $BC = \tan 30 \text{ deg.} = \sqrt{\frac{1}{3}}$, and $BD = 3 - \sqrt{\frac{1}{3}}$; hence,

$$AD = \sqrt{2^2 + \left(3 - \sqrt{\frac{1}{3}}\right)^2} = 3.141533+.$$

But, the semicircumference when the radius is 1 is $\pi = 3.141593-$, and the difference between the two values is 0.00006, or a little less than $\frac{2}{1000}$ of 1 per cent. J. J.

ANALYSIS OF FORMULA FOR FINDING TAPER PER FOOT

W. W.—On page 898 of MACHINERY'S HANDBOOK there is a rule for finding the taper per foot when the center distance is given and the transverse measurements are taken at right angles to the line through the disk centers. Why is it necessary to find first the sine and then the tangent?

A.—Referring to the illustration, ba' is tangent to the two circles; gg' is the line through the centers; bo, ag, $b'o'$, and $a'g'$ are all perpendicular to og'. Then, letting $t =$ taper per inch, $\frac{t}{2} = \frac{bo - b'o'}{C} = \frac{ag - a'g'}{C'}$. Of all the lines in these two fractions, only C is known; hence, the numerator over C must be found by calculation. Draw cb' parallel to oo' and $bb'c = v =$ one-half the angle of taper. Let $R =$ radius of large disk and $r =$ radius of small disk. Draw $oa = R$ and $o'a' = r$ perpendicular to ba'; then a and a' are the points of tangency. Draw $o'e$ parallel to $a'b$, and angle $ho'o = bb'c = v$. In triangle $o'eo$, $oe = R - r$ and $o'o = C$; hence, $\sin v = \frac{R - r}{C} = \frac{\frac{1}{2}D - \frac{1}{2}d}{C} = \frac{D - d}{2C}$, in

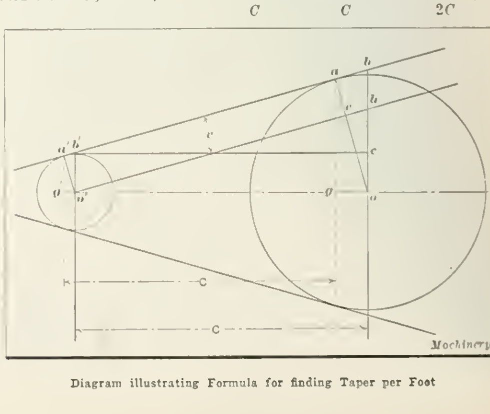


Diagram illustrating Formula for finding Taper per Foot

which D and d are the diameters of the disks. Knowing the sine, the angle can be found from a table of sines. Then, in the triangle $b'cb$, having a right angle at c, the angle v and the side $b'c$ are known, from which $cb = bo - b'o' = b'c \tan v = C \tan v$. Substituting this in the above expression for one-half the taper, $\frac{t}{2} = \frac{C \tan v}{C} = \tan v$, or $t = 2 \tan v$. Letting T be the taper per foot, $T = 12t = 12 \times 2 \tan v = 24 \tan v$, which agrees with the rule.

It is interesting to note that the second fraction above will give the same results, though a little more difficult to calculate, since C' is not known. For example, angle $gao = aob = v$, since ga and ob are perpendicular to $b'c$ and ao is perpendicular to $b'b$; for the same reason $g'a'o' = v$. Now $C' = o'o - go + g'o'$; but $go = ao \times \sin gao = R \sin v$, and $g'o' = r \sin v$; whence, $C' = C - R \sin v + r \sin v = C - (R - r) \sin v$. Similarly, $ag = R \cos v$, and $a'g' = r \cos v$; hence, $ag - a'g' = (R - r) \cos v$. Consequently, $\frac{t}{2} = \frac{(R-r)\cos v}{C - (R-r)\sin v}$. It now remains to be shown that the right-hand fraction is equal to $\tan v$. Dividing both numerator and denominator by $\cos v$, the result is $\frac{R - r}{\frac{C}{\cos v} - (R-r)\tan v} = \frac{oe}{o'e}$, since $R - r = oe$; $\frac{C}{\cos v} = \frac{o'o}{\cos v} = o'h$; $(R - r) \tan v = oe \tan v = ch$; and $o'h - ch = o'e$. But $\frac{oe}{o'e} = \tan v$; therefore, $\frac{t}{2} = \tan v$, and $T = 24 \tan v$, as before. J. J.

COMPARATIVE TESTS OF GAGES

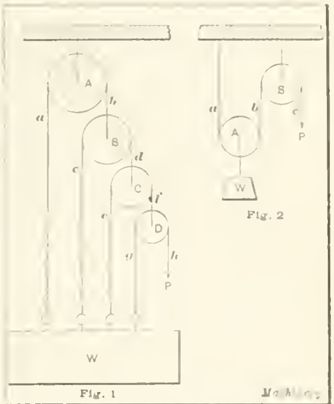
A. A. L.—I have two gages on a wheel press with a 9¼-inch ram; one is a Crosby recording gage indicating up to 200 tons on a 9¼-inch ram, and the other an Ashton hydraulic gage registering up to 225 tons on a 9-inch ram. I also have a portable press with a 10-inch ram and a gage registering up to 250 tons, marked "tons on ram." Now suppose all three gages are connected to the wheel press with a 9¼-inch ram and all register, say, 100 tons when pressing on the wheel. Does this agreement show that they are all correct? If not, please tell me how to make a comparative test.

A.—If all three gages register alike, say 100 tons, then at least two must be wrong, as a little consideration will show. These gages are not registering specific pressures (*i. e.*, pounds or tons per square inch or per square foot), but total pressures. If a gage registering pounds per square inch were attached to one of the presses, the total pressure in pounds would be found by multiplying the cross-sectional area of the ram by the number of pounds per square inch indicated by the gage; this product divided by 2000 would be the number of tons, and should agree with the gage on the press, if both are accurate. It is evident that the smaller the ram the higher must be the specific pressure to get the same total pressure; hence, the total pressures are inversely proportional to the areas of the rams, or to the square of the diameters of the rams since the cross-sections are circles

Let A denote the gage belonging to the press having the 9¼-inch ram; B, the gage for the press having the 9-inch ram; and C, the gage for the press with the 10-inch ram. Then, if all three gages are attached to the press with the 9¼-inch ram and gage A indicates 100 tons, gage B should indicate $9.25^2 \div 9^2 \times 100 = 105.6$ tons, and gage C should indicate $9.25^2 \div 10^2 \times 100 = 85.56$ tons, say 85.6 tons. If such be the case, we may safely assume that all three gages are correct. If, however, two of the gages register as calculated, we may assume that they are correct and the other one is wrong. That is, if gage B indicates 105.6 tons and gage C indicates, say, 84 tons, we assume that gages A and B are correct and gage C is wrong. If, however, neither gage B nor C indicates the proper value, but both indicate a greater or smaller pressure than that calculated, then increase the pressure until gage C indicates 100 tons. If gage B then indicates $10^2 \div 9^2 \times 100 = 123.45$ tons, say, 123.5 tons, we assume that gages B and C are correct and that gage A is wrong. J. J.

LAW OF VIRTUAL VELOCITIES

M. G. D.—In an old textbook on mechanics, I frequently encounter the expression "principle of virtual velocities," but I do not find an adequate explanation of its meaning. It is to be used in some way in connection with the following problem: With a system of pulleys arranged as in Fig. 1, what theoretical power P will be required to raise the weight W? Will you please explain?



Figs. 1 and 2. Diagrams illustrating Law of Virtual Velocities

A.—The simplest statement of the law of virtual velocities is: The power multiplied by the distance through which it moves equals the weight multiplied by the distance through which it moves. Here the word "power" means the acting force, and the law applies to all machines. The reason for using the word velocity instead of displacement (which is a better term) is that the older writers considered the time involved in the movement; but since the time the weight is moving is exactly equal to the time the power is acting, the time may be made unity and neglected, thus leaving the law as stated.

With reference to the problem, first consider Fig. 2. Here A is a movable pulley and B a fixed pulley. If the pulley A be lifted upward through a distance s, part a of the rope must be shortened an amount s and part b must be shortened the same amount, in order to keep the rope in contact with the pulley; in other words, a point or mark on the rope b will move upward a distance $2s$. Pulley B evidently exerts no influence other than to change the direction of the power from upward to downward. Hence, while W moves through a distance s, P moves through a distance $2s$. Now, according to the law of virtual velocities, $Ws = P \times 2s$, or $P = \frac{1}{2} W$, for the case of one movable pulley. In Fig. 1, if W be lifted a distance s, then, since pulley A is fixed, pulley B will descend a distance s; and since pulley B is movable, pulley C will descend $2s$ in consequence of the descent of pulley B, and it will also descend an additional distance s by reason of the ascent of W through that distance. In other words, C descends $2s + s$. Similarly, D descends twice as far as C and through an additional distance s, or $2(2s + s) + s = 4s + 2s + s = (2^2 + 2 + 1)s$. The free end of the rope h, which corresponds to b or c in Fig. 2, descends twice as far as pulley D and an additional distance s, or $2(2^2 + 2 + 1)s + s = (2^3 + 2^2 + 2 + 1)s = 15s$. Consequently, when W moves through a distance s, P moves through a distance $15s$; hence, by the law of virtual velocities, $P \times 15s = Ws$, or $P = 1/15\, W$. If $W = 1200$ pounds, $P = 1200 \div 15 = 80$ pounds, neglecting friction. J. J.

PROBLEM IN DYNAMIC BALANCE

C. T.—I would like to obtain some definite information regarding a question which has been widely discussed in our

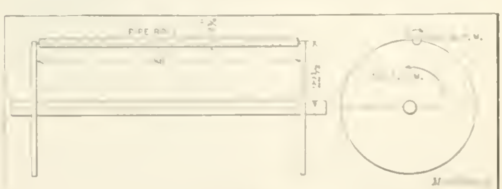


Diagram showing Arrangement of Mechanism which gave Trouble due to Lack of Accurate Dynamic Balance

factory, but concerning which no final decision has been reached. In a certain machine there is a member consisting of two large disks which rotate at 100 revolutions per minute in one direction and drive a number of shafts at 1000 revolutions per minute in the opposite direction. These shafts are made of pipe, and when the speed is increased beyond a certain limit, they show a tendency to "balloon" at the center, which causes serious trouble. Tests made by loading three different sizes of shafts with a dead load, while at rest, showed that the shaft made of the lightest pipe was deflected more than those made of heavier pipe, *i. e.*, a pipe with walls 3/16 inch in thickness was deflected more than a pipe with walls ¼ inch thick. What I wish to know is whether the results of the dead weight test give any indication of the probable action of the pipes when rotating; or will a pipe of heavier material deflect more than a light one, owing to the extra weight and action of centrifugal force? If the latter assumption is correct, can you explain the method of calculating the proper thickness of pipe wall which will enable it to resist deflection for a specified speed? The accompanying illustration shows the arrangement of the mechanism and indicates the directions of rotation and speed of the different members.

A.—You refer to trouble experienced from pipe rolls "ballooning" at the center and ask whether this is likely to be more serious with rolls made of heavy pipe than with rolls made of lighter pipe. We infer that this trouble is not caused by the actual swelling out of the pipe at the center, as the speed is not high enough to distort the pipe; moreover, if such distortion were of sufficient magnitude to be readily observed it would result in actually bursting the pipe. Your trouble is probably due to lack of perfect balance in the rolls and not to the action of centrifugal force. It is likely that the wall of the pipe you are using is not of uniform thickness, so that the axis does not pass through the center of gravity; in other words, the pipe is not in a condition of dynamic balance while rotating, although it may be in perfect static balance. Unless the wall of the pipe is of uniform thickness, it is quite possible that variations in the distribution of metal may result in a state of static balance, although the pipe will not approach a condition of balance when running at high speed. Under such conditions the pipe tends to rotate about an axis through its center of gravity, which will result in straining the bearings and springing the shaft. This is probably the cause of the "ballooning" to which you refer. For instance, a pipe or shaft may be in a condition of perfect static balance and still run badly through lack of dynamic balance. This is caused by having the pipe out of balance at one end and an equal amount out of balance at the other end, so that it tends to rotate about an axis through the center of gravity. The trouble could doubtless be overcome by using seamless steel tubing such as the Shelby tubing made by the National Tube Co. The walls of this tubing are perfectly uniform, and so it would be an easy matter to secure a condition of dynamic balance for rollers made from this material.

DRILL ROD GAGE SIZES

R. B. T.—The article by Fred Horner in the February, 1916, number, entitled "How Machinery Materials and Supplies are Sized," stated, under the subject of drill rods, that drill rods are sized by the Stub's steel wire gage or by the Morse twist drill gage. Now these two gages differ, and the writer would like to know which in your opinion is used most in this country.

A.—Drill rod is made by the manufacturers to the Stub's steel wire gage. But in manufacturing establishments it is common practice for toolmakers and others to call for drill rod to agree with the Morse twist drill gage. This is possible because the differences between the Stub's gage and the Morse gage are in many cases only a thousandth or a fraction of a thousandth inch, and certain numbers of the Morse gage agree with numbers in the Stub's gage. For example, No. 6 Morse gage is the same as No. 5 Stub's steel wire gage; No. 11 Morse is the same as No. 10 Stub's; No. 15 Morse is the same as No. 14 Stub's; No. 20 gage Morse is the same as No. 20 Stub's; and so on. However, the best practice to follow when ordering drill rod is to order the sizes in thousandths inch. Then there can be no mistake. This practice should be followed both in ordering drill rod from the drill rod manufacturers and from the store-room in the shop. Reference to gages is bad practice and leads to mistakes and confusion. The confusion of gages generally is deplorable, and mechanics should avoid taking risks in ordering any material when the diameter or thickness can be expressed in thousandths inch.

LIMITS OF DRILL ROD AND SHEET STEEL

C. L. K.—What are the allowable variations in the diameter of drill rods and the thickness of sheet steel cold-rolled?

A.—The Navy Department specifies that drill rods may have a variation of 0.0005 inch on sizes 7/16 inch diameter or less, and 0.001 inch on sizes larger than 7/16 inch. These are the maximum variations allowed. The Navy Department also permits variations of 0.003 inch on cold-rolled or cold-drawn machinery steel rods and bars up to and including 1 inch. Above 1 inch and including 2½ inches, the allowable variation is 0.004 inch, and above 2½ inches, 0.005 inch. The Halcomb Steel Co., Syracuse, N. Y., manufacturer of drill rods, advises that all sizes of drill rods produced up to 1½ inch round, which is the largest size on the list, are within 0.0005 inch above or below the specified size or decimal size. It is willing to guarantee that on all sizes less than 1 inch, the limit above or below will be 0.00035 inch of the specified size. On cold-rolled strip steel, the Worcester Steel Co., Worcester, Mass., allows the following variations: from 0.025 inch to 0.100 inch in thickness, $\pm$ 0.0015 inch; from 0.100 inch to 0.200 inch in thickness, $\pm$ 0.0025 inch; and from 0.200 inch to 0.275 inch in thickness, $\pm$ 0.0035 inch. The General Electric specifications call for the following: up to and including 0.3 inch diameter drill rods, over size 0.000, under size 1 per cent of the diameter, eccentricity ½ per cent of the diameter; above 0.3 inch and including 1 inch, over size 0.000, under size 0.003 inch, eccentricity 0.0015 inch; above 1 inch and including 2½ inches, over size 0.000, under size 0.004 inch, eccentricity 0.002 inch; above 2½ inches, over size 0.000, under size 0.005 inch, eccentricity 0.0025 inch. The A. O. Smith Co., Milwaukee, Wis., manufacturer of automobile parts and steel stampings, uses a great deal of blue annealed steel. The limits of variation allowed on this grade of steel are 0.005 inch under or over the specified gage. The Westinghouse companies permit the variations of cold-rolled steel specified by the American Society for Testing Materials, but have a number of different allowances for different applications. The Brown & Sharpe Mfg. Co. states that all the drill rod used passes an inspection and is accepted with a variation of 0.0005 inch large or small. In cold-rolled or drawn machinery steel, the limits vary from 0.001 to 0.005 inch, depending on where the stock is to be used.

* * *

Manufacturing industries of the United States are growing at a rate that has resulted in doubling the output of manufactured products since 1900. The aggregate value of manufactured products in 1915 was $24,000,000,000, and in 1900 it was only $12,000,000,000. The production value in 1910 was $20,500,000,000, and only $14,750,000,000 in 1905. Up to the outbreak of the present war, the United States was rated third as an exporter of manufactured products, Great Britain being first, Germany second, and France fourth. The British total in annual value was about $2,000,000,000 more than that of the United States, and Germany's about $1,500,000,000 more. The growth in percentages is also interesting. In 1890 the manufactured products exported were 25 per cent of the total manufactured; in 1910, 45 per cent; in 1913, 47 per cent; and in 1915, more than 51 per cent.

* * *

Although the manufacture of pistons and piston rings used in steam and gas engines has been developed to a high plane since the manufacture of automobiles began on a large scale, there is much to be learned about piston ring design and the best method of making the so-called leakless type. What constitutes a perfect piston ring? How should it be fitted in the groove? What pressure should a ring exert against the cylinder wall when in position? What should be the relation of the piston ring to its groove? Is the eccentric type desirable? If not, why not? These and other questions can be profitably discussed, and readers of MACHINERY are invited to take part.

PREPAREDNESS IN MANUFACTURE

RESULTS OF LACK OF PRELIMINARY PLANNING IN A MUNITIONS PLANT

BY J. J. R.

During the past few months a number of manufacturers have taken up lines of work in connection with munitions with which they were entirely unfamiliar and the requirements of which were very exacting as compared to many other lines of manufacturing work. In many cases work has been produced and carried through on a large scale only to find that when completed it did not fulfill the requirements of the government inspectors, so that many parts were rejected for a variety of reasons. In the majority of cases of this kind, the reason for rejection can be traced directly back to a lack of knowledge on the part of the manufacturer, together with a lack of preparation for the work in the preliminary planning as well as in the design of the tools and gages. This article will take up such conditions as are illustrated in the manufacture of bayonets, giving a general account of the organization and processes, together with the equipment used and a statement concerning many of the points which were responsible for the failure to produce satisfactory work.

The severity of government inspection, as applied to military equipment, has never before been realized to such an extent by manufacturers, and for this reason a large proportion of the material offered for acceptance was found to be below the standard, with the result that severe financial losses were entailed. In some cases, better results have only been obtained by radical changes in methods of manufacture, and this also has caused a delay in delivery and heavy financial losses, many orders having been executed at an actual loss where the profits should have been great if the work had been properly handled. Some of the troubles which have been experienced by one company in the manufacture of bayonets will be taken up in detail in this article and an attempt will be made to show how the lack of knowledge and proper planning caused the failure.

Data Given to Manufacturers

In the case of bayonets to be manufactured, samples of hardened, semi-finished blades were received by the contractors, together with sealed patterns of bayonets having the government certification that they were standard and met all requirements. Complete drawings of the bayonet itself were also furnished. Inspectors having years of experience at that work in government arsenals were sent over to take charge of the final acceptance. Drawings of machines used in testing were furnished and each inspector had a full set of drawings and gages.

Data Not Given

There was no indication of manufacturing methods which had previously proved successful and no hint was given where trouble had been found; no suggestions for the design of working gages; no assistance in supervising and no suggestions for final acceptance gages. The drawing of the bayonet was absolutely correct and any blade which was made to conform to the drawing would fit the gages.

Shop Organization

The organization as planned by the contractors was to be composed of men who had made military rifles for years and bayonets by the hundreds of thousands. It consisted of men who had also had years of experience in government and private work, each of which was a specialist in his own line. Practical mechanics of proved ability were chosen who in many instances had worked together before. None of the men, however, had previously handled manufacturing matters on a large scale or had worked as heads of departments. The supply of money for the purchase of equipment was unlimited, and it simply remained for the specialists to indicate the classes of machines which were needed and the purchasing department would immediately negotiate for the equipment. In each department the specialists had charge in a large way of the design of everything in the department but had not had previous experience in designing. First quality material was bought in all cases and the quantity needed was determined upon by the head of the department.

The general idea in taking up this work, was to use the bayonet job as a sort of experimental center around which an organization would be built which could handle the more complicated military rifle problems to the best advantage. In conference, a scheme of manufacture was laid out and manufacturers from different parts of the country gave every assistance in suggesting methods and equipment. Orders were given for machine tools, jigs and fixtures, the design of which was directly under the supervision of the specialists. The factory buildings were built by outside contractors working on a percentage basis and with a time limit on the completion of the work. After the essential points in the buildings and machine shop equipment had been taken care of, young technical graduates who could be trained were installed as inspectors and were detailed to the various shops to watch the progress of the orders.

Bayonet forgings were ordered from outside manufacturers in sufficient quantities so that the machining operations could be started as soon as the machines were installed, which was scheduled for a month before the first delivery was due. Men were appointed to oversee the forging operations, make preliminary tests, standardize hardening of the bayonet and take care of the incoming machinery. After the organization was complete for the bayonet department, preparations were started for the manufacture of the military rifle itself, as it was considered that the organization was complete for the bayonet and everything seemed to be running along smoothly. The essential requirements in the handling of this problem were that the production should be accomplished in the shortest possible time, and it should be remembered in this connection that the problems as presented were entirely new. A general scheme of manufacture was laid out and rough sketches were made of the jigs and fixtures necessary; working time was estimated, and types and quantities of machines were computed and ordered. There was no supervision nor assistance furnished by the purchasing government, and although it would have taken only a short time to have inspected methods and conditions in the arsenals where the work was being done, this point was not considered. Neither did it occur to the executives to submit samples of various grades of steels for manufacture in the aforesaid arsenals so that tests as to their suitability could be made after they had been carried through the various processes. It must be assumed that the executives considered that any such precautions as this must have reflected on American mechanics, methods and materials, and although these matters might have been easily taken up, before the actual manufacturing commenced in this country, it was not done.

Preliminary Test of Hardening Method

At an early stage in the manufacture, it was realized that the tests for physical condition of the bayonet were more severe than had been used in this country, so that preliminary tests were roughly carried out with drop-forged unfinished blades, seemingly with satisfactory results. Records were made of hardening and drawing temperatures and the matter was considered settled. Representatives of the steel companies furnishing the steels were present at the time of testing, but no finished blades were ever tested before manufacture in quantity was commenced. On the basis of a rough test of hand forged blades a large quantity of steel was bought, and after a second test still more steel was ordered.

Method of Manufacture

The fundamental point in the method of manufacture of the bayonet was to take advantage of the supposed superiority of drop-forging in this country and to forge the blade so that 0.010 inch would be allowed for finish on each side. It was

planned to reduce the actual machining operations to a minimum, employing grinding operations instead. For this reason the drop-forging dies were made with the greatest care.

A steel having the carbon content of a military bayonet is extremely sensitive to high temperatures and loses the carbon on the surface rapidly. Some of the blades which were put through at this time showed decarbonization after being finished for over 1/32 inch depth all over. It was found necessary to keep the drop-forging heats very low or the blade would be ruined. Owing to the fact that there was not sufficient metal on the original forgings to allow for decarbonization, thousands of the bayonets were "scrapped." It was finally found necessary to change the drop-forging dies so as to allow for a finish of about 0.060 inch, at the same time making the back of the blade very full and then milling instead of grinding it. The allowance for grinding on the point was also increased.

When the forgings were ready and the machinery came in, some of the operations on the bayonet were started. Machines were received with jigs attached and in many cases no work was necessary except to connect the machines with the countershaft. Men were put to work on the various machines and taught just how the machines should be handled.

About this time the trouble commenced. In many cases the jigs were sketched originally on scraps of paper and were later detailed by men who had never seen the parts for which the jig was intended. Drawings were not checked in some instances, so that after the tools were finished they were incorrect. The locating points were not properly placed and sometimes there was no provision at all for locating the work. Some of the operations as planned which appeared reasonable on a superficial examination were afterward found impossible or undesirable for some reason or other. The new mechanics, who were mere machine tenders, were not skillful enough to make the required changes. As the time of first delivery approached, a notice was sent to the original groups of executives and a meeting was held, in order to straighten out the tangle if possible. In the meantime the rifle production planning, the buying of new machinery, the designing of new tools, and so forth, was allowed to take care of itself. During this time, many of the soft-handed ex-machinists worked day and night in making over gages and testing jigs until finally the various machines were started in operation in one way or another. No records were made of the changes, however, and the drawings still showed the fixtures as they were originally.

There was no toolroom which could be called such, although there were a lathe, drill press, tool and cutter grinder and a shaper. There were no small tools of any account and not a real toolmaker in the toolroom. This was for a shop having a capacity of 600 men! Just about this time, after the fixture troubles had been straightened out, more difficulties appeared in the hardening room. The furnaces for heating the bayonets were too short; the tempering pots were too shallow, and temperatures could not be regulated properly because of lack of proper instruments for temperature measuring. The cooling tanks were too shallow and of insufficient size, while only one experienced hardener was available.

As the organization increased in numbers, politics and interfering authority began to take a hand in the management. In the course of three weeks, seven different men were put in charge of and removed from the hardening room. Finally steel experts from three different companies were called in and many kinds of steels were tried before the final choice was made of an expensive alloy steel. Even after the selection of this stock, but one out of two bayonets passed the test for some months. The blame was thrown on outside manufacturers for the choice of materials, and methods and errors were covered over and buried wherever possible. Good men who were not in the clique were discharged or forced out of the organization.

Local purchasing was personally done by a responsible head with no understudy, and many thousands were spent without a thought, while small items were held up and haggled over for days while men waited for the material. Available assistance was not used to help matters along, and in one case technical graduates having from three to seven years' experience were kept inspecting guide and catch sizes for weeks, while experienced heads neglected big matters to attend to minor details. New men were appointed as heads of departments and more cliques were formed. Workmen were paid as little as possible, thus causing dissatisfaction and creating a likelihood of a strike in the future. The discipline around the plant was almost military, and finally when the strikes came, "German bribery" was assigned as a reason. The final result of the many mistakes in the organization and management can be found in the fact that some weeks after the production should have reached 1000 per day, not one bayonet had been accepted. Even months after the production should have reached several thousands per day, not 500 per day were coming through the works, and a year after the contract was started the desired production had not yet been reached.

The severity of the specifications was not entirely responsible for this, as the rifle itself was one of the crudest of the modern arms in use. The facts are as follows: The order was in hand February 1 and machinery was being delivered during April. In December, 18,000 pieces of one part were scrapped, because they were 1/16 inch under size. The government gages were in the possession of the factory in March and delivery was to be started in August. Owing to the many troubles experienced and the lack of preliminary planning, together with improper organization, it does not now seem probable that the full production will be reached before the fall of this year.

It may be argued that the instance stated is exaggerated, but this can be easily refuted by an investigation. It will be found that a somewhat similar condition has existed in many plants, although not always to the same extent as that stated. Manufacturers of jigs and fixtures throughout the country have shipped complete series of tools to various factories and have later received revised drawings, necessitating building a new series before the first equipment was received by the factory. In these cases fundamental errors in design were discovered.

There is a valuable lesson to be learned from the experiences of the company cited in this article, and that is, the extreme importance of preliminary planning. The motto "Make haste slowly," seems particularly applicable to work of this kind. Unless the planning is done in advance and is carried out to the most minute details, any organization of this sort is likely to meet with disaster.

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POLISHING OPERATIONS

Polishing operations on metals are usually known as roughing, dry fining and finishing or oiling. The abrasives used for roughing usually run from No. 20 to No. 80, for dry fining from No. 90 to No. 120, for finishing, from No. 150 to No. 65 F. For the first two operations—roughing out and dry fining—the polishing wheel should be used dry. For finishing, the wheels are first worn down a little and then tallow, oil, beeswax and similar substances are used on the wheel. This third operation is sometimes known as greasing. Sufficiently good finish is frequently secured by the dry fining operation when the wheel is covered with charcoal and smoothed down with a piece of flint. Most polishers keep a lump of pumice stone handy to clean the greased wheel or remove the glaze from finished wheels.—*Grits and Grinds.*

* * *

An ordinary hand-operated arbor press can often be used in the job shop as a punch press when a number of simple punchings are required. In order that the arbor press may be utilized as a punch press, it is necessary to provide a simple sub-press provided with the required punch and die. The sub-press is put in place in the arbor press and worked by bringing the ram down against the ram of the sub-press. The springs raise the sub-press ram, following up the ram of the press on the return stroke. With this equipment it is possible for an ordinary job shop to produce simple punchings at a comparatively low labor cost and with a very small investment in tools.

INTERNATIONAL TRADE CONDITIONS

MANUFACTURING IN THE COUNTRIES AT WAR—SOUTH AMERICAN RELATIONS

MANY people are asking: What will be the status of the United States after the war? Some think it will retain its present commercial supremacy, while others think it will again allow England and Germany to dominate the markets of the world. But the post war status of the United States will depend almost as much on matters over which it has no control as on its actions at this time.

England owes much of its commercial supremacy to the fact that during the reign of anarchy throughout Europe at the beginning of the last century, every nation was dependent on the factories of England for its supplies. While at present the entire world is buying supplies from this nation, it is not because of the destruction of the factories of the other countries and their lack of skilled workmen, but rather because of the abnormal demand for some things and conditions that make it, temporarily, impossible for these countries to make those articles. But just as soon as peace is restored there will be available in all countries well equipped factories fully manned with skilled workmen. The equipment and methods of these factories are most efficient, so that one of the reputed advantages of the American factories has been lost. How great has been this increased efficiency is shown by the fact that in one case, though an extreme one, the hourly output of a British machine was increased from eight or twelve to ninety pieces. Besides, the American manufacturer will hereafter have to compete with those able to employ large numbers of women. In Great Britain over two million women are employed in industries that formerly employed only men. While women have not entered as many new industries in France and the other belligerent countries, it is because they have always done work that in the United States and Great Britain has been considered fit occupation for men only. Edward R. Stettinius, chief of the export department of J. P. Morgan & Co., said recently: "Most of the reconstruction of the European countries now at war will be done by themselves when the war is ended. Many of the large factories that have sprung up for the production of war munitions will be utilized for other purposes when the war is over; besides, many of the men returning from the front will have to be given employment."

Contrary to the general opinion, and many reports, the belligerent countries are not rapidly becoming impoverished. While Germany has not been able to send its products freely to the outside world, before the British Orders in Council went into effect a year ago its exports to the United States were $10,000,000 a month. During the last half of 1915, it sent to the United States a little over $2,000,000 worth of toys; $1,000,000 each of leather goods and chinaware; $500,000 each of laces, paper and raw skins; $200,000 of furs; $250,000 of photographic papers; $120,000 of musical instruments; $241,000 of gelatine; $160,000 of glassware; $133,000 of knit goods; $125,000 of clocks; $29,000 of books; $10,000 of post cards; $116,000 of chemicals and drugs. Germany's shipments to this country still amount to $1,000,000 a month.

While all limited companies, mining companies, etc., must pay a war tax of 50 per cent of the additional profits earned during the war, 1000 of the 6500 companies paid this tax; the average tax for fifty-three of these companies was 650,000 marks. The Rhenish Metal Ware Co. paid a tax of 5,300,000 marks; besides, from its net profits of 9,876,619 marks, against 3,524,439 marks in 1914, it invested 2,605,876 marks in securities, principally war loans, and raised the wages of its employes from 5.22 to 5.8 marks per man per shift. It also increased the number of its employes from 14,414 to 24,000. The Hirsch Copper & Brass Works paid a war tax of 4,000,000 marks; besides, it paid a dividend of 18 per cent, against a dividend of 8 per cent for the past three years. It also wrote off 1,490,539 marks for depreciation. The Adler-Oppenheim Leather Co. paid a tax of 3,000,000 marks; the Thale Iron Works, a tax of 1,900,000 marks; and the Rheydt Electro-chemical Co. a tax of 1,850,000 marks, its net profits being 3,580,592 marks, against 385,635 marks in 1914. The Gas Apparatus & Gas Works Co., of Mayence, which has a capital of 1,080,000 marks, had a net profit of 3,636,547 marks, against 33,985 marks in 1914; besides paying a war tax of 1,800,000 marks, it declared a dividend of 125 per cent and invested 2,879,661 marks in the war loans. The average dividends of 118 of the leading raw sugar manufacturers was 13.6 per cent, against 8.3 per cent in the preceding year; this is the largest dividend yet paid in this industry. The Rhenish Tannery Goods Co., of Benrath, paid a war tax of 200,000 marks and a dividend of 25 per cent, against 16 per cent last year. The Wiemann Leather Co. paid a tax of 1,400,000 marks; the Neckar Ulmer Cycle Co., 2,000,000 marks; the Wanderer Cycle Co., 1,000,000 marks; and the Durkopp Cycle Co., 1,000,000 marks. The Harzer Works at Rubeland-Zorge has raised its dividend from 6 to 25 per cent and paid a war tax of 425,000 marks. Hugo Schneider Co. Metal & Brass Works, Leipsic, declared a 20 per cent dividend, against a 6 per cent dividend in 1914. The Upper Silesian Railway Metal Co. paid a 10 per cent dividend, against 2 per cent in 1914. The Niederschoneweide Works, which began business in 1914, paid a 16 per cent dividend and a bonus of 84 per cent; while the Magdeburg Machine Tool Co., which also began business in 1914, paid a 15 per cent dividend. This spring, the builders in the smaller towns voluntarily raised the wages of their men; while the government, because of the enormous profits made by the agrarian interests, nearly doubled the rentals of seven of its large estates in Prussia. If Great Britain will permit the delivery of the 15,000 tons of dyes contracted for, Germany will have in this country an addition to its trading balance here of $90,000,000.

That Germany is still intent on seeking all the commerce possible is shown by the statement of the Koch Shipbuilding Co., of Lubeck, at its stockholders' meeting, that it had enough orders to keep its yards, which will build ships up to 15,000 tons, busy for several years. Over 1500 persons are now enrolled in the Turkish classes recently established by the German Turkish Society in thirty German towns. The forty-mile pipe line that has just been built between Drohobycz and Chyrow, in Galicia, will admit of the movement of about 700 tons of oil daily. The number of German salesmen that went to Bergen and Molde, Norway, after the large fires there was so large that the Norwegian railways had to double the size of its trains.

Germany is constantly seeking new trade in South America, as the feeling of the people is expressed by Count Reventlow, when he says:

> The economic side of the present war is closely related to the military and political aspects of it, more so than at any previous period. After this war a state that cannot make sure of its economic future by its own unaided strength will practically be condemned to extinction. Laden with a huge burden of debt, with keener conditions of life, and with the necessity of providing for their military security, the countries concerned will not be able to export too great a quantity of commodities. It is therefore all the more necessary for Germany, too, to make certain that she shall secure the most stringent guarantees for the free exercise of every sphere of her economic life.

Germany is especially interested in Turkish chrome mining, for which sixty charters have been granted. The Krupps have purchased two of these mines and are operating two others. Besides, seventy charters have been granted for lead mining, one of which will supply the entire German demand.

Notwithstanding the enormous army France has in the field, on May 7, the canal connecting Marseilles with the Rhone, and thus giving it direct water connection with Havre and the North Sea, was officially opened. Though this canal is only sixty miles long, five miles of it is a tunnel 75 feet wide and 70 feet high, placing this among the largest tunnels in the world. As the canal is navigable to vessels less than 600 tons,

destroyers and small warcraft can pass through it from the Mediterranean to the North Sea. Also, in order that France will lose none of its commerce, on May 18 President Poincare signed a decree creating a committee to aid in the reconstruction of towns and regions invaded and affected by acts of war. A large number of the textile factories in the invaded regions are now being operated in the southern part of the country; it is doubtful if some of them will again return to their former towns. During April, France exported 33,500,000 francs worth of goods more than in the same month last year.

England's exports have not decreased except in some things. The advantage its merchant marine gives it in trade is shown in the fact that British shops have recently secured contracts for iron and steel products from South American countries, because of the difference in freight rates. On one inquiry from Rio Janeiro, a rate of $40 a ton was quoted from Gulf of Mexico ports, while the freight rate from British ports was only $14 to $15 a ton. Due chiefly to the diversion of trade by the British blockade, the exports from the Port of London to the United States during the first four months of this year were $13,000,000 more than for the corresponding period last year. According to the Board of Trade returns, the exports from England for April showed an increase of $23,240,000.

B. M. Rasmusen, U. S. Consul at Gothenburg, Sweden, recently said, in the *Swedish-American Trade Journal*, that, owing to the lack of transportation facilities, high rate of exchange, and economic depression in Russia, the export of agricultural machinery, petroleum motors, and telephone instruments from Sweden to that country decreased to such an extent that industrial concerns depending on such markets found it necessary to retrench. While war orders were abundant in the latter part of last year, a lack of raw material, especially aluminum, copper, lead, tin, celluloid, emery, hardwoods, leather belting, oils, rubber, etc., interfered with the production of the factories. The lack of coal also added to the increased cost of production for many, but in most cases manufacturers have been able to meet the advanced costs by advanced prices. As the freight rate on coal is now twice as much as the total cost of coal, including the insurance and freight, to the Swedish railways, in 1914, plans are being made to utilize the water power of the country to the fullest possible extent, though about 50 per cent of all manufactured products are now made in factories using this power.

Stanley H. Rose, agent in charge of the New York office of the Bureau of Foreign and Domestic Commerce, says that investigation shows that between $50,000,000 and $60,000,000 worth of Russian raw products could be used here annually. Owing to the closing of the Baltic and Black Sea ports, however, the Russian Government has been forced to restrict the use of the White Sea so that no vessel can load or unload there without a special permit. This rule applies to all vessels, irrespective of whether they are carrying goods for the government or not. Application for space must be made to the Russian Commercial attaché, Mr. Medzikhovsky, who cables the request to London and Petrograd and then reports to the shipper the probable date of shipment. This restriction, though, does not apply to the Pacific ports. Recently it was estimated that nearly $10,000,000 worth of goods were awaiting release from the government, for which only $1,500,000 worth had been passed upon, and of these only $400,000 worth had been received in this country.

In a letter to Edward N. Hurley, vice-chairman of the Federal Trade Commission, President Wilson said: "If we are to be an independent factor in the world's markets, we must be more thorough and efficient in production. The encouragement of trade associations and standardization in better cost-accounting methods in our business concerns will go a long way toward accomplishing this end."

Paul M. Warburg, of the Federal Reserve Board, on his return from the Pan-American Conference at Buenos Aires, was enthusiastic over the progress apparent in the strengthening of the commercial financial relations between the United States and the South and Central American republics. He regards the experience of the Latin-American business world during the European war as calculated to cement commercial relations with the United States, but says that if this nation is to secure its proper position in the world all legislative obstructions that stand in the way of a free unfolding of its economic powers must be removed. Some of the countries visited, he said, had to solve difficult problems due to or accentuated by the European war. But these problems had produced men whose sincerity and ability foster a perfect reliance that their country's fate is in good hands and will ultimately be worked out successfully. He also said that almost all of these countries offer wonderful possibilities and the United States has a serious obligation to lend a helping hand to them in the development of their marvelous resources. There is, however, strong evidence of the awakening of the American spirit of enterprise in almost all of these countries; whether in railroading and developing the ore lands in Brazil, in packing houses in Uruguay and Argentine, in mining in Chile and Peru, or in raising sugar and tobacco in Cuba.

Plans have been completed for the construction on some point of Long Island or the Connecticut shore of the highest tower in the world to be used by the Federal Holdings Co. in wireless communication with a tower near Buenos Aires, for which a concession has been obtained from Argentine. Efforts are being made to obtain concessions for similar towers in Brazil, Uruguay, and other places in South America. In addition to its war value, intercontinental wireless will be of great value in the campaign for South American trade, besides its importance in the direct exchange of news. As the cable rate from New York to Buenos Aires is 85 cents a word, the papers of Buenos Aires at present are the only ones in South America that print much news from the United States. Besides making a rate at least one-third of this, the wireless will permit the transmission of independent news, for now the news received in South American countries goes very largely over lines controlled by the trade rivals of America. It has therefore been asserted that one reason for the poor opinion of the United States held by many South Americans has been that news has received an unfriendly color in its transmission through European hands to the South American press.

Because of the lack of shipping facilities for the manufactured articles, orders have been placed in the United States for the equipment for a complete shoe factory in Colombia, for the manufacturing of fencing, telephone and telegraph wire, and tinware in Brazil, and a nail factory in Argentine. Robert Lee Dunn, secretary of the All-Americas Association, says that the people of Central America want to do their foreign business in the United States and are willing to trade on a cash basis. There has been deposited with his organization since January 1, to be drawn against, almost $500,000 in gold, besides millions of dollars of negotiable paper by buyers in South and Central America.

In accordance with its policy to aid American countries in all parts of the world, the National City Bank, of New York, has arranged to open a branch in Genoa, Italy, which will be under the direction of Paul Grosjean. Arrangements are also being made for the opening of banks in Russia, Spain, and the Scandinavian countries. D. E. J.

* * *

The motor truck has proved its worth as a means for rapidly conveying troops and supplies in the European war, and the U. S. government is making use of motor trucks with advantage in quelling the Mexican trouble. An unusual order for trucks was placed in May with the Locomobile Co. of America by the government for thirty three-ton Riker trucks. These trucks are fitted with a flanged rim device developed by A. L. Riker, vice-president and chief engineer of the Locomobile Co. of America, by which the trucks are converted into railway motor cars. One of the trucks ran from Columbus, N. M., to El Paso, Texas, over the rails of the El Paso & Southwestern Ry. System, a distance of ninety-three miles at the rate of nineteen miles an hour, carrying twenty soldiers with complete equipment. When the end of the run was reached, the truck was derailed, the flanged rims removed, and the truck was then ready to be driven on a highway as usual.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

NATIONAL MANUFACTURING MILLING MACHINE

This machine is intended for manufacturing operations, and it will be seen that the design includes features of both the Lincoln and knee types of milling machines. The machine may be equipped for individual motor drive, with a cone pulley for driving from a countershaft, or with a single pulley and geared drive. Eight changes of feed are provided, ranging from 0.007 to 0.202 inch per revolution. With the three-step cone pulley and two-speed countershaft, there are twelve changes of speed ranging from 16 to 224 revolutions per minute.

The design of the No. 6 manufacturing milling machine which has recently been placed on the market by the National Transit Pump & Machine Co., Oil City, Pa., has been developed along lines which enable certain features of the Lincoln type of milling machine and the knee type of milling machine to be combined. Two views of the machine are shown in Figs. 1 and 2, and it will be evident from these illustrations that the vertical position of the table remains constant, and as it is carried on a fixed support, ample strength may be easily provided; combined with this feature is the fact that the open-

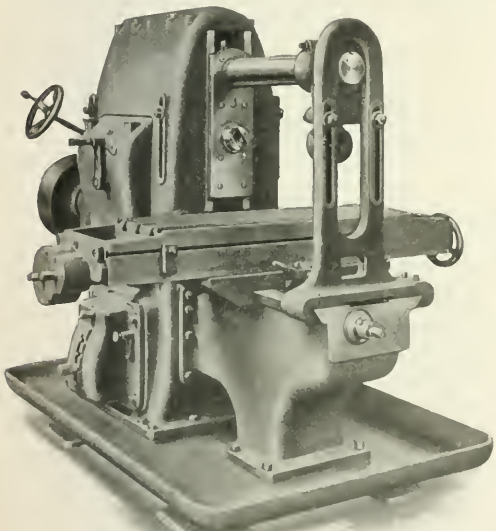


Fig. 1. No. 6 Manufacturing Milling Machine built by National Transit Pump & Machine Co.

side principle of the knee type of milling machine has been retained in the present design. It will be evident that the machine is intended primarily for manufacturing operations.

The column or main frame of the machine is a box section casting, and the spindle head is supported in this column on four separate guides. The front guides for the head are finished on their inner edge; these guides are of the narrow type, having a ratio of width to length of 1 to 5. All driving gears are of the spur type and they are liberally proportioned, as regards both pitch and face width, to insure smooth running and long life. The gears in the driving train and all other gears in the machine are made of machine steel, the blanks being press forged. The machine may be driven from an overhead countershaft, in which case a three-step cone pulley is mounted on the driving shaft; or it may be equipped with individual motor drive, for which purpose a five-horse-

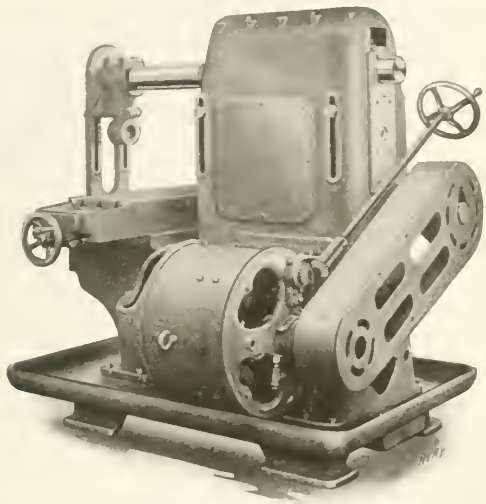


Fig. 2. National Milling Machine equipped with Motor Drive

power Reliance motor is recommended having a speed range of from 300 to 1200 revolutions per minute.

For a two-speed countershaft with speeds of 125 and 500 revolutions per minute, the available spindle speeds are 16, 20, 25, 33, 42, 54, 67, 85, 117, 139, 176, 224 revolutions per minute. There are two back-gear ratios of 5.9 to 1 and 2.8 to 1, respectively. Fig. 3 shows a cross-sectional view through the back-gear box. Changes are obtained by the upper lever in Fig. 1 which controls the pair of sliding gears to provide for obtaining either of the two available back-gear ratios. The two changes obtained in this way are multiplied by three by means of the cone pulley changes; and the six speeds available in the machine are again multiplied by two through the use of a two-speed countershaft

A cross-sectional view through the spindle head and driving gear connection is shown in Fig. 4 The spindle is 3 1/4 inches in diameter at the front bearing and is bored for No. 11 B. & S. taper. The bearing is oiled by a wick which dips into a reservoir that is furnished with an overflow and a "wash-out plug" at the bottom. Fig. 6 shows a cross-sectional view of the table and saddle. The lower spline shaft runs direct from an inner-feed bearing. The feed-gear box is driven by

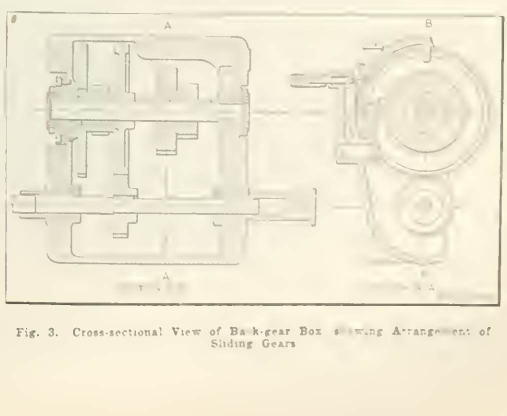


Fig. 3. Cross-sectional View of Back-gear Box showing Arrangement of Sliding Gears

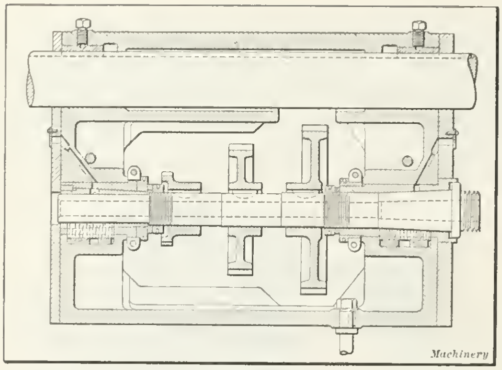


Fig. 4. Cross-sectional View of Spindle Head and Driving Gear Connections

a chain and means of adjustment are provided to take up any slack which may develop in the chain after it has been in service for a long time; the feed gear that drives the spline shaft rocks about the spline shaft gear, allowing ½ inch vertical adjustment.

Reference to the cross-sectional view of the table will make it evident that all gears, with the exception of the reversing gears, are so proportioned that a speed reduction is obtained. The narrow guide principle is applied to the table on the working side; and the table is held down by a square clamp at the opposite side. The feed trip is of the lever type and is located at the center of the front side of the table. Starting, stopping or reversing of the table is accomplished by one lever, with a push-pin that must be pushed in before the direction of feed can be reversed. It will be seen from Fig. 1 that the feed-box is cast in a single piece. The gear system in this box is of the tumbler type, and eight changes of feed are provided by operating two levers. The range of feed is as follows: 0.007, 0.010, 0.013, 0.023, 0.068, 0.087, 0.122 and 0.202 inch per revolution of the spindle. Machines are also built with table feeds of 20, 30, 36 and 42 inches per minute.

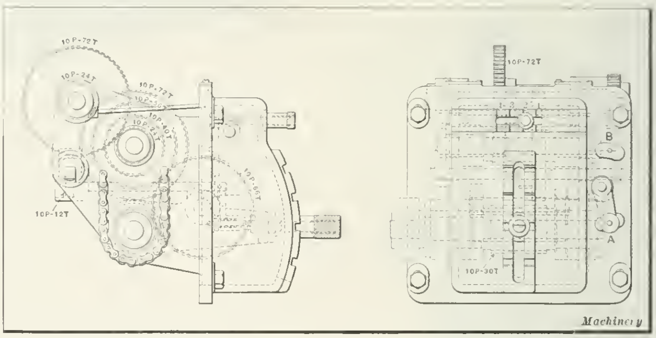


Fig. 5. Arrangement of Gearing in Feed-box of National Milling Machine

The principal dimensions of these machines are as follows: range of vertical spindle travel, from 1½ inch to 11½ inches above the table; width of table, 13 inches; width of T-slots in table, ⅝ inch; maximum adjustment of table in line with spindle, 12 inches; diameter of over-arm, 4 inches; diameter of spindle, 3¼ inches; diameter of hole through spindle, 1 1/16 inch; height of column from floor, 69 inches; floor space occupied, 68 by 68 inches; and weight of machine, 4200 pounds.

BROWN VERTICAL SURFACE GRINDER

The vertical surface grinding machine which forms the subject of this description is built by the Reed-Prentice Co., Worcester, Mass., this firm having acquired the interests of the Brown Cotton Gin Co., New London, Conn., by which the machine was developed. It will be seen that the grinding head is mounted on a cylindrical column which is 12 inches in diameter. The head is elevated through the action of a spiral rack and worm; the worm is made of bronze and the rack of steel. Raising or lowering of the wheel head is controlled by the same lever that governs the table feed; but when this lever is used to change the elevation of the head, the clutch is first released to disengage the feed mechanism. The drive is carried from the vertical shaft at the back of the machine to the wheel-spindle by means of a 3-inch Link belt which is entirely enclosed and runs in oil.

Power to drive the feed mechanism is also taken from the main shaft by a pair of bevel gears. The length of table travel is conveniently regulated by making the required setting of adjustable dogs carried in a T-slot at the front of the table. There are three ¾-inch T-slots in the top of the table to provide for securing work in place; and any standard form of magnetic chuck may also be used for this purpose. Six changes of feed are available, the range covered being from 2 to 12 feet per minute, which corresponds to feeds of 0.021, 0.043, 0.049, 0.063, 0.097 and 0.142 inch per revolution of the spindle. Means are provided for securing minute advances of the wheel to the work, the handwheel which governs this movement being graduated so that it is possible to obtain the required setting within 0.001 inch. The maximum hand adjustment of the grinding wheel is 5 inches; in addition, power feed is provided for raising or lowering the head through a greater distance than is possible by using the handwheel.

The spindle is usually driven at a speed of 1050 revolutions per minute when carrying a grinding wheel of the standard size which is 14 inches in diameter. The lower end of the spindle runs in an adjustable bearing 3 inches in diameter by 8 inches in length; and the upper end of the spindle is carried by a sliding bearing within the steel sprocket sleeve that drives the spindle. This upper bearing is 2¼ inches diameter by 8 inches long. The weight and thrust of the spindle is supported on ball bearings. The pull of the chain belt which drives the spindle is supported by the sprocket sleeve, the end of which is held in a babbitted bearing in the head; and in this way all belt strain is adequately taken care of without any tendency to put an unnecessary load on the spindle itself.

The spindle is hollow and the supply of water is fed through it and delivered direct to the part of the work on which the grinding wheel is engaged; a centrifugal pump delivers a copious flow of water in this manner. At the back of the machine there is a large tank which is divided into two parts, one section of which serves to remove grindings and abrasive dust from the water before it is again delivered to the work; the other section of the tank contains the filtered water and

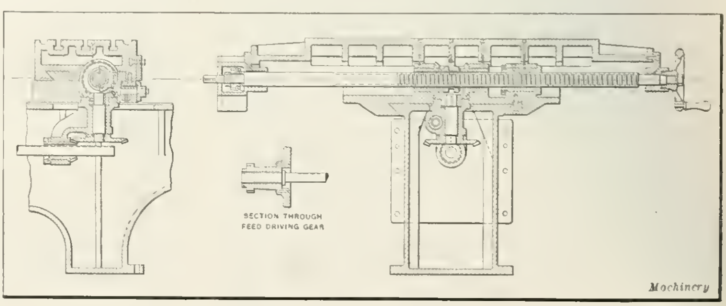
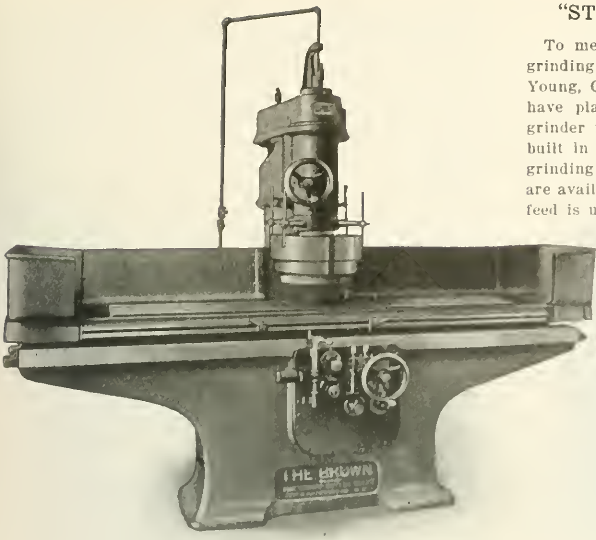


Fig. 6. Cross-sectional View of the Milling Machine Table and Saddle



Brown Vertical Surface Grinder built by Reed-Prentice Co.

is connected with the pump. The pump is driven by bevel gears which are secured to their shafts by friction disks of leather, these disks being tight enough to drive under normal conditions, although they will slip in the event of the pump becoming clogged, thus avoiding danger of damaging the mechanism.

The countershaft used in connection with this machine is equipped with a driving pulley 24 inches in diameter by 6 inches face width; and the tight and loose pulleys are 10 inches in diameter with a face width of 6 inches. The countershaft should be driven at 500 revolutions per minute. On the machine, there is a driving pulley 15 inches in diameter, which carries a 6-inch belt; this pulley runs at 750 revolutions per minute, and is mounted on the outside of a bronze sleeve, one end of which is clutched to the main driving shaft. Fifteen horsepower is required to drive the machine. The principal dimensions are as follows: size of table, 12 by 78 inches; maximum size of work which can be handled, 12 by 78 by 15 inches; with the table in its central position, the floor space occupied by the machine is 9 feet, 8 inches by 5 feet; with the table at one extreme of its travel, the floor space occupied is 16 feet, 2 inches by 5 feet. The net weight of the machine is 8000 pounds.

MILLER & CROWNINGSHIELD HAND MILLING MACHINE

Miller & Crowningshield, Greenfield, Mass., have added to their line a No. 3 hand milling machine which is of similar design to the hand milling machine formerly manufactured by this company, with the exception that it is provided with an over-arm and outboard support for the arbor. The principal dimensions of the No. 3 hand milling machine are as follows: maximum feed of table, 9 inches; cross-feed of saddle, $3\frac{1}{4}$ inches; vertical movement of knee, $6\frac{1}{2}$ inches; full size of table, $6\frac{1}{2}$ by 17 inches; maximum distance from table to center of spindle, $6\frac{3}{4}$ inches; width of driving belt, 2 inches; maximum vise opening, 2 inches; and weight of machine, 365 pounds.

"STERLING" CYLINDRICAL GRINDER

To meet the requirements of manufacturing plants where grinding operations have to be performed on cylindrical work, Young, Corley & Dolan, Inc., 149 Broadway, New York City, have placed on the market the 18 by 50 inch "Sterling" grinder illustrated and described herewith. The machine is built in plain and universal types, and may be equipped for grinding crankshafts and cam-shafts; hand and power feed are available on the machine. For manufacturing work, hand feed is usually preferred, and by using a wheel wide enough for the work the grinding operation may be completed without longitudinal travel. The standard wheel housing on the machine provides for taking a grinding wheel 20 inches in diameter by 2 inches face width; and special housings can be supplied to accommodate wheels of greater width. Power table feed may be supplied as an extra feature, and can be provided on plain machines. The construction is such that adjustable stops are mounted on a rail on the table and are set to engage a lever which reverses the feed. The feed is driven by cone pulleys from the main driving shaft and provides three changes; power cross-feed is not provided.

The main frame of the machine is made of semi-steel and ribbed to give the necessary rigidity. The table is supported by one flat and one V bearing, which are lubricated by automatic oiling rollers. The table can be set over to grind tapered work having a taper up to $1\frac{1}{2}$ inch per foot. The grinding wheel carriage is supported by one flat and one V way of the same form as those which carry the table, and it is actuated by a $2\frac{1}{2}$-inch square-thread screw which dips into an oil bath so that adequate lubrication is insured. The wheel-spindle is made of high-carbon steel and runs in bronze-bushed bearings which are provided with means of adjustment for wear. Any length of work can be handled up to 50 inches. For crankshaft grinding only one steadyrest is employed, which is designed to take work up to 3 inches in diameter. The grinder can be equipped with a cam-shaft grinding attachment and provided with a mounting for any master cam which may be required for the work. The machine is driven from a floor type countershaft which does away with the necessity of using overhead works. This is convenient in places where the amount of overhead room is restricted. Where electric drive is employed, a slow-speed motor can be connected direct to the main driving shaft.

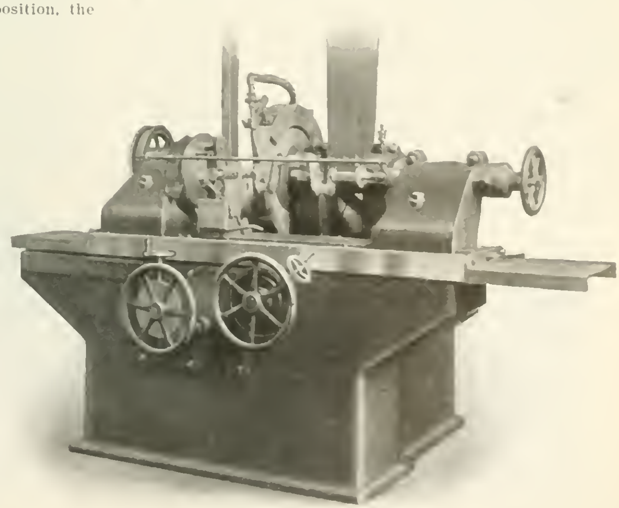


Fig. 1. Front View of "Sterling" Grinder built by Young, Corley & Dolan, Inc.

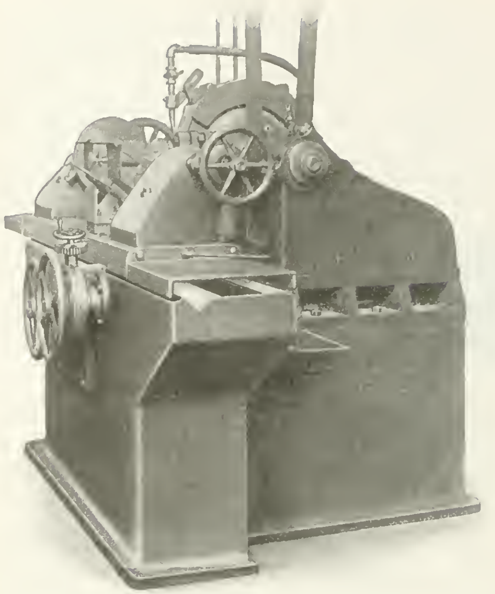


Fig. 2. End View of "Sterling" Grinder built by Young, Corley & Dolan, Inc.

The principal dimensions of this grinding machine are as follows: diameter of wheel used, 20 inches; width of wheel used, from 1½ to 2 inches; speed at which 20-inch wheel is driven, 1000 revolutions per minute; distance from floor to center of driving shaft, 10 inches; distance from floor to center of spindle, 42 inches; power required to drive machine, 10 horsepower; floor space occupied, 6 by 10 feet; and net weight, approximately 8000 pounds. The regular equipment furnished includes four work-rests; a pump, water tank, and water guard; a countershaft, driving drum, and bearing hangers; and the necessary wrenches for making all adjustments.

"ESCO" GROOVING MACHINE

This is a special machine designed for milling the powder grooves in shrapnel fuse time-rings to a uniform depth, width and length; the design is such that the groove is cut on a true circle. Adjustment is provided for milling grooves of any diameter up to four inches. The machine works within a limit of accuracy of 0.002 inch; and is capable of milling the groove in a fuse time-ring in thirty seconds.

One of the greatest troubles experienced by the manufacturers of war munitions since the opening of the European war has been the difficulty of obtaining in shrapnel fuse time-rings powder grooves of uniform depth, of absolutely true circumference, and with the length accurate to 0.001 inch. The nature of this work and the fact that standard machines have proved unsatisfactory have led to the design of several types of fuse-ring grooving machines, ranging in form from lightly constructed drilling machines, modified and equipped with special attachments, to machines especially designed for this class of work, many of which, although they are an improvement in some ways, have been designed in a manner more or less cumbersome as well as intricate. In many cases two machines are used, one for roughing out and another for finishing the groove.

Because of the absolute accuracy required in the powder groove length, depth and width, which must be within limits of ± 0.002 inch, the Walco Mfg. Corporation, Providence, R. I., has designed a very simple but satisfactory machine for milling the powder groove or routing the vent chamber of fuse rings in one operation. This machine will groove the rings as rapidly as one in thirty seconds, and as it removes the chips as rapidly as they are formed, no trouble is experienced by the chips remaining in the groove. By a positive automatic feed and stop arrangement, no over-cutting or under-cutting on the length of the groove can occur. The depth of the groove is milled absolutely uniform, and the circumference is held absolutely true. The machine consists of two parts, the head or chuck frame being adjustable transversely for milling grooves of any size up to 4 inches in diameter. The chuck frame rests on a ½-inch scraped V-guide and a 2-inch scraped pad, which keep the head square with the bed of the machine. Adjustment transversely is accurately obtained by sliding the head on these supports; and two ⅞-inch set-screws, tightened against a lug which projects from the head into an opening in the machine frame, rigidly hold it in place. After the required adjustment is obtained, the head is firmly bolted down on the bed by two ¾-inch bolts. There is no possible chance for any variation in the diameter of the fuse-ring groove after the head is once adjusted and bolted down.

A ⅞-inch cutter-spindle revolves on ball bearings in a 3-inch cast-iron sliding sleeve in the frame casting, and is provided with a bronze taper bearing at the cutter end, which maintains the cutter absolutely true and smooth-running. Adjustment is obtained by lock-nuts at the end of the spindle. The cutter is fed into the work by the action of a crank lever which works in a bronze shoe on the side of the spindle sleeve. Accurate groove-depth adjustment is obtained by two lock-nuts at the rear end of the spindle sleeve. With these simple adjustments once made, the machine can be operated readily by unskilled labor. The cutter-spindle runs at 5000 revolutions per minute and is driven by a 3-inch tight pulley; the tight and loose pulleys run on a bronze bushing fastened in the spindle sleeve, so that the spindle is relieved of all belt strain. The action of feeding the cutter into and away from the work automatically shifts the belt on the pulleys, so that while the cutter is not in the work the spindle does not revolve; this prolongs the life of the bearings and also permits the changing of cutters when required.

The fuse ring is rigidly held in a rapid-operating chuck which consists of a steel cup eccentrically grooved at the sides and fitted over a cast-iron faceplate, on which the work

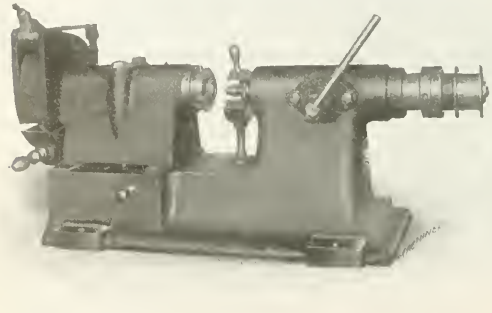


Fig. 1. "Esco" Fuse Time-ring Grooving Machine, showing Arrangement of Work-holding Fixture and Milling Cutter

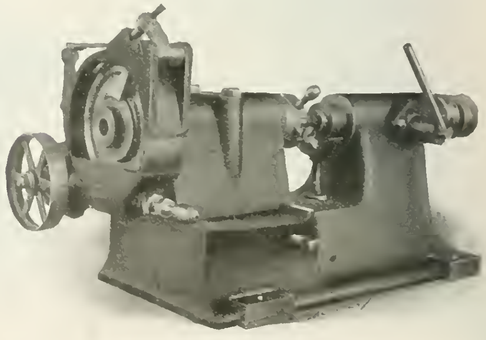


Fig. 2. Partial End View of Machine illustrated in Fig. 1, showing Arrangement of Work-spindle Drive

is clamped by turning the cup on pins projecting from the faceplate. A slight tap on the chuck handle instantly releases the cup and the fuse ring is taken out. The chuck is fastened into a 3-inch spindle 12 inches long, and is revolved according to the speed of operation desired, at from one revolution in thirty seconds up to one revolution in seventy seconds. The drive is provided by a worm meshing with a worm-wheel, and the power is transmitted through a pair of miter gears from a 7-inch pulley. Accuracy of groove length is obtained by an automatic knock-off stop arrangement, consisting of a hardened steel plate at the end of a long release arm, which rests on another hardened steel plate fastened to the worm casing. A 1/32-inch travel at the end of this release arm throws the worm out of mesh with the worm-wheel, instantly giving a positive stop. The starting point of the groove is maintained by an adjustable stop, previously set for the length of groove desired.

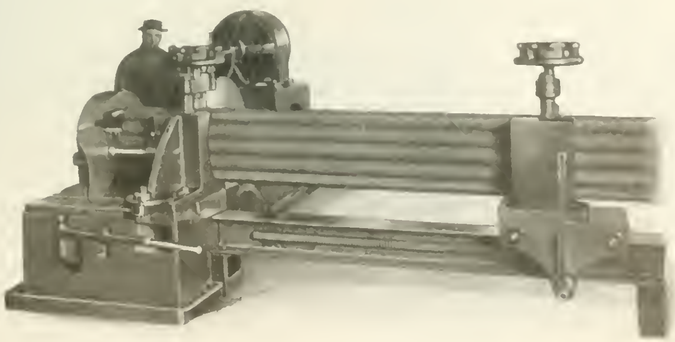
In operation, the ring is placed in the chuck, positioned by a center pin, the chuck clamped tight and brought up against the stop by one movement, the cutter fed into the work, and the automatic feed engaged. After the groove is milled, the machine stops automatically. The machine is rigid and substantial in every respect, requiring very few and simple adjustments. Several machines can be operated by one man, with an average production of fifty rings an hour per machine. The finished groove is cut from the solid ring in one operation, no finishing cut being required.

ESPEN-LUCAS SHELL BAR CUTTING-OFF MACHINE

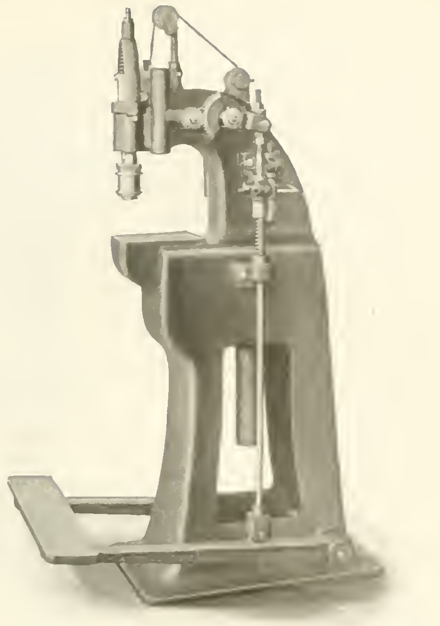
The accompanying illustration shows a cold saw built by the Espen-Lucas Machine Co., Philadelphia, Pa., which is particularly adapted for use in shell manufacturing plants. This machine is provided with a special clamping mechanism for holding five bars 3½ inches in diameter at a time. This special apparatus may be taken off the cutting-off machine, by the removal of a few bolts, and the machine is then ready for use as a standard cold-sawing machine. The object in designing this stock-holding device was to provide a radial arrangement of the bars to be cut off, so that the saw would sever them all in the same time that it would take to pass through one bar.

The stock brackets are curved so that the bars are held on an arc of the same curvature as the periphery of the saw. One stock bracket is held in a fixed position, and the other is mounted on a beam and is adjustable for the varying lengths of bars, by means of a hand-operated ratchet lever. The bars are clamped in the brackets by radius clamps, each clamp being pivoted upon one of the two clamping bolts to enable them to swing out of the way for inserting or removing bars. For this purpose, it is only necessary to loosen the clamps and swing them away from the second clamping bolt. The handwheel of each clamp is so designed that after bringing it down on the work, a bar may be inserted and the stock then tightened firmly in position.

As will be seen from the illustration, the usual pin method of gaging the lengths to be cut off has been discarded and a cam plate used. This plate may be seen in the illustration; it is swung into position when the stock is moved out ready for a new cut, and swung out of the way while the machine is in action. This special clamping mechanism can be furnished for holding three 6-inch bars instead of five 3½-inch bars, if so desired. The saw is fed at the rate of ⅞ inch per minute, and guaranteed production from the machine is forty cuts of 3½-inch bars per hour. The approximate weight of the machine and clamping mechanism is 17,000 pounds.



Espen-Lucas Cold Saw with Special Rack for cutting off Five Shell Blanks at a T



No. 2 Pneumatic Riveter built by Blomquist-Eck Machine & Mfg. Co.

BLOMQUIST-ECK PNEUMATIC RIVETER

The No. 2 pneumatic riveting machine illustrated and described herewith is a recent addition to the line of machinery built by the Blomquist-Eck Machine & Mfg. Co., 203 St. Clair Ave., N. E., Cleveland, Ohio. There are many classes of work that are assembled by the operation of forming a head on one of the parts, and on which this head cannot be formed by compression under steady pressure, owing to the distortion which would result in other portions of the work. It is for performing operations of this kind that the Blomquist-Eck No. 2 pneumatic riveting machine is particularly adapted

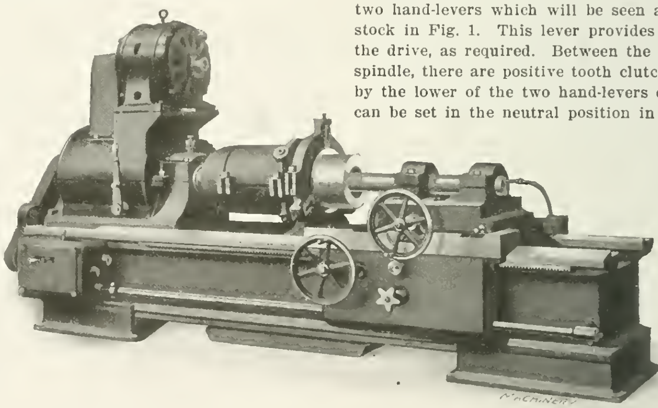
The anvil base is heavily built to absorb vibration, and the design of the one-piece bed and frame gives extreme rigidity and strength. The hammer, which is of standard design, is mounted on a balanced slide provided with a tapered gib adjustment, and there is a vertical movement of 4½ inches for the slide. The hammer set is revolved by a belt from the pulley at the side of the machine, from which power is

transmitted through bevel gears to the vertical drum. A flat belt from this vertical drum drives a pulley on the hammer, thus causing the hammer set to revolve. The face of the set is cut away in order to make the blow more effective.

The movement of the hammer slide, as well as the admission of air to the cylinder, is controlled by a foot-treadle, so that both of the operator's hands are left free to handle the work. The cam on the right-hand side of the machine is adjustable so that admission of air can be controlled in this way. This pneumatic riveting machine is especially adapted for the performance of riveting operations on automobile wheel rims, and the anvil base can be designed to serve the purpose of a "horn" if so desired. The depth of throat is 9¾ inches, and the maximum distance from the anvil base to the face of the hammer is 7 inches.

"SIMPLEX" HEAVY-DUTY LATHE

The heavy-duty single-purpose lathe which forms the subject of this description is manufactured by the Cleveland Machinery & Supply Co., Cleveland, Ohio, and is made in three sizes, *viz.*, 26½-inch swing with a 12-foot bed; 20-inch swing with a 10-foot bed; and 16-inch swing with an 8-foot bed. Any of these sizes may be furnished with a bed of additional length, if so desired. It will be evident from the illustration that the outstanding features of these machines are strength of construction combined with ample power for the performance of heavy manufacturing operations. The lathe is well adapted for shell manufacture, and special attachments may be furnished for handling work of this kind. The illustration shows a 26½-inch machine with the tailstock removed and a special carriage substituted to adapt the machine for the performance of heavy shell boring operations. Kellogg & Co., 120 Broadway, New York City, are selling agents for this machine.



"Simplex" Heavy-duty Single-purpose Lathe built by Cleveland Machinery & Supply Co.

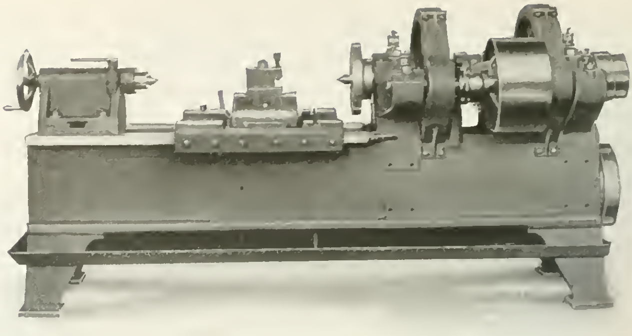


Fig. 2. Opposite Side of Johnston & Jennings Lathe, showing Arrangement of Single Pulley Drive

JOHNSTON & JENNINGS LATHE

The accompanying illustrations show front and rear views of a 20-inch manufacturing lathe recently placed on the market by the Johnston & Jennings Co., Cleveland, Ohio. When so desired, this machine may be furnished with a six-hole turret; and the oil pump on these turret lathes delivers the oil through the base of the turret to the individual turret tools.

As the machine is intended for manufacturing work, a sufficient range of speeds is provided by a single pulley drive and double back-gears, having ratios of 5 to 1 and 6 to 1. The driving pulley is mounted on the back-gear shaft and provided with an expanding clutch which is operated by the upper of two hand-levers which will be seen at the front of the headstock in Fig. 1. This lever provides for starting or stopping the drive, as required. Between the two sets of gears on the spindle, there are positive tooth clutches which are controlled by the lower of the two hand-levers on the head. This lever can be set in the neutral position in order to disengage both sets of gears; and by throwing it to the right or left, either of the two sets of gears may be engaged according to the speed which is required. When one set of gears is engaged, the other is idle, and *vice versa*. It will be seen that the feed-rod is driven by a two-step cone pulley, mounted on the end of the spindle, and in this way two changes of feed are provided.

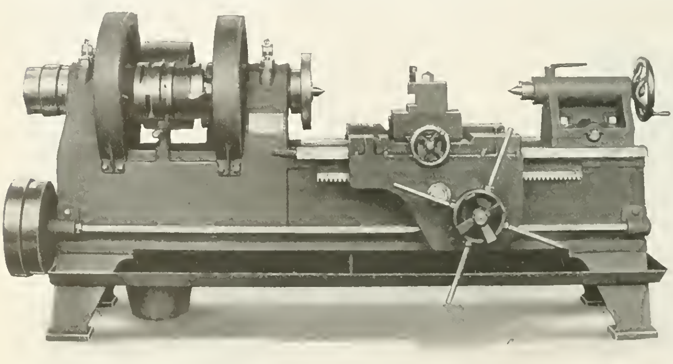
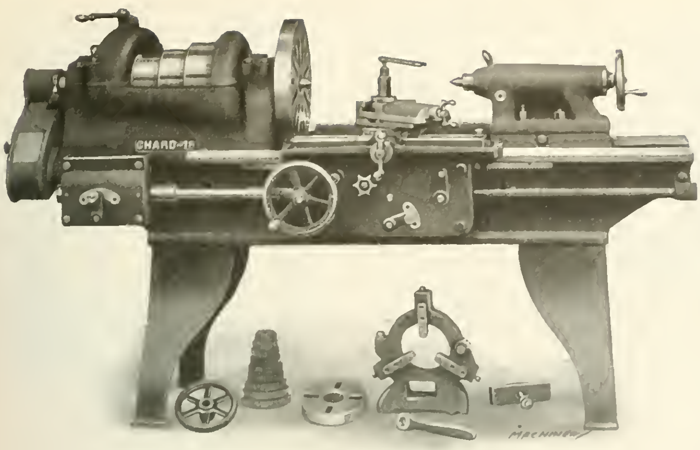


Fig. 1. Johnston & Jennings 20-inch Manufacturing Lathe built with 8- or 10-foot Bed

Other features of the machine are so simple that they will be readily understood by reference to the illustration; but attention may be called to the fact that the design has been worked out along extremely simple lines, and that all parts of the machine are made very heavy, so that ample strength is provided to handle the heaviest classes of manufacturing operations. The principal dimensions of the machine are as follows: distance between centers for a lathe with an 8-foot bed, 36 inches; number of feed changes, 2; available rates of feed, 1/16 inch and 1/20 inch per revolution of the spindle; swing over bed, 20 inches; swing over tool-slide, 10 inches. This machine is built with 8- and 10-foot beds, according to the requirements of the work.



Engine Lathe built in 18-, 20-, 24- and 28-inch Sizes by Chard Lathe Co.

CHARD ENGINE LATHES

The Chard Lathe Co., Newcastle, Ind., is now building engine lathes in 18-, 20-, 24- and 28-inch sizes. These machines can be provided with a four-step cone pulley and single back-gears or with a three-step cone pulley and double back-gears; and they are built with quick-change and semi-quick-change gear-boxes. A taper attachment will be furnished when required, as well as a compound turret tool-block and front and rear tool-blocks. All parts and attachments for the Chard lathe are interchangeable, so that new parts may be provided at any time with the assurance that they will fit without the necessity of hand work.

The spindle bearings are lined with an alloy composed of 86 per cent tin, 7 per cent antimony, and 7 per cent copper. The spindle is made of steel of the following analysis: 0.45 to 0.55 per cent carbon; 0.50 to 0.60 per cent manganese; 0.03 per cent phosphorus; 0.035 per cent sulphur, and 0.20 per cent silicon. The spindles are machined from forgings which are hammered down from 6-inch billets; after the forging operation, the steel is thoroughly annealed, then reheated to a temperature of from 1525 to 1550 degrees F. and quenched in water; after this heat-treatment, the forgings are re-annealed at a temperature of from 1225 to 1250 degrees F. The rack is made of 0.40 to 0.50 per cent carbon steel. The tops of all Chard lathe beds are chilled so that the metal is 20 per cent harder at the top than the surface of any part sliding on the bed. The top of the lathe bed is chilled to a depth of over 5/8 inch below the bottom of the V, which gives a degree of hardness that insures the maintenance of perfect alignment of the bed. All castings are pickled and sandblasted before being machined.

The cross-feed and compound rest are provided with large graduated collars reading to 0.001 inch; and the figures are large and distinct so that they may be easily read. The dovetail on the carriage is inverted in order to obtain greater strength through the bridge. The carriage is provided with shear wipers and an oiling device which is an integral part of the carriage. The movement of the carriage on the bed is perfectly free and requires only a slight exertion on the part of the operator. The cross-feed and compound rest move in a similar manner. This ease of movement is brought about by accurate alignment and accurate fitting of all parts of the lathe. The apron has a double bearing for all studs due to the double-plate type of construction. All bearings in the back-plate are oiled from one oil hole in the top of the carriage, and there are no gears running on fixed studs.

Particular attention is called to the fact that the handles on the hand-wheel on the apron and cross-feed crank are made in such a way that the hand-grips do not revolve in the operator's hand. These grips revolve on fixed studs so that the operator is enabled to take a firm hold of either handle and turn it without the handle slipping around in his hand. The action is somewhat similar to that of the familiar bit brace used by carpenters, where it will be recalled that the wooden handle rotates on the brace without itself turning in the workman's hands.

The legs have a three-point bearing which does away with all possibility of springing the bed when the legs are bolted in place. The tailstock is graduated to provide for setting it over for taper turning operations; and the faceplate on the headstock is made exceptionally heavy, a large and a small faceplate being furnished as part of the regular equipment. All Chard lathes are designed on "Safety First" principles, the gears and other dangerous mechanisms being completely enclosed to provide for the safety of the operator.

ESPEN-LUCAS RAIL-ENDING MACHINE

In the manufacture of rails, it is customary to size them to uniform length by milling off the excess stock from the end. For the performance of this operation, the Espen-Lucas Machine Co., Philadelphia, Pa., has brought out a rail-ending machine which is shown in the accompanying illustration. This machine was developed for the sole purpose of facing the ends of rails of any weight up to 150 pounds to the foot.

The machine is of comparatively simple construction. Upon the heavy base, the spindle is mounted in large bearings; and at one end of the spindle is mounted the cutter-head that carries an 18-inch three-blade face-mill of patented construction. At the rear or driving end, there is a large worm-wheel and worm that are driven by the fifteen-horsepower motor that may be seen at the side of the machine. It is evident that on a machine of this type, the thrust is very great, and on this Espen-Lucas rail-ending machine, it is taken on a roller thrust bearing of large diameter.

The spindle is provided with a 4-inch longitudinal travel; the feed is of a friction type, and there is a hand-feed wheel that may be seen at the left of the machine for bringing the

Rail-ending Machine built by Espen-Lucas Machine Co. for milling off Rails to Standard Length

cutter-head up to the starting point of the cut. The power feed is at the rate of 1 inch per minute. The approximate weight of the machine is 17,000 pounds.

HARRIS RIFLE SIGHT LEAF NOTCHING MACHINE

The rear sight leaf of the Russian military rifle has ten irregularly spaced notches cut in each of its reinforced edges. As the accuracy of the rifle is dependent upon the precision with which these notches are cut, it is apparent that the greatest care must be taken in the performance of this operation. The limit of accuracy is 0.001 inch over the entire length of the sight leaf. To attain this result and to enable the work to be done as rapidly as possible, the special machine described in the following article was developed. One operator can look after several machines, and the rate of production is unusually high.

The rear sight leaf of the Russian military rifle is supported on a hinge in order that the sight may be set in the proper position to get the required elevation for the muzzle of the rifle for any desired range. This rear sight leaf is of a rather peculiar form, being curved to a radius of about 16 inches and having twenty irregularly spaced notches cut in the reinforced edges at an angle of 45 degrees. There are ten of these notches on each side of the sight leaf and they are V-shaped. Owing to the fact that the accuracy of the finished rifle is dependent upon the precision with which these notches are cut in the rear sight leaf, it is necessary for the spacing to be as accurate as possible.

Various methods have been tried for doing this work, and the most successful attempt to use a standard machine was made with a punch press equipped with a tool for cutting ten notches on one side of the sight leaf at a time. Using a solid toothed tool and a special work-holding device on the bolster of the press, which was provided with a slide to be operated by hand, it was found possible to accomplish the desired result, although the method left a great deal to be desired. One of the obvious defects was that the mechanism was operated by hand, and hence there was danger of the operator moving the work at the wrong time. A more serious defect lay in the difficulty of making a solid tool and holding the required relation between the positions of the ten irregularly spaced cutting teeth during the time that the tool was being hardened. As the limit on the location of the notches in the rifle rear sight leaf is 0.001 inch for the total length of the sight, it will be apparent that this was a particularly difficult problem to solve.

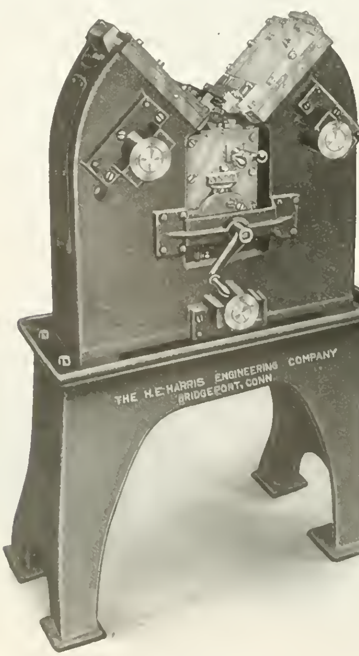


Fig. 1. H. E. Harris Machine for notching Rear Sight Leaf of Russian Military Rifle

Fig. 2. Sight Leaf showing Notches cut by Machine in View at Left

With the view of developing a more efficient method of handling this work, the H. E. Harris Engineering Co., 1041-1055 Broad St., Bridgeport, Conn., recently brought out the special machine illustrated and described herewith. Owing to the delicate nature of the work and the peculiarities of its design, and as the clearance in which the tools have to work is very small, the machine had to be carefully designed with the view of eliminating backlash in the reciprocating parts. Provision also had to be made for taking up any lost motion which is likely to develop as the result of wear.

At the top of the machine, opposed to each other and inclined at angles of 45 degrees to the vertical center line, there are two slides or rams somewhat similar in design to the ram of an ordinary shaper. Special tool-holders are mounted on these rams, which carry tools for cutting the notches in both sides of the rifle sight leaf at the same time. The tool-holders which carry the tools used for this purpose must be very carefully made, the same precision being required as in the manufacture of high-grade gages. All of the tool-holders must be made of exactly the same dimensions so that they are interchangeable with any other tool-holders that are used; and each machine is supplied with an extra set of tools and holders so that there will be no interruption of the work while tools are being ground other than that involved in making a change of tools.

The actual working time of the machine on each part is less than five seconds. The machine runs very slowly and develops no vibration. The average speed of the tool is about six feet per minute, but during the actual cutting operation it is much slower than this, as the cutting is done during the time that the crank is going over the dead center. When grinding the tools, they are merely set out a little further by means of adjusting screws in the tool-holder, after which the entire set of tools is ground at the same time, the surface grinder on which the work is done being equipped with a special fixture for this purpose. An idea of the efficiency with which this special rifle sight leaf notching machine operates will be gathered from the fact that the output is said to be equivalent to that of eight men operating standard punch presses and tools of the type referred to in a previous paragraph. In replacing broken or worn out tools in different tool-holders, it is merely necessary to replace the individual tools as they are worn out, and the original accuracy of the set-up is not in any way affected by the substitution of one or more new tools in the set.

The work is held between vise jaws on top of the vertical slide which will be seen at the center of the machine. This is operated automatically while the notches are being cut in the leaf by means of a crank motion, and a fine tooth ratchet to elevate the slide. As soon as the crank has passed the highest part of its cycle, the cut has been made to the required depth. The mechanism is then automatically released and the operator lowers the vertical slide to the bottom of its travel by means of a crank handle at the front of the machine, after which the work is released from the vise jaws by turning a small crank. A new blank is then set in the vise, secured in place and the machine is ready to perform the next cycle of operations.

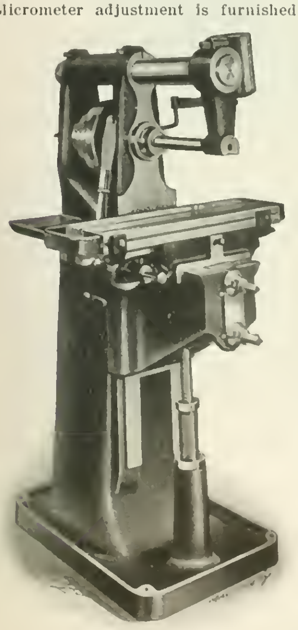
As the relation between the positions of the hinge hole in the sight leaf and the notches cut at each side of this leaf must be uniform, it will be seen that great care must be taken to have the two tool-slides and the vertical slides which carry the work set in exactly the proper relation to each other. This calls for fine workmanship in making the machine and the provision of means for taking up any wear which may develop after the machine has been in use for some time. Individual means of adjustment are provided for regulating the depth of stroke on both the cutting slides and the height of the work-holding slide. These adjustments are very accurate, but the means provided on the machine enable them to be made very rapidly.

DAVENPORT HAND MILLING MACHINE

The Davenport Mfg. Co., Meadville, Pa., is now building a heavy-duty hand milling machine, which is illustrated and described herewith. The table of this machine has a longitudinal movement of 6 inches with one setting of the hand-lever, and a total range of feed of 16 inches. The transverse movement of the saddle is 6½ inches and the vertical movement of the knee, 19 inches. The table has a working surface of 24⅛ by 8 inches and is furnished with a ⅝-inch T-slot. Adjustable stops provide for limiting the movement of the table in either direction.

The spindle is made from a crucible steel forging and runs in bronze-bushed bearings which are provided with means of compensation for wear. The spindle is 2½ inches in diameter and the socket is bored No. 10 B. & S. taper. The nose of the spindle is 2¼ inches diameter, and it is threaded with ten right-hand threads per inch. A ⅝-inch draw-back screw provides for holding the arbor in place. The knee is heavily constructed and accurately scraped to fit the bed and saddle; and a telescopic screw is used to afford the required vertical movement without the necessity of cutting a hole through the floor to accommodate the lower end of the screw when the knee is in its lower position. The overhanging arm, which is made of steel, is 3¼ inches in diameter; and the under side of this arm is 6⅝ inches from the center of the spindle. An arbor 1 inch in diameter by 7½ inches in length under the nut is furnished as part of the equipment of the machine. The arbor support is bronze-bushed.

Micrometer adjustment is furnished for the vertical and horizontal feed-screws, by collars which are graduated to 0.001 inch. The oil pot which has a capacity of two quarts is supported by an adjustable bracket and is fitted with a stop-cock. It will be seen that the machine is driven by a three-step cone pulley which carries a belt 2½ inches in width. A two-speed countershaft is used, which should provide speeds of 125 and 165 revolutions per minute. The clutch pulleys are self-oiling, these pulleys being 10 inches in diameter by 3 inches face width. The floor space occupied is 46 by 46 inches, which includes the limit of table travel; and the weight of machine is 1200 pounds.



Heavy-duty Hand Milling Machine built by Davenport Mfg. Co.

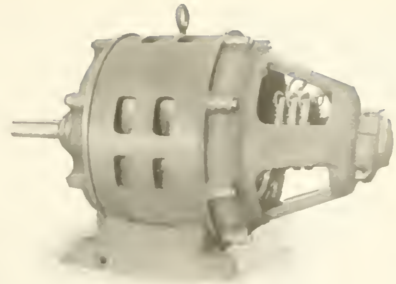


Fig. 1. Westinghouse 75-H.P. Type CI Slip Ring Induction Motor with Rolled Steel Frame Construction

WESTINGHOUSE INDUCTION MOTORS

To meet the requirements of severe intermittent service with varying conditions of speed, the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has recently developed a line of Type CI slip ring induction motors. These motors are especially adapted for use on heavy-duty cranes or hoists, draw-bridges, roller lift bridges, railway turntables, transfer tables and similar installations. They are made in sizes ranging from 1½ to 200 horsepower, for operation on 25- or 60-cycle two- or three-phase circuits of 220 or 440 volts.

The frames of the smaller sizes are made up of steel laminations riveted between forged steel housings; and in the larger sizes the frames are made of rolled open-hearth steel. The brackets are of cast-iron with reinforcing ribs to insure rigidity and perfect alignment of the bearings at all times. The bearings are of the oil-ring type; and the steel brush-holders are supported by and insulated from the bracket which is opened to permit of inspection and renewal of the brushes.

The rotor is small in diameter, thus reducing the flywheel effect. This feature, together with perfect balance and secure attachment of the windings, makes these motors especially adapted for frequent starting, stopping, and reversing. The shaft is of axle steel and can be removed from the rotor without disturbing the windings. The running torque of these motors is the maximum obtainable, and the starting and pull-out torques in all motors exceed twice the full-load torque. They are so constructed that in case of accident repairs can be quickly made; and maximum strength is obtained, while weight and over-all dimensions have been reduced to a minimum.

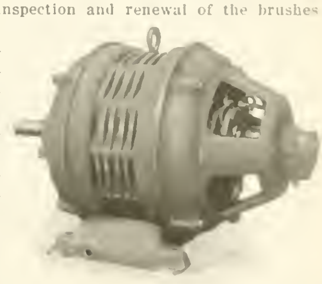
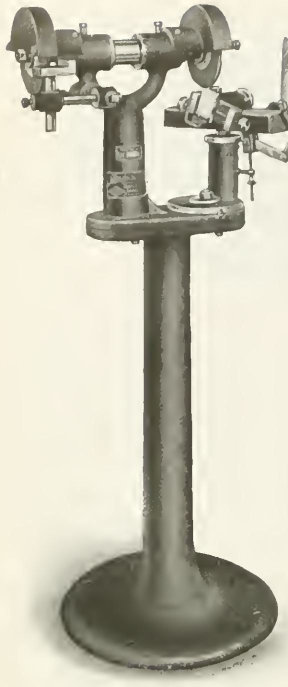


Fig. 2. Westinghouse 10-H.P. Motor of Type shown in Fig. 1, but with Built-up Frame Construction

ACME THREADING DIE CHASER GRINDER

The threading die chaser grinder illustrated and described herewith is a recent addition to the line of the Acme Machinery Co., Cleveland, Ohio. It will be seen that the machine is of the single wheel type, and adjustment is provided which enables all sizes of dies to be ground with the same wheel, thus avoiding the necessity of changing grinding wheels for sharpening various sizes of chasers, and saving the cost of extra wheels. The grinding wheel used on the machine is 6 inches in diameter by ¼ inch face width. The correct angles for the die throat are obtained by moving the die-slide and die-holder to the proper positions, as indicated by graduated plates on the slide base and die-holder. The setting is quickly and easily made.

There is a point in the grinding of die chasers which is not very clearly understood. In regrinding a threading chaser,



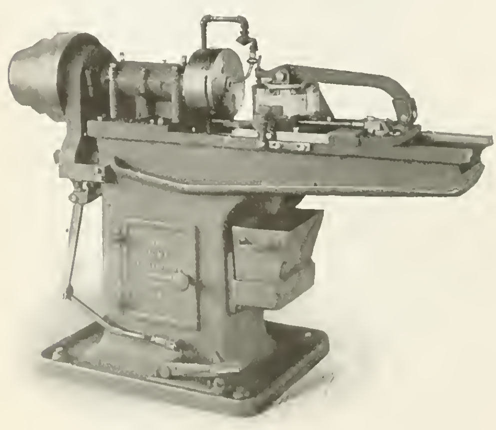
Acme Threading Die Chaser Grinder

it is essential that the entrance or throat be not unnecessarily enlarged, but the throat angle should be reduced. This is not always done, with the result that the greatest efficiency is not obtained from the chasers. Another point is to have all the chasers in any one particular head with the same throat angle and starting at the same point. This is made possible by the Acme die grinder, due to the design of the fixture in which the chasers are set for grinding.

The wheel-spindle is made of crucible steel and runs in bronze-lined bearings. The die-slides are carefully scraped to fit, and gibs are provided to afford means of compensation for wear. The work is moved vertically to the grinding wheel by means of a hand-screw located beneath the slide, and horizontally to the grinding wheel by a hand-lever. The principal dimensions of the machine are as follows: size of driving pulley, 8 inches in diameter by 1¾ inch face width; size of tight and loose pulleys, 4 inches in diameter by 1¾ face width; speed of countershaft, 1000 R. P. M.; speed of grinding wheel spindle, 4000 R. P. M.; floor space occupied by machine, 23 by 20 inches; and net weight, 200 pounds. The equipment furnished includes a countershaft, two grinding wheels, and the necessary wrenches.

ACME TURRET TYPE BOLT POINTER

The feature of particular interest on the bolt pointer illustrated herewith, made by the Acme Machinery Co., Cleveland, Ohio, is the indexing turret which is provided so that the machine can be kept in practically continuous operation. The work is placed in holders, eight of which are carried in the top face of the turret which is indexed automatically. When the work is indexed into the working position, it is clamped by a fulcrum lever over the top of the turret, that comes into action on the work as the turret slide advances. The machine is provided with a three-step cone pulley, so that suitable speeds can be obtained for different diameters and materials. The foot-lever shown on the right-hand side is for stopping and starting the turret, which is done through a clutch. When the machine has been properly set up, the foot-lever is depressed and held down by means of a catch until it is necessary to stop the machine in case of accident or for some other emergency. The operator is merely required to load the work into the turret as the bolts are automatically ejected.



Turret Type Bolt Pointer built by Acme Machinery Co.

ACME DUPLEX NUT BURRING MACHINE

The nut burring machine which forms the subject of this description and which is a recent product of the Acme Machinery Co., Cleveland, Ohio, was designed to remove the burrs from both square and hexagon hot-pressed nuts. The work is placed in the feed chutes by hand, after which the operation is automatic as regards feeding the blanks to the spindles, performing the burring operations and ejecting the finished nuts. The mechanism is enclosed in the bed of the machine where it is thoroughly protected from dust and grit; but the design has been worked out in such a way that all parts of the mechanism are readily accessible. The shafts and gears are made of steel, and the bearings are bushed with bronze. Lubrication is afforded by pipes leading to each bearing.

Two-spindle Nut Burring Machine built by Acme Machinery Co.

The nut feeding mechanism is simple and positive in its action. The nuts slide down the feed chutes to the burring plate which carries them under the spindles. If for any reason a nut gets stuck, a spring release mechanism causes the feed to stop; but the feed will start again automatically as soon as the nut is free. Each cutter-head carries three cutters arranged so that they may be easily removed for dressing. These heads are adjusted to the work by means of hand-screws located at the top of the machine. The cutters are held against the work by the weight of the spindle and head, assisted by a spring which allows the cutter to rise and thus prevents damage in case a nut of unusual thickness is fed into the machine. The spindles are provided with ball thrust bearings, and are lifted by cams cut in the side of the driving worm-wheels.

The drive is through a three-step cone pulley from which power is transmitted through bevel gears to the worms and worm-wheels which drive the spindles. Working on 5/8-inch nuts, the capacity of this machine is 4500 per hour.

This duplex nut burring machine is made in three sizes with nominal capacities of 5/8 inch, 1 inch and 1 1/2 inch, respectively. The 5/8-inch machine is suitable for working on 5/16-, 3/8-, 7/16-, 1/2-, 9/16-, and 5/8-inch nuts; the 1-inch machine for 1/2-, 5/8-, 3/4-, 7/8- and 1-inch nuts; and the 1 1/2-inch machine for 1-, 1 1/8-, 1 1/4-, 1 3/8- and 1 1/2-inch nuts. The equipment furnished with these machines includes a countershaft, wrenches, automatic feed mechanism, and one set of cutter blades. Five sets of adjusting strips are included in the equipment for handling these sizes of nuts, and also five nut pilots for handling the sizes of work referred to.

BOWEN MILLING MACHINE

It will be seen that this machine may be used for either vertical or horizontal milling, but it was especially designed for the performance of various thread milling operations. A feature of the design is that the machine does not require a special lead-screw for each pitch of thread to be cut. The vertical position of the table is fixed, and adjustment for depth of cut is secured by moving the cutter-head on its bearings on the column. Lateral adjustment is obtained by moving the cutter-head column in or out from the table; and the table is traversed by a lead-screw.

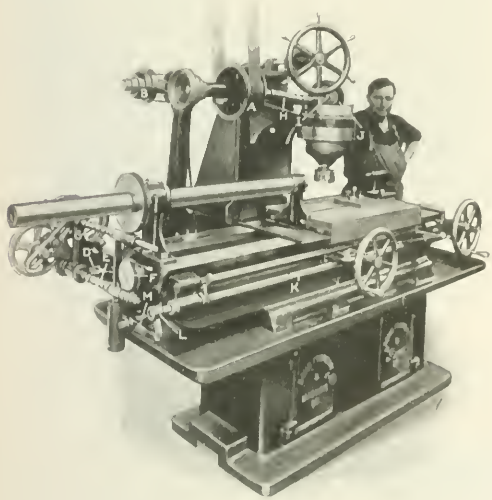


Fig. 1. Bowen Milling Machine built by Bond Foundry & Machine Co.

The Bond Foundry & Machine Co., Manheim, Pa., has perfected and placed on the market the Bowen milling machine illustrated herewith. This machine was designed by James E. Bowen, mechanical engineer of this firm, who was formerly with the Milled Screw Co., Sayre, Pa. While this is a universal milling machine, in that it can be used for vertical or horizontal milling of almost any type, it is particularly adapted for thread milling; and Fig. 3 shows the machine set up for milling a helical groove. Unlike many thread milling machines, it does not require a special lead-screw for every pitch of thread to be cut.

The table of the Bowen milling machine is non-adjustable vertically, and runs upon a bed that is cast integral with the base. The base is made very broad and heavy, and it is claimed that much of the vibration incident to operation is absorbed in this heavy base. Adjustment for depth of cut is secured by moving the cutter-head vertically on its bearings on the column by operating the pilot wheel at the front of the machine. Lateral adjustment is made by moving the cutter-head column in or out from the table on ways on the machine base, this adjustment being controlled by the operation of the handwheel beneath the table. The table of the milling machine is traversed by a lead-screw that receives motion through a worm and worm-wheel, leading back to the driving mechanism. The table has a maximum longitudinal travel of 4 feet, and automatic stops are provided to limit the movement in either direction. A handwheel at the extreme right-hand end of the machine provides for traversing the table by hand.

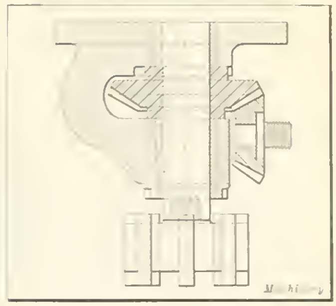


Fig. 2. Cross-sectional View of Vertical Cutter-head shown on Machine in Fig. 1

The entire operation of the machine is controlled from driving pulley A, which may be seen near the center of the machine. Rotation is carried back to shaft B, and thence down to a secondary driving shaft C that terminates, as may be seen in Figs. 1 and 4, in a bevel gear D. This bevel gear transmits motion to worm-shaft E that carries power to the worm-wheel F which operates the carriage through a lead-screw. From the opposite end of worm-shaft E, a spur gear carries rotation through a set of change-gears to the worm-shaft G that operates the work-holding spindle. This mechanism may best be seen by referring to Fig. 1 in connection with the line illustration Fig. 4.

From the main driving shaft, rotation is carried to the cutter-head as shown in Fig. 3 by a universal joint connection H. By means of gearing, motion is carried from this universal joint shaft to the cutter-arbor, and at the same time a speed reduction is made in the ratio of 9 to 1. On the cutter-head is a bevel pinion that receives rotation from the small bevel pinion I, and transmits it through the larger pinion J. This arrangement permits the cutter-arbor and gearing to be swiveled to any angle in the horizontal plane. From the shaft on which gear J is mounted, a spur pinion meshes with another spur gear that carries rotation down to the cutter-arbor. From worm-shaft E, brackets support the spindle worm-shaft

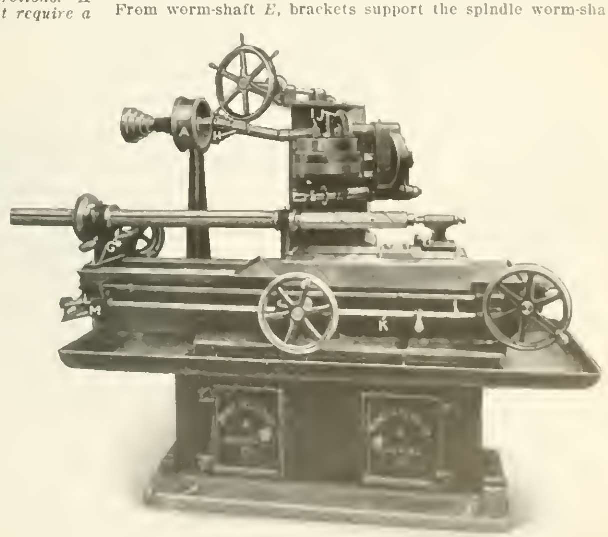


Fig 3. Bowen Milling Machine set up for milling a Helical Groove

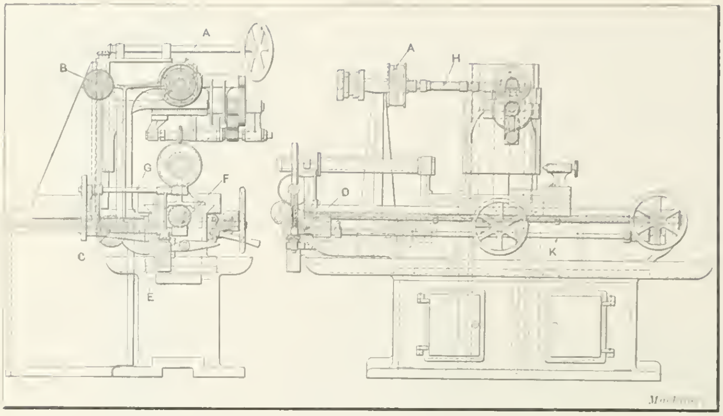


Fig. 4. End View and Front Elevation of Bowen Milling Machine

G, and when the worm on the lower shaft is disengaged, the upper one also is disengaged. The worm-disengaging mechanism is operated through a hand-lever on rod K at the front of the machine. The rocking of this shaft causes finger L to operate lever M and thus raise or lower the two worm-shafts to engage or disengage the two worms.

By making the proper changes in the spur gears at the rear of worm-shaft E, a helical groove may be cut of any desired pitch from a keyseat to the finest thread. It is obvious that the work-holding spindle may be fitted with any form of chuck or faceplate, and that the table is provided with a tail-center for supporting long work. Fig. 1 shows the machine set up with a vertical attachment on the cutter-head for face-milling; and the design of this cutter-head may be seen in Fig. 2 which illustrates this mechanism in cross-section. The drive is from the same spindle that operates the cutter when working on thread milling. Rotation is received from the bevel gear on the right-hand side, as viewed in Fig. 2, and meshing with this pinion is a bevel gear on the vertical cutter-spindle. Cutters up to 10 inches in diameter may be used.

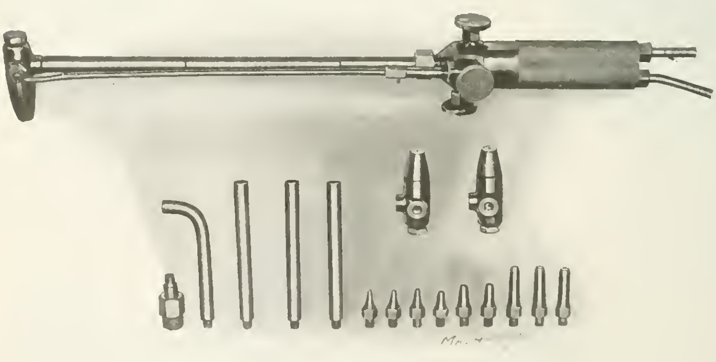


Fig. 1. "Hoover" Torch with Head mounted in Right-angle Position

"HOOVER" COMBINATION WELDING AND CUTTING TORCH

The Oxy-Acetylene Products Co., 810 Diversey Parkway, Chicago, Ill., has recently placed on the market a combination oxy-acetylene torch which is adapted for the welding and cutting of all metals. A feature of this torch is that it may be adjusted to adapt it for welding work of a great variety of sizes; and the torch may be easily changed to make it suitable for either welding or cutting operations.

The head is cast *en bloc* to avoid the possibility of leakage between the head and tip. The cutting head is adjustable to either of two different positions, one of which, shown in Fig. 1, gives the regular right-angle torch; and the other position, shown in Fig. 2, provides a straight-head torch. The provision of this means of adjustment is a great convenience in handling many classes of work. For cutting various thicknesses of metal, different heads are provided for use on the torch. The design of these heads is such that they may be used on a medium- or high-pressure system; and the entire design of the torch has been worked out with the view of securing the maximum simplicity and strength at points where there is danger of breakage. For example, the tips are enclosed within the head, which eliminates exterior leakage and resulting danger of damage from the leaking gases taking fire.

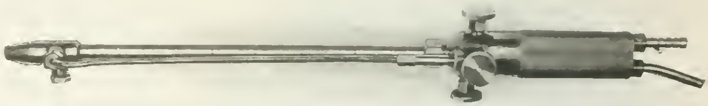
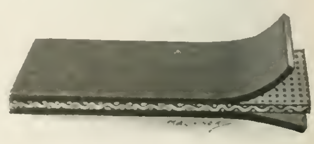


Fig. 2. "Hoover" Torch with Head mounted in Straight Position

SOUTHWICK DUCK-CENTER CHROME BELT

The George W. Southwick Co., Stamford, Conn., has recently added to its line of power transmission specialties the "duck-center" chrome leather belt illustrated and described herewith. It will be seen that this belt consists of two thicknesses of chrome leather with a strip of duck between them, and the entire belt is glued together in such a way that it is guaranteed not to stretch, come apart or be impaired by the action of water or oil. It is claimed that this belt grips the pulley more tightly, and on this account is able to transmit 25 per cent more power than a standard leather belt of the same size. The center is reinforced with 48-ounce duck which is said to add 40 per cent to the strength of the belt. It is also stated that this belt runs just as true as any other kind of belt, and that the duck center makes it extremely flexible; consequently, it is well adapted for use on high-speed machinery. It is made in single and double thicknesses.

In making this belt, the duck center is first stretched to its utmost capacity, and while under tension the leather is cemented to it. After the cement has dried, the tension is released; and in this way it will be evident that the duck center takes all the strain when the belt is under load. It is this condition that enables the belt to cling so tightly to the pulley. In order to demonstrate the waterproof qualities of the belting, it is stated that a sample was boiled for twenty-four hours, after which it was removed

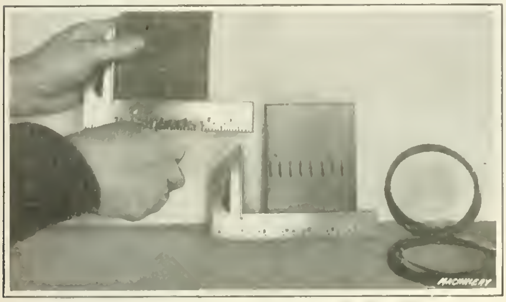


Duck-center Chrome Leather Belt made by George W. Southwick Co.

from the water and dried, and subsequent examination failed to reveal that the strength of the cemented joint had been impaired in any way.

SOUTHWICK BELT TEMPLET SQUARE

In the April, 1913, number of MACHINERY, a description was published of the twisted rawhide belt lacing which had just been placed on the market by the George W. Southwick Co. Subsequent experience in the use of this belt lacing has shown that it is highly important to have the holes correctly spaced and located at just the proper distance from the end of the belt. To facilitate laying out these holes, the George W. Southwick Co., Stamford, Conn., has recently placed on the market a combination templet and square which is illustrated herewith. The use of this tool is made apparent from the illustration, so that further description is unnecessary; and it will be apparent that in using a tool of this kind there should be absolutely no excuse for failure to obtain exactly the required location and spacing for the lacing hole.



Templet Square for spacing Holes for Twisted Rawhide Belt Lacing

ESPEN-LUCAS BILLET SLITTING SAW

In the manufacture of steel bars, the best practice is to slit the rough billets into quarters and then forge these quarters into bars of the required shape. This obviates danger of carrying a "pipe" down with the billet and thereby leaving every bar with a flaw. By the billet slitting method the "pipe," if there is one, is left on the outside of the stock where it will be removed by subsequent machining operations.

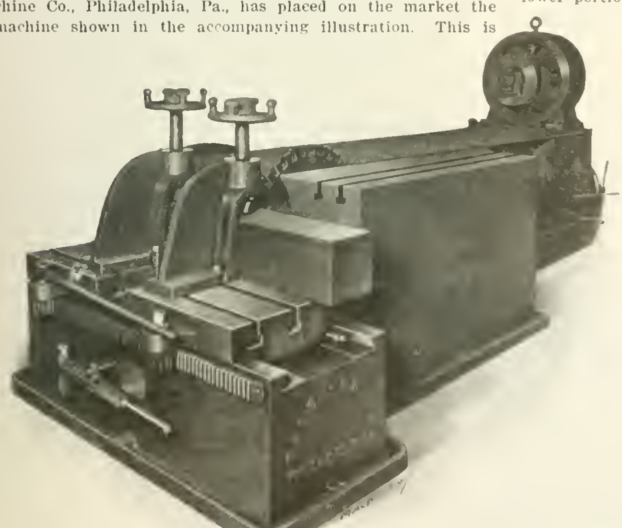
For the rapid slitting of steel billets, the Espen-Lucas Machine Co., Philadelphia, Pa., has placed on the market the machine shown in the accompanying illustration. This is really a combination machine, as in addition to being used for slitting billets, it may be used as a regulation cold saw. The inserted-tooth blade that the machine carries is 45 inches diameter and extends 14 inches above the table on which the billets are held. The saw has a travel of 8 feet, so that it can slit a billet 14 inches in diameter by 8 feet long at one cut It is driven by a twenty-five-horsepower variable-speed motor From the motor, a belt drive transmits power to a worm and worm-wheel, and then to the saw arbor.

The feed is at the rate of $1\frac{1}{2}$ inch per minute, when the saw is cutting at a depth of 14 inches, and is secured through the Espen-Lucas type of friction plate, both plates being of the same size. The machine may be controlled from the front by means of a lever that may be seen on the side of the machine, or from the rear, making it convenient for the operator. Automatic stops are provided to disengage the drive at any desired point. All gears are adequately covered. The machine weighs approximately 50,000 pounds.

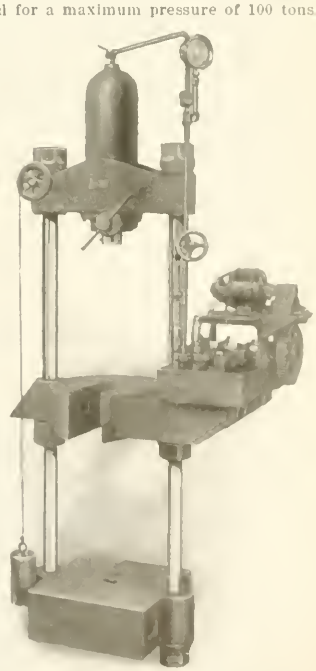
INVERTED HYDRAULIC FORCING PRESS

The inverted hydraulic forcing press illustrated and described herewith is a recent product of the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. It was especially designed to meet the requirements of two distinct forcing operations, *i. e.*, for forcing locomotive piston rods into piston heads, and also for removing the piston heads from the rods. However, it can readily be seen that the press is suitable for handling a variety of other work of this kind. In addition, this press is suitable for the performance of certain classes of arbor and broaching operations, the open slot of the upper base allowing ample space for the arbor or broach to pass through the work.

For forcing on a piston head, the head is set on the lower base with the rod passing up through the slot in the upper base, after which the pressure is applied to the end of the rod, thus forcing it into the piston head. When the press is used for forcing the piston head off the rod, the head and rod are hung on the upper base and the pressure is applied at the upper end of the rod, thus forcing it out of the head. More pressure is required for this operation, and so the upper part of the press is designed for a maximum pressure of 100 tons. The forcing of the rod into place in the head does not require so much pressure, and so the lower portion of the



Billet Slitting Cold Saw built by the Espen-Lucas Machine Co.



Inverted Forcing Press built by Hydraulic Press Mfg. Co.

press is designed for a maximum pressure of 50 tons, which is ample for handling this class of work.

The usual method of installation is to erect the press so that the upper base is just above the floor level, with the lower base under the floor. The press is self-contained, pressure being furnished by a direct-connected motor-driven horizontal double-plunger pump, with a double gear reduction. A T-screw hydraulic operating valve controls the pressure of this pump to the press cylinder. The diameter of the ram is 10 inches, and it has a run of 22 inches; the ram is equipped with a rack and pinion attachment for raising or lowering it to the work. In this way various lengths of work can be admitted to the press and the pressure can be instantly applied at the first stroke of the pump. The "daylight" space for the upper portion of the press is 36 inches, and for the lower part 50 inches, making the total "daylight" or working space 86 inches.

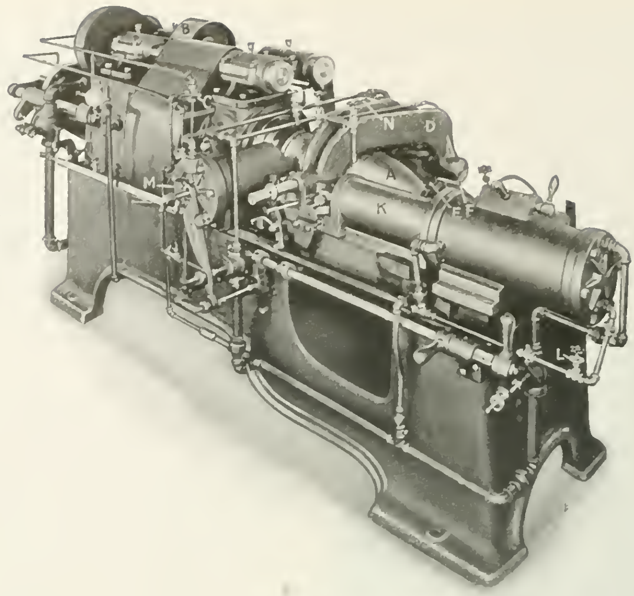


Fig. 1. Partial End View of Warren "Hydraulic" Lathe for Large Shells

WARREN "HYDRAULIC" LATHE FOR LARGE SHELLS

This machine is intended for the performance of external operations on shell forgings as large as 9 or 10 inches in diameter. The turning tools are carried on a pivoted holder which may be swung to provide for generating the pointed nose of the shell. The work-spindle is moved axially by the pressure of oil in a cylinder to provide for feeding the work to the tools; and the cutting-off tools are also fed by oil pressure in cylinders at the front and back of the lathe. The machine is designed for heavy work and is provided with ample power to drive high-speed steel cutting tools to the limit of their cutting capacity.

The Warren "hydraulic" lathes built by the Lombard Governor Co., Ashland, Mass., for turning small shells were described in the February and May numbers of MACHINERY. Another form of this lathe has now been put on the market which is intended for exterior operations on shell forgings as large as 9 or 10 inches in diameter. As in the previous forms of this lathe, the thrust of the revolving spindle, which has a minimum diameter of 9 inches, is taken wholly by oil under pressure, so that as far as the end thrust is concerned the spindle is practically frictionless. The oil which absorbs the end thrust also provides a hydraulic feed for the spindle which travels axially. The cutting-off tools in this new form of lathe are also fed hydraulically, so that the machine is very nearly automatic and consequently "fool-proof."

Fig. 1 shows a partial end view of the machine as one looks down at it. The total length is 12 feet, width, 50 inches, height, 56 inches, and approximate weight, 8000 pounds. Shell forging *A*, in this case 8 inches in diameter, is clamped by a hydraulically expanding arbor approximately 5 inches in diameter, which, in itself, is drawn into the 9-inch spindle by the same hydraulic pressure which provides the clamping action. In consequence, the mounting of the forging is so rigid that it is entirely unnecessary to provide any support at the outer end, and the heaviest chips can be taken without appreciable vibration. The drive to the spindle is from the pulley *B* through a hydraulic clutch controlled by the three-way valve *C*, Fig. 2, the double back-gear giving a ratio of 21 to 1.

The heavy tool carrier *D* swings about a vertical pivot *E* and is mounted upon a trunnion *F*; consequently, the tool carrier can be lifted up so as to throw the tools entirely out of contact with the work, as shown in Fig. 2, which is necessary when forgings are being put onto or taken off the expanding arbor. The tool-holder *D* carries two heavy tools at *G* and *H*; and the outer end of carrier *D* is slotted so as to pass over a swiveling block *I* which travels on ways through the movement of the hydraulic piston *K* that is controlled by the graduated needle valve *L*. This provides an extremely convenient and infinitely adjustable method of feeding tool carrier *D*. As tool carrier arm *D* swings around pivot *E* as a center, tool *G* generates the curved nose of the shell, and tool *H* is out of action; but when piston *K* reaches the forward limit of its travel, as it comes up against a solid abutment, tool *H* is forced into the revolving shell.

While the nose of the shell is being generated by tool *G*, tools actuated by two cutting-off cylinders *M* and *N* (the latter not clearly shown in Fig. 1) are at work trimming off the large end of the shell. This cutting-off operation proceeds very rapidly, and as soon as it is completed the pistons automatically back out the tools. As soon as the nose of the shell is finished through the action of the swinging arm *D*, piston *K* feeds forward until it comes up against its abutment, and simultaneously throws over control lever *O* which starts the main spindle of the machine moving forward. Consequently, the two tools *H* and *G* which are now held sta-

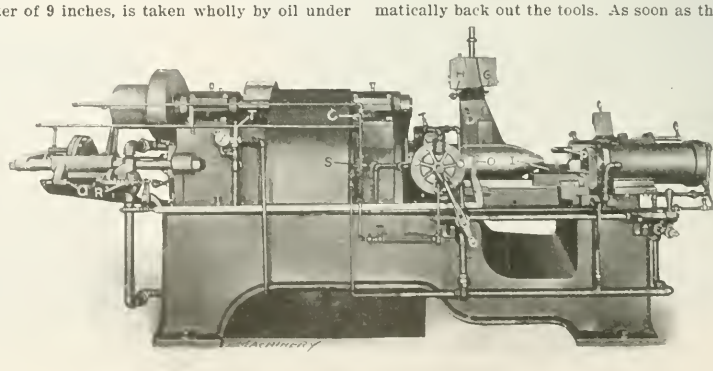


Fig. 2. Front View of Machine with Tool Carrier lifted to throw Tools out of Contact with Work

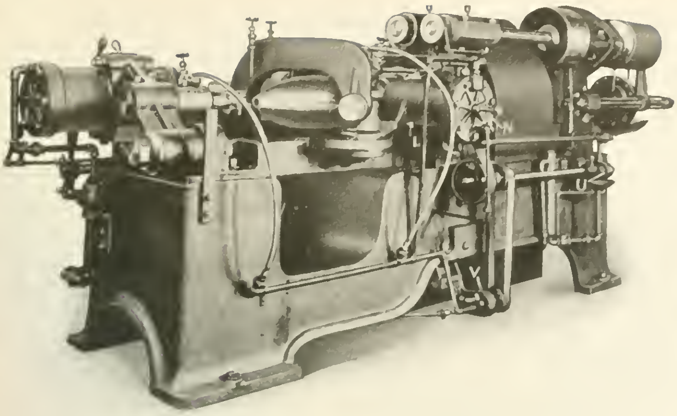


Fig. 3. Rear View of Machine, showing Oil Pumps U and V

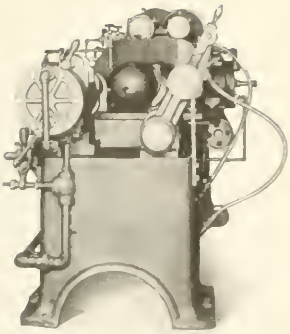


Fig. 4. End View of Warren "Hydraulic" Lathe for turning Large Shells

tionary turn the cylindrical surface of the shell. At the same time, drill *P* which has been swung down into a position in line with the center of the shell forces its way through the nose of the forging. When the main spindle of the machine reaches the end of its forward travel, the stop-screw *Q* actuates the discharge valve *R* and the operator after moving the clutch valve *C* one-fourth turn lifts the arm *D* into the position shown in Fig. 2 and removes the forging from the spindle after it has been released by turning valve *S*.

All the feeds on the machine are controlled by graduated needle valves, and they may be instantly changed from 0 to 1/4 inch or more per revolution. No harm can result if the point of a tool fails, because there are no gears or complicated feed mechanism to break. In such a case the hydraulic pistons will merely exert their full pressure, which is limited by the relief valve *T*. The frame of the machine and the main spindle bearings are cast integral, and the whole structure is so rigid that it is free from vibration on any kind of foundation. The power of the machine is limited only by the endurance of the tools. Cuts can easily be taken which will overheat the best quality of high-speed steel.

The oil supply for the operation of the machine consists in a small rotary pump on the back of the machine at *U*, Fig. 3, while the supply of cutting compound is furnished by another rotary pump at *V*. The supply of oil furnished by the latter is piped to all the tools. An end view of the machine is shown in Fig. 4. It is estimated that thirty horsepower should be provided to operate this powerful lathe to its full capacity. The diameter of pulley *B* is 12 inches, the face width 7 inches, and the speed, 600 revolutions per minute. It is believed that this semi-automatic lathe is capable of giving exceptionally satisfactory results on large forged shells, by removing the metal rapidly and by performing several operations simultaneously.

NEW MACHINERY AND TOOLS NOTES

Micrometer Caliper: L. S. Starrett Co., Athol, Mass. A micrometer made for the Union Twist Drill Co. for use in measuring three-fluted tools such as drills, taps, cutters, etc. The anvil of the standard micrometer is replaced by a 60-degree V-block to enable it to handle work of the kind referred to.

Bench Grinding Machine: Grayson Tool & Mfg. Co., Indianapolis, Ind. A bench machine especially adapted for grinding dies, punches, gages, etc. The machine has a table 12 by 14 inches in size with suitable provision for feeding the work to the wheel. The overhead works are supported by a pipe stand reaching from the bench to the ceiling.

Hand Screw Machine: Loisy-Patton Co., Cleveland, Ohio. A hand screw machine, the design of which follows standard practice in the construction of machines of this type. It has a capacity for handling bar stock up to 1 inch in diameter, and work can be turned up to 6 inches in length. The swing over the bed is 14 inches, and over the cut-off slide, 6 inches.

Tool-holder: Worcester Flexible Tubing Co., Worcester, Mass. A tool-holder suitable for use on lathes, planers, shapers, etc., in which the cutter is supported right out to the edge. No set-screws are used on the tool-holder, and the construction is such that the possibility of breaking the cutter or holder is said to be reduced to a minimum. The holder can be used either right-hand or left-hand.

Thread Miller: Edwin Harrington, Son & Co., Inc., Philadelphia, Pa. A thread milling machine designed for handling general work such as milling screw threads, helical slots and spiral gears of either right- or left-hand. The work may be of fine or coarse lead, and either single or multiple. The work is gripped in a chuck at one end and supported by a steady-rest at a point directly beneath the cutter.

Multiple Toolpost: Rex Mfg. Co., Hyde Park, Boston, Mass. To meet the requirements of turning operations where multiple cutting tools are used, the "Rex" multiple toolpost has been placed on the market. The toolpost is so constructed that several can be placed side by side in the tool-block, and no change is required unless it is necessary to use more toolposts than there is room for in the tool-block.

Facing Head: Mummert-Dixon Co., Hanover, Pa. A facing head made in 6-, 9-, and 12-inch sizes. These heads can be used in connection with a bar on any machine that will hold and drive a bar supported on centers. The heads can also be used without a bar, in which case they are mounted on a tapered shank fitted into the end of the spindle. The head and its feeding arrangement are a self-contained unit.

Band Seat Turning and Waving Machine: Traylor Engineering & Mfg. Co., Allentown, Pa. This machine is especially designed for use in turning and waving the band seat in six-inch shells. It is equipped with an air chuck which has ample power to hold the shell securely during the machining operation. The floor space occupied is 6 by 4 feet, and the weight of the machine, approximately 9000 pounds.

Four-jawed Chuck: Mann Corporation, Chicago, Ill. A heavy-duty four-jawed chuck designed to meet the requirements of work which calls for the use of a four-jawed direct screwed chuck with a large hole and small range of jaw travel. The chuck is said to be especially adapted for use on heavy cutting-off machines, and for gripping shrapnel or high-explosive shells of all sizes during the performance of various machining operations.

Heavy-duty Lathe: Houston, Stanwood & Gamble Co., Cincinnati, Ohio. A heavy-duty high-power lathe, equipped with an all-geared headstock and single pulley drive. The tailstock is of the offset type and provided with the adjustable set-over feature to provide for handling tapered work. The swing over the carriage is 30 1/2 inches; swing over the bridge, 19 inches; distance between centers, 72 inches; and weight of the machine, about 13,000 pounds.

Direct-reading Ohmmeter: Roller-Smith Co., 203 Broadway, New York City. A direct-reading ohmmeter for portable service; the instrument was especially designed for use in measuring the resistance of relay points in electric signaling systems. It consists of a slide wire bridge with a self-contained galvanometer of sensitive but rugged design. The instrument is packed in a hardwood box which enables it to be conveniently carried from place to place.

Multiple Punching Machine: Hilles & Jones Co., Wilmington, Del. The machine is designed for use in the manufacture of mine screens and other perforated work of a similar nature. The space between the housings is 62 inches; the machine is equipped with an automatic spacing table, and it has sufficient capacity to punch thirty-five holes 1 1/2 inch in diameter through a 1/4-inch mild steel plate, or fourteen holes of the same size through a steel plate 1/2 inch in thickness.

Electric Hoist: Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. The design of this hoist follows that of the preceding model of this company's manufacture. The chief point of difference is in the gear construction; the gears on the new hoist are heat-treated in order to increase their durability and strength. The hoist frame consists of two cylindrical castings which are flanged and bolted to each other at the center of the hoist. The motor is of the standard series-wound, slow-speed type.

Rifle Barrel Drilling and Rifling Machines: International Engineering Co., Cleveland, Ohio. A deep drilling machine and a rifling machine for use in drilling the holes and cutting the rifling grooves in rifle barrels. The drilling machine is of the duplex type and provides for drilling two rifle barrels at a time. The rifling machine works on one barrel at a time. On the rifling machine, the bar is moved along the bed by a lead-screw and the work is indexed by a cam and dog mechanism after each stroke of the cutter-bar has been completed.

Automatic Screw Machine: Chicago Automatic Screw Machine Co., Chicago, Ill. This machine is driven by a single belt from the lineshaft so that the use of a countershaft is unnecessary. It is equipped with a turret 7½ inches in diameter, and either four or five holes may be provided in the turret. The spindle capacity is for work up to 2 inches in diameter. The floor space occupied by the machine is 36 by 124 inches, and its approximate weight is 3450 pounds. The John Macnab Machinery Co., 90 West St., New York City, is selling agent for this machine.

* * *

CORRECTION

In the May number of MACHINERY a description was published of two turret heads made by the Newman Mfg. Co., 717 Sycamore St., Cincinnati, Ohio. In describing the lathe turret, the statement was made that it is intended for use on the tailstock spindle; but this was incorrect, as the turret is intended for use on the toolpost of the lathe. Also, it should be noticed that this toolpost turret provides a series of four tools instead of five, as stated in the description published in the May number of MACHINERY.

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THIRD NATIONAL EXPOSITION OF SAFETY AND HEALTH

The Third National Exposition of Safety and Health which was held under the auspices of the American Museum of Safety at the Grand Central Palace, New York City, May 22 to 27, inclusive, contained exhibits of the widest imaginable scope, ranging from the safety of infants to national safety through preparedness. Among the most numerous and most elaborate exhibits were those of various railroad companies, whose exhibits included examples of safety applied to railroading in all of its many stages. Some of the lesser exhibits included safety gasoline cans, safety matches, safety eye goggles, safety mining lamps, safety stair treads, safety electric lamp lowerers, safety belt lacing, safety elevator locks, safety fire extinguishers, safety set-screws, and safety mechanical stopping devices for machinery. Other exhibits which came under the head of either safety, sanitation or health were bubbling drinking fountains, sanitary towels, malted milk, disinfectants, life-saving devices, and insurance.

One exhibit deserving mention as applying more directly to the machine tool building trade, was that of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Among the various articles exhibited were chipping screens, milling cutter guards, punch press guards, punch press feeders, compressed air press ejectors, magnetic press feeders, safety insulated screwdrivers, safety babbitt ladles, safety acid jug, safety foot press requiring both hands to release the ram before it can be operated by the foot, circular saw guards of several types, and safety ladder.

By far the largest exhibit was that of the United States Army and Navy representing the various phases of military life, aiming to show how national safety may be insured through preparedness.

* * *

HEALTH INSURANCE

The American Association for Labor Legislation, New York City, has been instrumental in introducing bills for health insurance in the legislatures of Massachusetts, New York and New Jersey. These bills differ in principle in one important respect from the report just adopted by the National Association of Manufacturers in regard to the carrying agency. Those responsible for drafting the bills thought it essential that the normal insurance carrier should be a mutual association of employers and employes under their joint control and organized according to trade or locality. By this method a workman is automatically insured in the fund for his own trade or if there is no such fund, he is insured in the local fund for his district, and thus the costly process of acquiring business, inherent in the present industrial insurance, is eliminated. The economics of this system of administration are evident. Since the funds designed in these bills to carry insurance are under the control of employer and employe who are contributing to the fund and receiving the benefits, there will not be the same temptation to extravagant administration so often charged against state-managed enterprises. For this reason the often alleged necessity for competition with state-controlled insurance is not valid. The acceptance of the principle of compulsory health insurance and the distribution of the cost in relation to the responsibility for sickness by the manufacturers' associations are encouraging signs of industrial betterment. Health insurance is in the same class of industrial betterment as "Safety First" and related movements to eliminate danger to life and limb.

* * *

BULLARD "MAXI-PAY" PLAN

The Bullard Machine Tool Co., Bridgeport, Conn., has adopted a "Maxi-pay" plan for its employes which is described in a statement distributed to the men May 13, as follows:

Skill and proficiency are the actual foundations of low cost of production—not a low hourly wage rate. Skill at the machinist's trade may be acquired by years of application in any of a thousand shops, but proficiency in the construction of a highly specialized product like ours can be obtained only by long association with that product, through which may be developed a knowledge of its working and appreciation of the exacting requirements of the construction of the various details which enter into it. The longer a man is with us, the better is his worth, because of his development in skill and his greater knowledge of the special needs of the building of our machines. In the final analysis, that man's work costs less, even though his hourly wage is considered high, because of his superior quality and the greater efficiency with which it has been produced.

Our "Maxi-pay" wage plan has been developed from these basic facts. It recognizes the value of skill and proficiency and provides suitable rewards for their attainment. It presents a high mark for the good men to aim at and opens the doors of opportunity for advancement to all in our employ—even to those who are now unskilled.

By close personal study of the individuals in our organization and a careful inspection of their records, E. P. Bullard, Jr., our president, in conference with the shop executives and foremen has grouped the men into six distinct classes, four of which cover the mechanics, one the apprentices, and one the non-mechanical and unskilled members of our force. Future advancement will be made the subject of an equally fair and careful consideration.

In class AA, from which will be recruited our future shop executives and foremen, are grouped the sub-foremen and leaders in charge of the working gangs of mechanics. The maximum wage rate is limited only by ability, facility and occupation, while a high minimum of 55 cents per hour has been set.

Class A, comprised of the mechanics of highest skill, forms the basis of promotion to class AA, and like it has an unlimited maximum hourly rate dependent only on ability, and a minimum rate of 50 cents an hour.

Mechanics of good average ability are rated in class B, for which a wage of 45 cents per hour has been set. Advancement in grade will be the logical reward of proved merit and diligent service.

In class C have been grouped those mechanics of lesser skill but who by their records show merit and possibilities of development which will warrant advancement to the highest class. The hourly rate is 40 cents.

All apprentices, both special and regular, are put in class D, and when their term expires promotion will be promptly made to the classification for which they have qualified. The apprenticeship rates are advanced approximately 10 per cent.

The non-productive skilled labor and the unskilled labor, such as truckers, cleaners, sweepers, etc., have been grouped in class E which has a minimum rate of 25 cents an hour, and a maximum which is limited only by occupation and

skill and proficiency therein. In recruiting this force, preference will be shown to those who can speak and write the English language and who show possibilities of advancement and development.

To the unskilled there is offered the opportunity to acquire skill with the regular or special apprenticeship courses. Our aim and hope is to have a mechanical organization composed mainly of AA and A men, with B, C and D men in sufficient numbers only to provide for natural growth and expansion and to make up the small losses that are bound to occur in any large organization.

As a further incentive to continued regular attendance, we will maintain our continued service bonus payment of 10 per cent of the full weekly wage. This is in no sense a part of the hourly rate, nor is it considered by us as a wage payment. It is a distinct reward for regular and continued service and is made possible only by the fulfillment of a production schedule which could not otherwise be maintained.

Bridgeport, Conn. BULLARD MACHINE TOOL CO.

Several months ago the company adopted the eight-hour workday and placed its plant on a twenty-four hour schedule, working three shifts, eight hours each. The further adoption of the "Maxi-pay" plan, so called because no limit is placed on earnings, places the company in the front rank of liberal and cooperative employers. The innovation, if such it can be named, will be watched with the keenest interest.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly on the 1st at New York, N. Y., for April 1, 1916.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of MACHINERY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press	140-148 Lafayette St., New York
Editor, Fred E. Rogers	" " " " "
Managing Editor, None	
Business Managers { Alexander Luchars, President	" " " " "
Matthew J. O'Neill, Gen'l Manager	" " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press	140-148 Lafayette St., New York
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
Erik Oberg	" " " " "

3. That there are no bondholders, mortgagees or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 22nd day of March, 1916.

FRANK J. SCOTT,
Notary Public, No. 321, Kings County.
(SEAL) Certificate filed in New York County No. 247.
(My commission expires March 30, 1917.)

PERSONALS

John S. Rountree has taken the position of advertising manager of the Searchlight Co., Chicago, Ill., succeeding Grover Clark, resigned.

H. B. Hoover, formerly manager of the Turner Brass Works, Sycamore, Ill., is now general manager of the Oxy-Acetylene Products Co., Chicago, Ill.

J. W. Lee, Jr., publicity agent of the Pennsylvania Railroad, has resigned the position and will move to New York City, where he will be associated in business with Ivy L. Lee.

Grover Clark has resigned his position with the Searchlight Co., Chicago, Ill., to take the position of advertising and sales manager for Ludwig & Ludwig, of 2427 W. 14th St., Chicago, Ill.

S. S. Buckley, who for the past five years has been in charge of the tool steel sales of the Bethlehem Steel Co., has been made president of the newly organized Onondaga Steel Co., Syracuse, N. Y.

John J. Cruice, for the past eight years representative for Edgar Allen & Co.'s high-speed and carbon steels, has been appointed Detroit representative for the Haynes Stellite Co. of Kokomo, Ind.

R. T. Lane, general sales manager of the Standard Tool Co., Cleveland, Ohio, delivered a lecture with stereopticon views in Passaic, Monday evening, May 15, on the "Uses and Abuses of Cutters, Drills, Taps, Reamers and Other Tools."

E. D. Newkirk, formerly superintendent of the Rome Wire Works, Rome, N. Y., and later secretary and general manager of the Marvin & Casler Co., Canastota, N. Y., has been made secretary and treasurer of the Onondaga Steel Co., Syracuse, N. Y.

D. M. Crossman, who for some years has been an assistant in the department of publicity of the Niles-Bement-Pond Co., New York City, has been made manager of publicity, succeeding H. M. Cleaver, who has been transferred to the Pond Works at Plainfield, N. J.

Joseph E. Vincent, Jr., for a number of years connected with Wheelock, Lovejoy & Co., and the Swedish Iron & Steel Corporation, has been made general manager of the newly organized Iron, Steel, Metal & Alloy Co. of America, Liberty Tower Bldg., New York City.

W. S. Quigley, president of the Quigley Furnace Specialties Co., 26 Cortlandt St., New York City, read a paper before the Philadelphia Foundrymen's Association, May 3, entitled "Tests of High-temperature Furnace Cement," containing data useful to users and makers of high-temperature furnaces.

Henry Cave, president of the Cave Welding & Mfg. Co., Springfield, Mass., has associated himself with the Davis-Bournonville Co., Jersey City, N. J., and will have active charge of its research department. Mr. Cave will retain his connection with the Cave Welding & Mfg. Co.

Richard Martens, vice-president and managing director of R. Martens & Co., Inc., New York City, sailed May 16 on the *California* for Petrograd, Russia. During his six months' stay in America Mr. Martens completed the organization of his American company and studied the manufacturing industries here in relation to Russia as a future market.

F. L. Cone, who for more than twenty years was associated with the Windsor Machine Co., Windsor, Vt., for the past eleven years as general superintendent, has resigned and started in business for himself. He will build an automatic lathe, and has begun the erection of a shop 60 by 100 feet. The new concern will employ about 100 men at the start.

George H. Higgins has been appointed factory manager of the Burd High Compression Ring Co., Rockford, Ill. Mr. Higgins was formerly with the Stone & Webster Corporation, the Westinghouse Electric & Mfg. Co., Ford Motor Co., Buick Motor Co. and the Oakland Motor Car Co. Mr. Higgins will have general supervision over the factory matters and will give special attention to problems involving production.

Dr. Edward E. Pratt, chief of the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce, is the director of an educational course in foreign trade which has just been announced. The course is supplied to corporations and firms for study by their employes and to others interested in foreign trade. It is being issued through the Business Training Corporation with offices at 185 Madison Ave., New York City.

Oskar Kylin, for six years connected with the Warner & Swasey Co., Cleveland, Ohio, for the past few years as head designer, has taken a position with the Foster Machine Co., of Elkhart, Ind. Mr. Kylin was responsible for the designing and perfecting of the Warner & Swasey 2A and 3A turret lathes and the No. 4 universal screw machine now well known to the trade. He has also designed several other machines which are to be put on the market in the near future.

Joseph A. Horne was elected second vice-president of the Yale & Towne Mfg. Co., at a meeting of the board of directors held in April. Mr. Horne will retain his present position and title as general superintendent. He has been over twenty-four years in the company's service, and as general superintendent is responsible for the entire management of the Stamford works and of all the manufacturing operations of the company, including those of its Canadian plant at St. Catherines, Ont. His election as a vice-president is in recognition of his successful administration in the past, and of the ability that he has shown in discharging the duties of his responsible position.

OBITUARIES

Hugo Friedmann, a machine designer of considerable reputation and a contributor to MACHINERY, was killed in Detroit, Mich., February 20, by being struck by an automobile.

Rev. Dr. Josiah Strong, organizer and president of the American Institute of Social Service and founder of the "Safety First" movement, died April 28 in the Roosevelt Hospital, New York, aged sixty-nine years. Dr. Strong was associated with Dr. William H. Tolman in the early days of the safety movement and was active in founding what afterward became the American Museum of Safety.

Fred A. Welles, inventor of a friction adjustment for machinists' calipers, died at the home of his father, J. C. Welles, in Milwaukee, Wis., May 14, following an illness of a few days, aged fifty-two years. Mr. Welles was born in Milwaukee;

after having secured an education in the public schools, he entered the E. P. Allis Co.'s Reliance Works, where he learned the machinists' trade. In early youth he showed great aptitude for things mechanical and built steam engines, boilers and other apparatus in his father's gun shop with remarkable ingenuity. The originality and skill displayed bordered on the marvelous, considering the age of the boy. He invented many things besides the friction adjustment for calipers, among which were an improved valve gear and governor, and a surface gage having novel features; in all, he made over one hundred inventions, but these were never patented owing to continued ill health. He placed the Welles caliper on the market in 1889. In 1894 he became greatly interested in the gas engine and built a number of different types. He was among the first to enter the automobile field, and built a car having several original features, such as the planetary gear, cantilever springs, etc. In 1905 he moved to Waukesha, Wis., where he took his tool business; but continued ill health forced him to dispose of the business to one of his former employes, A. J. Machek. With his passing, the world of mechanics has lost another master of tools, and one, like the late Dr. John E. Sweet, gifted with ability to make sound deductions and clear, comprehensive explanations of mechanical principles.

JOHN E. SWEET

John E. Sweet, president of the Straight Line Engine Co., past-president of the American Society of Mechanical Engineers, and one of the best known mechanical engineers in America, died at his home in Syracuse, May 8, aged eighty-three years.

He was born at Pompey, New York, in 1832, and his boyhood, spent on his father's farm, was given up to the varied work that a farmer's boy is called upon to do and to securing a common school education at the local schools of his native town. His mother, Candace Avery, was of the Avery family, which numbered among its members many able mechanics, among them the Avery who patented the first American steam turbine, which was one of the earliest turbines in the world to be put to any practical use. In 1835 several of these were in operation, one being used to drive a saw-mill at Syracuse, N. Y. It is probable, therefore, that young Sweet was by inheritance destined to become a machinist and engineer; and this in spite of his early training, which was in quite a different sphere. That he had a mechanical bent was early evident, one of his achievements as a boy being the construction of a violin, which so pleased his parents that he had the distinction of being sent to take violin lessons—a very unusual event at that time for a farmer lad.

At the age of 18 he was apprenticed to learn the carpenter's and joiner's trade and his time was devoted to carpentry and building until nearly 30 years of age. After completing his apprenticeship he secured a position in the first architect's office opened in Syracuse conducted by Elijah T. Hayden, where he had an opportunity to become familiar with drawings of framed structures and building details. The laying out of such details passed for "architecture" in those days, since the artistic side of building design had not then received much attention, particularly in the smaller towns and cities.

The building plans of Sweet, the architect, bore the stamp of originality that characterized his later work. One of his most successful efforts, from a utilitarian point of view, was a set of plans for a model farm barn; and so great was the call for these that they were several times published in the *Rural New Yorker* and led to a series of articles in this publication by the young architect. His last work as an architect was in connection with the building of a hotel in Alabama, which was in process of construction at the outbreak of the Civil War. In common with many Northerners then in the South, he came North with the opening of hostilities. Later he went abroad, traveling in England and on the Continent, the immediate reason for his trip being the famous London Exposition of 1862. While abroad he contributed a series of letters to a Syracuse paper, showing him to be a versatile writer along popular as well as technical lines.

Singularly enough, the beginning of his mechanical career was made in England. He secured a patent on a nail machine in which the Patent Nut & Bolt Co., of Birmingham, England, took an interest, so he went there and entered their employ while superintending the making of his machines. While there he began writing upon technical subjects, contributing to London *Engineering*.

His mechanical career in America began in 1864 when he was employed by the firm of Sweet, Barnes & Co., of Syracuse, as draftsman. He was here engaged upon a varied line of machines, one of which was a matrix-impressing machine arranged with a keyboard and aiming to do away with the use of movable type. This machine was really a progenitor of the present linotype machine, and the first and only one constructed was exhibited at the Paris Exposition of 1867 and later presented to Cornell University, where it now is.

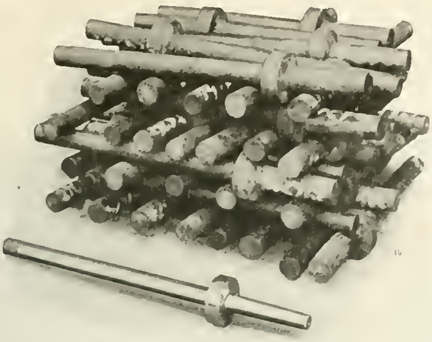
In the early seventies Mr. Sweet's efforts were extended in still another field—that of bridge building. At about this time, however, he had conceived the idea of his Straight Line engine which is inseparably connected with his name and is perhaps his most characteristic piece of work. The features of the engine are too well known to require extended description. Nearly every feature was different from what had been done before. The straight lines of the frame, the oiling arrangement, the governor, the arrangement and location of the flywheel, the substitution of a plain sleeve for piston rod packing, etc., have been much discussed and have influenced machine design in general.

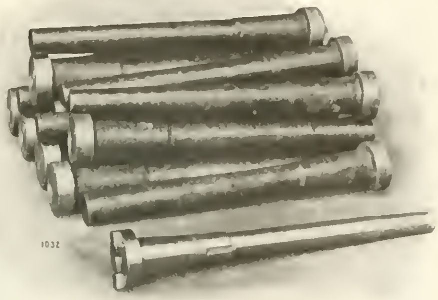
John E. Sweet

Prof. Sweet's connection with Cornell University began in 1873 and terminated in 1879. One of the first college machine shops in the country was established at this institution, and Prof. Sweet gave instructions both in shop work and in machine design. The second Straight Line engine built was made by students in this college shop and exhibited at the Centennial Exposition. The Sweet measuring machine was developed while he was at Cornell and was the first machine for accurate measuring made in this country. He introduced into the Sibley shop the making of scraped surface plates and straightedges, and of ground standard gages, at a time when such auxiliaries to shop processes were considered unnecessary refinements. Another of his Cornell products was the Sweet engine lathe, having a cone of change-gears located in the headstock beneath the main cone of the lathe and so connected that any feed or thread could be obtained without putting on or taking off change-gears as in the ordinary type of lathe. Another feature of this lathe was the support of the bed upon three points, a principle that he had adopted, also, in the Straight Line engine frame.

In this period of six years with Cornell University Prof. Sweet arose from a position of comparative obscurity to one of national prominence. Mechanical engineering as a department of organized education was a new thing. There were no precedents and regarding its practicability there was almost universal skepticism. Its plan, its scope, its aims, were unformed even among its friends—and its friends were few. There were no experienced educators. His work was first that of a teacher, and second, that of a pioneer in mechanical construction. In the latter capacity he laid an enduring foundation for interchangeable manufacturing. His experience as a draftsman in England had shown him the fundamental importance of the work of Joseph Whitworth, which heretofore had found little appreciation in America. Combining a keen appreciation of Whitworth's advanced standards of accuracy with original conceptions of correct principles, he established a school of construction, the influence of which was far-reaching. Along with this went an application of art in design—not the art of organization, but the art of perfect adaptation to purpose.

Shortly after his resignation from Sibley College, the Straight Line Engine Co. was organized at Syracuse, with Prof. Sweet as president and manager. In the building and equipment of this plant his originality was manifest, as always. It was one of the first sawtooth roof shops to be erected in this country and among the tools was a planer-type milling machine, then not a common machine in America,





The Spindles and Arbors of Cincinnati Millers are Chrome Nickel Steel

The spindles have an elastic limit of from 90 to 100,000 pounds. On all machines of High Power design, these spindles have flanged ends and drive face mills and arbors through hardened keys. They are not easily injured. The arbors have an elastic limit of from 130 to 150,000 pounds. They are not so likely to spring.

The keys which drive the cutters do not ruin them so easily, and when subjected to accidents they do not readily acquire a permanent "set."

Bunch these facts together and put them down as another reason why your choice should be

A Cincinnati Miller

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.

designed by him and built at the Straight Line Engine Co.'s works. The conduct of the plant was unique. A feature of greeting was the sign over the door, "Visitors Always Welcome." Prof. Sweet made it a rule to welcome and entertain the callers who had legitimate interests in mechanical engineering work. His shop contained no secrets and he freely gave advice and counsel to all who sought him.

Prof. Sweet was one of the founders of the American Society of Mechanical Engineers, was elected its third president and was accorded the honor of presenting the first paper, in recognition of his untiring services during its organization. He was also later elected an honorary member of the society. He was one of the judges on machine tools at the Chicago Exposition; an expert for the government on gun lathes; and one of the founders and first president of the Engine Builders' Association of the United States. He was honored by many societies. In 1914, Syracuse University conferred upon him the degree of doctor of engineering. He was awarded the John Fritz medal in December, 1914, "in recognition of his achievement in machine design and his pioneer work in applying sound engineering principles to the construction and development of the high-speed engine." It was one of the great disappointments of his career that the reciprocating steam engine was displaced by the steam turbine, and the years of thought, research and labor that he had expended had come to naught. He saw many of his engines taken out and thrown into the scrap heap to be replaced by the steam turbine, but he accepted the changes with philosophical cheerfulness. Dr. Sweet was twice married; his first wife, Caroline V. Fulton, died in 1887, and his second, Irene A. Clark, died last year.

COMING EVENTS

June 12-16.—Midsummer cruise of the Society of Automobile Engineers on the Steamship "Noronic," leaving Detroit June 12 and returning June 16. Reservations can be made by application to W. H. Conant, treasurer, 601 Kerr Bldg., Detroit, Mich.

June 14-16.—Annual meeting of the Master Car Builders Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 14-21.—Annual meeting of the Railway Supply Manufacturers Association at Atlantic City, N. J., in connection with the A. R. M. M. and M. C. B. Associations. J. D. Conway, secretary and treasurer, 2136 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual meeting of the American Railway Master Mechanics Association at Atlantic City, N. J. J. W. Taylor, secretary, 1112 Karpen Bldg., Chicago, Ill.

June 22-23.—Annual meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers in Cleveland, Ohio. Frank E. Sanborn, secretary-treasurer, Ohio State University, Columbus, Ohio.

June 27-July 1.—Annual meeting of the American Society for Testing Materials at Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

June 29.—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

August 15.—Annual meeting of the International Railroad Master Blacksmiths Association, Chicago, Ill. A. L. Woodworth, secretary and treasurer, C. H. & D. Ry., Lima, Ohio.

September 5-8.—Annual convention of the Traveling Engineers' Association at Chicago, Ill. W. O. Thompson, secretary, New York Central Car Shops, E. Buffalo, N. Y.

September 11-16.—Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Columbia University, Morningside Heights, New York City. Announcement of the summer session day and evening courses for July 10 to August 18, 1916.

New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass., has issued a business directory for 1916 containing the names and addresses of the members of this society, revised to January 1, 1916.

Stevens Institute of Technology, Hoboken, N. J., introduced report writing as a requirement for graduation about a year ago. The time given to report writing is one afternoon a week during the second half of the senior year. The present senior class is the first to complete this work. The data for these reports are obtained mostly by a search of the literature on the subject. Experimental work is neither required nor encouraged. The subject of the report is chosen by the senior himself during his first term and is submitted for approval to the head of the department in which it falls. The subjects of the reports which have just been submitted by the seniors at Stevens not only cover branches of mechanical, civil and electrical engineering, but also chemistry, civics, economics and welfare work in industrial organizations.

NEW BOOKS AND PAMPHLETS

The Technical Production of Hydrogen and Its Industrial Application. By Harry L. Barnitz. 11 pages, 6 by 9 inches. Published by the author, 617 W. 152nd St., New York City.

The industrial applications of hydrogen have assumed much importance during the past nine or ten years, and this review of the means of producing hydrogen in large quantities at low cost should interest the heads of many industrial works.

Oil Fuel. By Ernest H. Peabody. 34 pages, 6 by 9 inches. 47 illustrations. Paper presented at the International Engineering Congress, San Francisco, Cal., September, 1915, and reprinted from the Transactions.

The author is an engineer in the marine department of the Babcock & Wilcox Co., New York City, and the subject is treated from the standpoint of the marine engineer. The conditions of oil burning on shipboard are reviewed, and the oil burners and auxiliary apparatus used in oil burning are illustrated and described. Although the paper treats the problem from the marine engineering standpoint, it nevertheless will be of general interest to all concerned with the problem of utilizing oil fuel for steam generation.

Engineering as a Career. Edited by F. H. Newell and C. E. Drayer. 214 pages, 5 by 7½ inches. Published by D. Van Nostrand Co., New York City. Price, bound in cloth, $1.

This book is intended to be an answer to a father's questions, "What can my boy do as an engineer? What should he learn, or where should he go to school?" It is composed of the following essays: "The Engineer and His Profession," by A. J. Himes; "Shall My Boy Become an Engineer?" by Franklin De R. Furman; "Mechanical Engineering," by Worcester R. Warner; "Railway Engineering," by A. W. Johnston; "Hydraulic Engineering," by Chester W. Larner; "Metallurgical Engineering," by J. H. Herron; "Electrical Engineering," by W. H. Abbott; "Chemical Engineering," by M. C. Whitaker; "Iron and Steel Making," by S. T. Wellman; "Marine Engineering," by J. C. Workman; "Sanitary Engineering," by R. Winthrop Pratt; "Municipal Engineering," by Robert Hoffmann; "Municipal Needs," by Rudolph Blankenburg; "Bridge Engineering," by Frank C. Osborn; "Architecture," by Benjamin S. Hubbell; "Mining," by F. B. Richards; "Opportunities for a Mining Engineer," by Henry S. Munroe; "The Lure of Private Practice," by Ernest McCullough; "Vocational Guidance," by James F. Barker; "Scientific Manufacturing and Its Opportunities," by Waldemar Kaempffert; "Incomes of Technically Trained Men," by David Edgar Rice; "Technical Man in Business," by John Ritchie, Jr.

Mechanical Technology. By G. S. Charnock. 635 pages, 5½ by 8½ inches. 503 illustrations. Published by D. Van Nostrand Co., New York City. Price, $3 net.

The author has endeavored to bring together in one volume a connected and systematic account of the chief operations underlying mechanical trades. Under the general head of production and properties of the chief materials of construction the work deals with physical properties of materials; cast iron; wrought iron; steel; crucible cast steel; the Bessemer process; the open-hearth or Siemens process; structure of alloys; alloy steels; heat-treatment of steel; non-ferrous metals; copper-zinc alloys; copper-tin alloys; white metal alloys; properties and uses of stone; cement, asbestos, abrasives, etc.; oils; lubricants; leather; india rubber, etc. Under the general head of preparatory processes, the work deals with the production of castings; methods of molding; chilled castings; the foundry; production of steel castings; pouring molten metal; defective castings; foundry mixtures; aids to molding; operations of forging and stamping; forging machinery; classifications of operations in forging; the smith shop; the forges; examples of heavy forging in iron and steel; drop-forging; production of parts by rolling; wire drawing and wire drawing machinery; the production of tubes; manipulation of metals by flanging, etc. The work is comprehensive and should be of much value as a general reference work, particularly to students in technology, mechanical engineering, etc.

Cost Accounting—Theory and Practice. By J. Lee Nicholson. 341 pages, 6 by 9 inches. Illustrated with forms and diagrams. Published by the Ronald Press Co., New York City. Price, $4.

The author's purpose in writing this book was to provide for the public accountant and cost accountant a reference book dealing in a direct manner with the practical parts of cost accounting; to present the principles and methods of cost accounting in a simple and direct manner; and to furnish the manufacturer with a work containing all the important practical points in connection with cost accounting, summarized and briefly explained. The contents by chapter heads are as follows: Cost Finding and Its Functions; Elements of Costs; Interest in Its Relation to Cost; Principles and General Methods of Cost Finding; Methods of Distributing Indirect Expenses; Wage Systems; Recording the Material and Labor Costs; Compiling the Cost Data; Control of the Cost Records by the Financial Records; The Examination of a Plant; Devising a Cost System; Estimating Cost Systems; Departmental Systems; Special Order System Based on the Productive Labor Method; Special Order System Based on the Process or Machine Method; Product System on the Productive Labor Method, Product System Based on the Machine or Process Method, Forms Relating to Material; Production Orders and Requisitions; Time Reports and Pay-roll Forms; Summaries of Production and Cost; Forms Relating to Finished Product, Sales and Financial Records. The work is one that we believe will be found useful by many manufacturers and plant managers who have experienced difficulties in devising and operating efficient and simple cost accounting systems in their plants.

English and American Tool Builders. By Joseph Wickham Roe. 315 pages, 6 by 9 inches. 57 illustrations. Published by the Yale University Press, New Haven, Conn. Price, $3.

This historical work is timely and interesting. The early books such as Smiles' "Industrial Biography" are out of print, and no one had adequately covered the development of the machine tool building industry since these early works were published. The author says in his preface: "The purpose of this book is to bring out the importance of the work and influence of the great tool builders. Few realize that their art is fundamental to all modern industrial arts. Without machine tools, modern machinery could not be built. Little is known by the general public as to who the great tool builders were, and less is known of their lives and works." It surely is commendable to bring before the public knowledge of machine tools and the parts they play in the industrial world. Many able men display almost total ignorance of the fundamentals of manufacture—the means by which machinery is produced. The work contains twenty chapters with two appendices and a partial bibliography on tool building. Chapter heads in order are as follows: Influence of the Early Tool Builders; Wilkinson and Bramah; Bentham and Brunel; Henry Maudslay; Inventors of the Planer; Gearing and Millwork; Fairbairn and Bodmer; James Nasmyth; Whitworth; Early American Mechanics; The Rise of Interchangeable Manufacture; Whitney and North; The Colt Armory; The Colt Workman—Pratt & Whitney; Robbins & Lawrence; Brown & Sharpe Mfg. Co.; Central New England; The Naugatuck Valley; Philadelphia; The Western Tool Builders. The book gives every evidence of careful preparation and is replete with references to sources of information. It should have a place in the library of every mechanical engineer who is interested in any way in the means of manufacture—and what mechanical engineer is not?

NEW CATALOGUES AND CIRCULARS

Edwin E. Bartlett, 326 A St., Boston, Mass. Catalogue of Greenerd arbor presses.

Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. Circular advertising the "Lea" V-notch recording liquid meter.

Young, Corley & Dolan, Inc., 149 Broadway, New York City. Circular of the "Sterling" 18 by 50 inch, plain, universal or crankshaft grinders with hand or power table feed.

National Engineering & Tool Works, Oak Park, Ill. Circular of the "Neat" high-power fourteen-inch tool-room and manufacturing lathe, with three-step cone and double back-gears.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 11, illustrating the side-squeezing and gripping power of the new type National heavy-pattern forging machines.

National Forge & Tool Co., Erie, Pa. Catalogue descriptive of manufacturing tool-holders for heavy work, and hollow bored forgings, including clamp blocks, planer bolts, U-clamps, spindles, etc.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill. Bulletin 192, describing pneumatic stone tools, stone dressers, air compressors, and equipment for stone yards and monumental work.

Stow Mfg. Co., Binghamton, N. Y. Booklet entitled "Portable Tools of Proven Value," illustrating portable electric tools, motor-shaft combinations and flexible shafts of all sizes from ¼ inch up.

Roth Brothers & Co., Adams and Loomis Sts., Chicago, Ill. Bulletin 212 describing Types C and IX alternating-current motors, which are designed to meet the requirements of low operating and low maintenance cost.

Wallace Barnes Co., South and Parallel Sts., Bristol, Conn. Table of decimal equivalents of fractions from 1/64 to 63/64 inch, varying by sixty-fourths of an inch, mounted on heavy cardboard for convenient reference.

A. & F. Brown Co., 79 Barclay St., New York City. General catalogue 100, of shafting, pulleys, hangers, couplings, pillow-blocks, belt tighteners, and other transmission equipment, containing 129 pages, 5 by 8 inches.

T. P. Walls Tool & Supply Co., 75-77 Walker St., New York City. Circular of the simplex emery band grinder and the duplex emery band and disk grinder for finishing parts that require straight-grain finishes with emery cloth.

Vanadium-Alloys Steel Co., Pittsburg, Pa., has ready for distribution a new folder which describes "Red Cut Superior" high-speed steel, and contains suggestions concerning heat-treatment. A copy will be mailed free upon request.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill. Bulletin E-39, superseding E-36, illustrating and describing "Duntley" heavy-duty portable electric grinders and electric precision grinders for external and internal grinding.

Boston Gear Works, Norfolk Downs, Quincy, Mass. Bulletin treating of worm, spiral and helical gears, giving information as to the relative advantages of these types of drives and the conditions for which each is particularly adapted.

Acme Machinery Co., Cleveland, Ohio. Pamphlet entitled "A Message to the Superintendent and Tool-room Foreman," which illustrates and describes the Acme die grinder and Acme dies with standard die-caps. The correct way to grind a threading die is also shown.

A. G. Butler, Inc., Postal Telegraph Bldg., 253 Broadway, New York City. Leaflet of pattern letters and figures made of white metal and brass for the use of patternmakers, foundrymen, etc., in lettering and numbering patterns for castings. A table of sizes and prices is included.

Crowe Name Plate & Engraving Co., 1749 Grace St., Chicago, Ill. Catalogue illustrating various styles of nameplates, metal labels, signs, tablets and patterns, etc., manufactured by this firm. These plates are made with either sunken or raised letters. Prices and sizes are included.

New Departure Mfg. Co., Bristol, Conn. Leaflets for looseleaf catalogue, Nos. 63FE, 64FE, 65FE and 66FE, descriptive of typical two-bearing mountings, change-speed gearing for machine tools, ball bearing grinding spindles, and ball bearing attrition mill; also table of contents for FE edition.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 34-Q, entitled "A Few Applications of 'Giant' Gas and Fuel Oil Engines." The bulletin shows applications to a vertical triplex pump, horizontal duplex pump, direct-current generator, volume exhauster, fans, hoists, portable air compressors, etc.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 10 gives some facts about forging machine bed frames and illustrates the underslung steel bed frame of the National heavy-pattern forging machine, which is heavily ribbed and webbed in order to give the greatest strength and rigidity.

C & C Electric & Mfg. Co., Garwood, N. J. Bulletin 101 of Type SL motors of the four-pole, interpole type, built in sizes from 1 to 125 horsepower. The bulletin illustrates and describes the details of construction of the parts and contains a complete table of adjustable and constant-speed ratings, with full dimensions of all frames.

Ross Heater & Mfg. Co., Buffalo, N. Y. Catalogue A, describing and illustrating the Ross cross-head-guided expansion joint, for high- and low-pressure steam, oil, gas, and water piping. It is claimed that by the use of a crosshead-guided expansion joint, the pipe lines are kept absolutely free from stress both when hot and when cold.

Cincinnati Planer Co., Cincinnati, Ohio. Pamphlet entitled "The History of the Planer" which traces the history of the planer, step by step, from the earliest design (1751) to the highly developed machine of today. The book contains many illustrations showing the early types of planers compared with the modern Cincinnati planing machines.

Searchlight Co., 1016 Karpen Bldg., Chicago, Ill. Circular on dry vs. wet acetylene, telling why it takes more time and costs more money to make a poor weld with wet acetylene than it does to make a good weld with dry acetylene. The company sells compressed acetylene in cylinders, the cylinders containing 100 cubic feet of free acetylene gas, free from water.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 9023, treating of "Imperial" tie tamping outfits. Form 3026, devoted to Ingersoll-Rogler Class PRE duplex direct-connected, electrically driven air compressors. Pressure charts and tables are given, showing the sizes and capacities of these compressors. Form 3312 of "Imperial XB" duplex power-driven air compressors.

Herman A. Holz, 50 Church St., New York City. Catalogue descriptive of the new type of Brinell portable meter for accurately and conveniently determining the hardness of metal and metal products. This meter is adapted for testing the hardness of metals of any dimensions or shape and in any location. The total weight is 6½ pounds, and it can be carried in a 6 by 9 inch case.

C & C Electric & Mfg. Co., Garwood, N. J. Bulletin 102-X of Type IB motors with commutating poles. These new motors are furnished in ratings up to ten horsepower. They are of the bipolar type, and are built in the open, semi-closed and totally enclosed forms. They are especially suited for direct connection to machine tools, fans and general industrial machinery.

Sprague Electric Works of the General Electric Co., 527 W. 34th St., New York City. Bulletin 48706 of alternating-current, two- and three-phase motors and controllers for flat-bed and small rotary printing presses. Bulletin 48907 descriptive of 500-pound electric hoists, Type 1-5. Bulletin 49600 describing flexible steel armored conductors; flexible steel conduit; stamped steel boxes; and fittings and tools.

Wallace Barnes Co., South and Parallel Sts., Bristol, Conn. Booklet 7, treating of Barnes springs, screw machine products, cold-rolled steel and wire, washers, and stampings. The book contains a number of valuable tables, among which are: table for determining capacities of round wire helical springs; decimal equivalent table; table of standard gages used in the United States; tables indicating size, weight and length of wire, and weight per foot of cold-drawn steel, etc.

Machinery, 140-148 Lafayette St., New York City. Booklet of "Safety Don'ts," containing don'ts for machine operators in general, don'ts for lathe operators, don'ts for drill press operators, don'ts for planer and shaper operators, don'ts for milling machine operators, don'ts for slotter operators, don'ts for boring mill operators, don'ts for grinding machine operators, don'ts for gear hobbers, don'ts for screw machine operators, general machine shop don'ts, don'ts for electricians, belting don'ts, don'ts for crane and hoist operators, don'ts for foremen. Sent free on application.

R. G. Haskins, 541 W. Washington Blvd., Chicago, Ill. Catalogue 10 of "Strand" flexible shafts, portable grinders equipped with flexible shafts, motor-driven toolpost equipment and countershaft equipment. The "Strand" flexible shafts are adapted for external and internal grinding of dies in lathe and shaper, truing lathe centers, and grinding flat gages in shaper; sharpening punches in press without disturbing setting; grinding heavy castings, fins on gears and pulleys; cleaning castings with wire scratch brush; waxing furniture for stencil work; sanding the arms of chairs and removing paint; drilling in metal and boring in wood.

Richardson-Phenix Co., Milwaukee, Wis. Bulletin 5 describing a line of filters for purifying lubricating oil, having capacities of from 25 gallons a day to 50,000 gallons an hour. Some large-size filters for use in purifying lubricating oil from water wheel thrust bearings, large gas and steam engines in steel mills, and also for purifying cutting lubricants are illustrated and described. An idea of the size of the largest filters made may be gained from the fact that the oil connections into some of them are of ten-inch pipe. The catalogue serves to indicate the remarkable advance made in recent years in the science of oil filtration, and it shows how scientific principles are employed in the small as well as in the large filters.

Buffalo Forge Co., Buffalo, N. Y. Bulletin of hand and power punches and shears, showing a line of punches, shears and bar cutters for special work. Reinforced concrete construction has created a demand for powerful hand tools for cutting round, square and twisted bars, and for bending these and structural shapes. The catalogue not only shows these tools but also includes continuous slitting shears, angle-iron cutters that will not distort or flatten the metal, beam punches for channels, T-sections and I-beams; also a variety of power machines for heavier work, all of which are of armor-plate construction, lighter and stronger than cast iron. The new fan erecting shop which the company has just completed contains about 500 tons of structural steel, all of which was fabricated on the premises, using machines of the company's own make.

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Bulletin entitled "The Potentiometer System of Pyrometry," describing the pyrometer based on the use of the thermocouple but differing from the ordinary deflection galvanometer or millivoltmeter pyrometer in that the electromotive force resulting from the difference in temperature between the hot and cold ends is measured by a balancing method rather than by deflection of a needle. Thus, a variable but always known electromotive force is connected into the circuit with voltage opposing that of the couple. A galvanometer is also introduced into the circuit to show when the two voltages are equal, since at this time the pointer will stand at zero. This produces a pyrometer independent of the immersion and resistance of the thermocouple and of the temperature and length of the connecting leads and of the resistance and calibration of the galvanometer itself.

Graton & Knight Mfg. Co., Worcester, Mass. Catalogue 6 illustrating and describing the products made by this company, which include leather, leather belting, lace leather, belt cement, belt dressings, leather packings, strapping, automobile leathers, etc. This book also contains much matter of general interest to those who purchase belting, lace leather, packings and other leather products. The belting section is of unusual interest to buyers of belting, as it describes the characteristic qualities of each grade manufactured and explains why these grades are essential, their differences and capabilities. This section also embodies valuable mechanical rules, tables and formulas to further assist the buyer in determining the proper grade, width and weight of belting for any given drive. Another section of the catalogue is devoted to leather packings, describing all the various kinds, grades and advantages of each. A copy of the catalogue will be sent upon request to executives, purchasing agents, managers, superintendents, mechanical engineers and others interested in the buying of belting and other leather products.

Charles H. Besly & Co., 118-124 N. Clinton St., Chicago, Ill. General catalogue of Besly fine tools, machinists', mill and railroad supplies, brass, copper, bronze and German silver, brass wire cloth, disk grinders, helmet taps, etc.; 771 pages, 6¾ by 9 inches. An idea of the extent of this catalogue will be gained from the fact that the general index covers twenty-two pages. The first section is devoted to brass and the following sections to small tools ordinarily used in the machine shop, arranged in the sequence of their use, namely, drills, reamers, taps, dies, etc. The index or finding list not only contains the manufacturers' names and numbers of the various tools illustrated and described, but also indexes the tools under the common shop nomenclature. Each section of the catalogue is complete and contains tables of information relating to the particular tools illustrated in that section. Thus it is possible to withdraw any section and bind it in a separate binder. For example, the grinder section is issued separately as a condensed grinder catalogue, and this plan can also be followed, when desired, with the brass, drill, tap or any other section. The convenience of this feature is obvious.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Book treating of "Nonpareil" high-pressure covering for high-pressure and superheated steam lines, boilers, breechings, feed-water heaters, tanks, and other heated surfaces. Nonpareil high-pressure covering is composed of diatomaceous earth and asbestos fiber. The former substance is practically pure silica. It is claimed that this covering is a good non-conductor of heat, able to withstand relatively high temperatures without calcining, and is unaffected by moisture, thus making a very efficient material for heat insulation purposes. The book comprises a treatise on the subject of heat insulation, giving the results of tests. Particular attention is called to the comparative tests made at the Beaver Falls factory, which are described on pages 7 to 21. As a result of these tests, it has been possible to fix definitely the heat losses from various sizes of covered and uncovered pipe. These losses are given in B. T. U. per lineal foot, per degree difference in temperature for twenty-four hours, and are tabulated on pages 41 and 42. Tables are also given showing the most economical thicknesses of "Nonpareil" high-pressure covering to use, based on different steam costs, and a complete set of specifications covering the correct installation of these various thicknesses of covering is included. Anyone interested in the insulation of high-pressure and superheated steam lines will find this book of value, and can obtain a copy upon application to the company.

TRADE NOTES

Sibley Machine Tool Co., 8 Tutt St., South Bend, Ind., has changed its name to Sibley Machine Co.

Tropenas Converter Co. has removed its city office from 50 Church St., New York City, to 2243 Nostrand Ave., Brooklyn, N. Y.

Winter Bros. Co., Wrentham, Mass., is building a brick addition to its plant, 125 by 40 feet, to provide facilities for the increased business.

George P. Clark Co., Windsor Locks, Conn., manufacturer of shop trucks, has changed its New York office from 21 Park Row to 116 Nassau St., suite 601.

W. D. Molin & Co., Reading, Pa., manufacturers of machine vises, are increasing their plant facilities by the purchase of a three-story brick building near the present plant.

James Clark, Jr., Electric Co., Louisville, Ky., manufacturer of portable electric drills and grinders, has removed its Chicago office from Machinery Hall to 31 N. Jefferson St.

Atlas Machine Co., Providence, R. I., has removed from 110 W. Exchange St. to the Enterprise Bldg., 7 Eddy St., where a more complete equipment has been provided to increase the manufacturing facilities.

Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich., maker of electric furnaces, pyrometers and heating appliances, opened a branch office at 613 Unity Bldg., 185 Devonshire St., Boston, Mass., in charge of J. E. Hines.

Zeh & Hahnemann Co., Avenue A and Vanderpool St., Newark, N. J., has completed an addition to its plant that will increase the capacity about 25 per cent. The addition will be used as an erecting room and the new office.

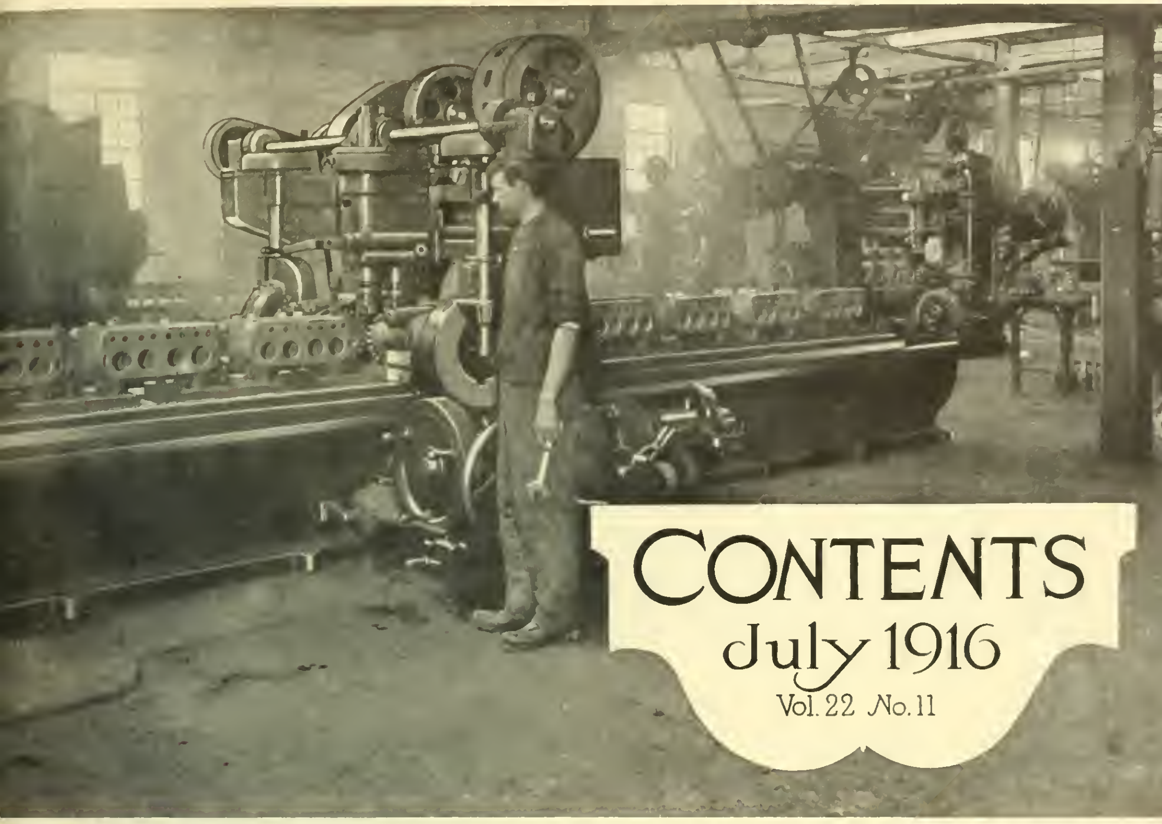
Norma Co. of America, 1790 Broadway, New York City, at its annual meeting elected W. M. Nones president and treasurer. Mr. Nones was formerly secretary-treasurer and general manager of the company, and he will continue to fill the position of general manager.

United Motors Corporation is a $60,000,000 company formed to merge the Perlman Rim Corporation of Jackson, Mich., the New Departure Mfg. Co. of Bristol, Conn., the Hyatt Roller Bearing Co. of Newark, N. J., the Delco Co. of Toledo, Ohio, and the Remy Co. of Indianapolis, Ind.

Worthington Pump & Machinery Corporation, 115 Broadway, New York City, has acquired all the property, assets and business of the International Steam Pump Co. and its various subsidiaries except the Henry R. Worthington Works, of which it holds most of the capital stock.

Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill., manufacturer of "Thor" air and electric drills, pneumatic riveting, chipping, calking and flue beading hammers, has moved its Georgia branch headquarters to Birmingham, Ala. A suite of offices has been leased in the Jefferson County Bank Bldg.

Goddard Tool Co., 341-351 W. Chicago Ave., Chicago, Ill., has been incorporated under the laws of Illinois with $500,000 capital stock, for the manufacture of milling cutters, hobs and special tool work. Paul B. Goddard, formerly with the Illinois Tool Works, is the general manager.



CONTENTS

July 1916

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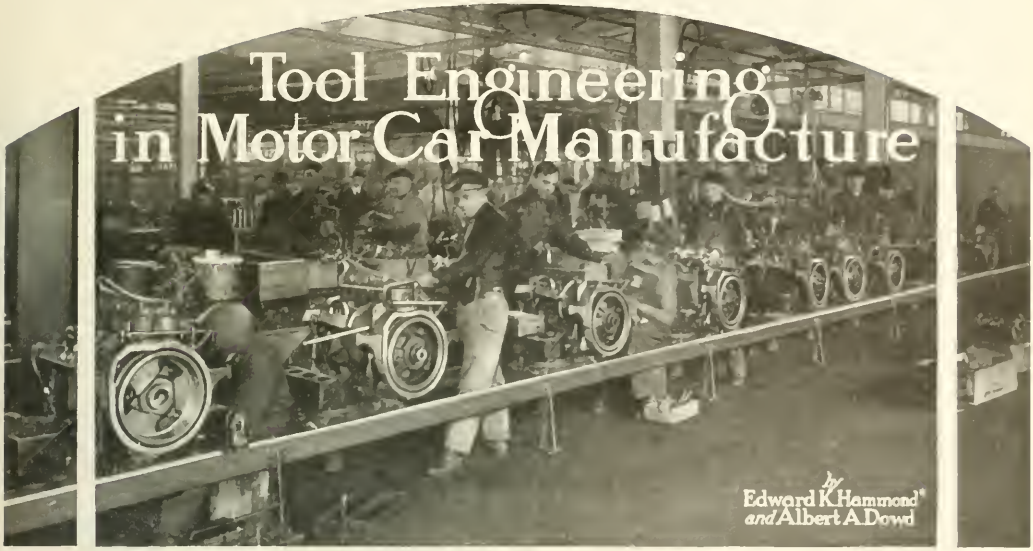
Know Where to Find What Is Known

The time and effort wasted in this busy world doing important things that have already been done, would make us all rich beyond our rosiest visions. Men give their days and nights to the solution of problems already solved, duplicating costly study, research and experiment, when very often the results they seek are already available at a fraction of the original cost.

MACHINERY receives, for example, a great many enquiries clearly indicating the writers' belief that they have come upon problems wholly new in engineering—things that have never been worked out by anybody. But very often the greatly needed data has been published for years. These manifold enquiries relate to every branch of mechanical engineering, ranging from the method of drilling holes in glass, or the direction of spiral for fluting a right-hand end mill, to the method of determining the weight of fly-wheels for punch presses, or the tractive force of a locomotive. Included in this wide range are such subjects as the volume of air and the size of fan required for heating a machine shop by the fan-heater system, the pressure required for making a six-inch forcing fit, excess allowance in dimensions required for bending a No. 10 gauge sheet steel article provided with six bends, the proper pitch of broach teeth and derivation of the Grant formula for determining the cutter for milling spiral gears. Those mentioned are typical of the enquiries recently received for which all the necessary data and tables are contained in engineering literature available to everybody.

Any man engaged in engineering work today may consider himself quite well informed if he knows where the data he needs or may hereafter need, can be found when wanted. He need carry but a very small percentage of this definite, specific information in his head—but it is of the utmost importance that he should carry in his head the recollection of what data are in existence and where they can be found. Of all the instruments of his art or business, nothing is quite so valuable to him as the vast fund of definite information worked out in actual practice, at great cost, by generations of engineers, past and present.

Know *where* to find *what* is known.



SUCCESS in any line of interchangeable manufacture depends to a large extent upon the care that is taken in planning machining operations and designing jigs and fixtures. This fact is shown by the unusually high rates of production and large returns from labor and investment in plant obtained in the automobile industry. Probably there is no line of manufacture in which the performance of machining operations along preconceived lines has found such wide application, and in which the work is done according to the actual requirements of the operation, regardless of what may be current practice on similar work. The man who looks after the work of planning operations and designing jigs and fixtures is generally given the title of tool engineer, and in order to handle this work successfully, he must have certain well defined qualifications. It is of the utmost importance for him to possess a wide knowledge of machine tools and methods of performing machining operations; and he must keep constantly posted in regard to the latest equipment used in the manufacture of interchangeable parts. The tool engineer must also be thoroughly familiar with the physical properties of all classes of metals used in constructing the product of the company by which he is employed, and with the cutting speeds and feeds which can be employed in machining these materials. Last, but not least, the tool engineer should be an experienced draftsman, and he should have sufficient knowledge of freehand sketching to enable him to express his ideas rapidly on paper.

The distinction between manufacturing and building machines is that manufacturing is generally understood to involve the quantity production of machine parts which can be assembled with little, if any, hand fitting, while building is understood to have reference to making a smaller number of parts which are fitted by hand. Manufacturing requires the use of special tools, jigs and fixtures; and the manufacturer's profits will depend to a large extent upon the care and skill with which the planning of machining operations and the designing of special tool equipments are carried out. The preliminary planning of machining operations has obtained wide application in the automobile industry, and the present article discusses the methods employed in planning; the conditions which govern the design of jigs, fixtures and special tools for each operation; and the principles involved in estimating production after the methods of machining have been decided upon and the design of tool equipments for these purposes has been completed. For the purpose of discussion, this article deals directly with the preliminary work involved in preparing for the manufacture of certain important parts of an automobile engine; but attention is directed to the fact that practically all the information presented is of a general character and capable of application to the interchangeable manufacture of a great variety of other products.

When the design of a new car has been passed by the engineering department of an automobile factory and a decision has been reached to place it on the market, the first step in taking up the manufacture of this car will be to send blueprints of all parts to the office of the tool engineer so that he may study the design of each part, lay out the order in which the machining operations are to be performed, and design jigs and fixtures for these machining operations. For the purpose of discussion in this article, we shall assume a case in which a factory previously engaged in automobile manufacture has adopted a new design of engine to be used in a car that this company is about to place on the market. In such a case the factory will be provided with practically all of the machine tool equipment required for the machining operations, so that the work of the tool engineer will be confined to the planning of operations and the design of the necessary jigs and fixtures.

When blueprints of the motor parts have been received by the tool engineer, and he has been given instructions to proceed with the design of jigs and fixtures for these parts, his first step will be to refer to the design of corresponding parts of the preceding type of motor and the tools used for machining them. This is done to ascertain whether or not any of the tool equipment formerly used can be changed at a moderate cost to adapt it for use in the manufacture of parts of the new engine. It almost always happens that many of the tools can be utilized in this way, but attention must be paid to the fact that all automobile manufacturers are continually called upon to furnish repair parts for obsolete types of motors of their manufacture. Such parts are generally made in lots of about one thousand, and are distributed to the service departments of the company, which are maintained in most important cities. For use in the manufacture of these parts, at least one complete set of jigs and fixtures is kept on hand. Card files are maintained to show the position of these tools in storage bins, and the bins are conspicuously numbered so that any particular lot of tools can be easily located.

Importance of Cooperation Between Tool Engineer and Chief Designer

In starting his work, the first point considered by the tool engineer is the character of the parts to be machined and the method of holding which appears to be most suitable for each particular case. In order to secure the most satisfactory

*Associate Editor of MACHINERY.

results, the tool engineer and the chief designer of the engineering department should work together. The reason for this is that the designer is not usually an expert on the performance of machining operations, and so he should secure the advice of the tool engineer in order to be sure that the design of all parts of the motor shall not only be perfectly suited to the service required of them, but that they shall also be made in a way which will enable them to be conveniently held while being machined. A few minutes devoted to conferences between the designer and tool engineer at specified intervals would often be the means of effecting large savings in the cost of manufacture, as it sometimes happens that many castings are made before it is found that they are of such a form that special means should have been provided for holding them. Had such a conference been held before the castings were made, it would have been an easy matter for the tool engineer to suggest the provision of lugs or recesses on the castings to engage clamps provided on the fixture. These conferences should be held before the drawings are sent to the pattern shop, so that after the design has once been approved by the chief draftsman and tool engineer, they may be circulated through the factory with the assurance that no subsequent trouble will develop.

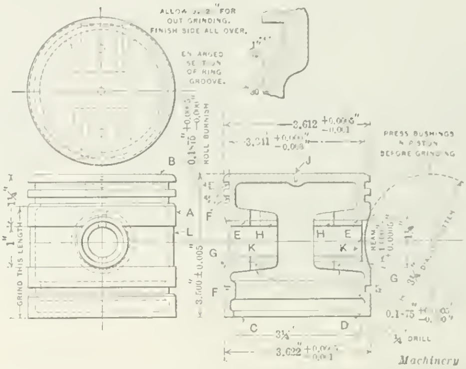
Subdivision of Tool Engineer's Work

It is a general principle of tool design that the method of procedure must be governed by the number of pieces to be produced, because it is obvious that a certain relation should exist between the cost of the jig and the amount of work to be produced in it. But although the tool engineer in an automobile factory pays a certain amount of attention to this point, it is not a matter which concerns him so vitally as it does the tool designers employed in some other lines of manufacture, because the average automobile factory has such a large production that any reasonable expenditure is warranted, provided it furnishes a means of handling the work with the maximum efficiency. In the following article it is assumed that equipment is being provided for a shop which is to pro-

TABLE I. OPERATION AND TOOL LIST FOR PISTON—COMPLETE FORM AS USED BY TOOL ENGINEER

Piece No. 5055

Name, Piston



Pattern No. M 18

Material Cast Iron

Operation No.	Operation	Type and Size of Machine	Location Points	Tools, Fixtures and Gages	Tool Drawing No.	Tools Ordered, Date	Estimated Hourly Production per Machine	No. of Machines
1	Pickle to remove sand and scale	Pickling bath	....	Sulphuric acid	......	....	..	..
2	Rough-turn outside A and face end B	Semi-automatic chucking machine	Inside of cored surfaces	Expanding air chuck. Turret and cross-slide tools	F-2160 F-2161	9 3 15 9 5 15	28 ..	3 ..
3	Face open end C, bore and ream hole D	Turret lathe, 2 by 26	Outside machined surface	Soft jaws for 12-inch chuck. Two boring-bars—one reamer 3.250 inch	C-3612 C-3612	9 5 15 9 5 15	60 ..	2 ..
4	Drill wrist-pin hole E	Duplex horizontal drill	Faced open end and inside bosses	Drilling fixture. 15 16-inch high-speed steel drills	F-2162 Stock	9 8 15	72 ..	2 .
5	Finish-turn outside A, face end B and rough out ring grooves F	Semi-automatic chucking machine	Open end	Draw-back chuck with pin through wrist-pin hole. Turret and cross-slide tools	F-2163 F-2164	9 11 15 9 11 15	35 ..	3 ..
6	Rough- and finish-ream wrist-pin hole E	Turret lathe, 2 by 26	Open end and drilled hole	Pot fixture. Locating bar. Rough and finish piloted reamers of floating type	F-2165 F-2166	9 13 15 9 13 15	60 ..	2 ..
7	Mill relief G around wrist-pin hole	Horizontal milling machine	Open end and drilled hole	Indexing fixture with stud. High-speed steel milling cutters 3¼ by 2 inches	C-3615 Stock	9 13 15	60 ..	2 ..
8	Press bronze bushings H into wrist-pin hole	Arbor press	Outside and drilled hole	Special fixture. Shouldered bar	F-2167 F-2167	9 15 15 9 15 15	100 ..	1 ..
9	Center-drill and countersink closed end at J	Sensitive drilling machine	Outside and open end	Special plate jig. Combination drill and countersink	C-3617 Stock	9 15 15	100 ..	.. ..
10	Drill oil holes K in bosses	Two-spindle sensitive drilling machine	Inside bosses	Jig plate with V-blocks to drop over bosses M. ¼-inch high-speed steel drills	F-2168 Stock	9 20 15	100 ..	1 ..
11	Cut wide oil groove L	16-inch engine lathe	Open end and center	Special nose-piece with driver. Wide forming tool	F-2169 A-1360	9 21 15 9 21 15	80 ..	1 ..
12	Rough-grind outside A of piston	Plain cylindrical grinding machine	Open end and center	Special nose-piece with driver. Grinding wheels—crystolon K-30. Limit gages	F-2172 Stock	9 21 15	30 ..	3 ..
13	Finish-grind outside A of piston	Plain cylindrical grinding machine	Open end and center	Special nose-piece with driver. Grinding wheels—crystolon K-30. Limit gages	F-2172 Stock	9 15 15	30 ..	3 ..
14	Rough-ream wrist-pin bushings H	Turret lathe, 2 by 26	Open end and drilled hole	Pot fixture (see Operation 6) Locating bar. Roughing piloted reamer	F-2165 F-2166	9 17 15 9 20 15	60 ..	2 ..
15	Finish piston ring grooves F	16-inch engine lathe	Open end and center	Special nose-piece with driver. Burnishing tools for grooves	F-2169 F-2169	9 22 15 9 22 15	40 ..	2 ..
16	Finish-ream wrist-pin bushings H	Bench	....	Holding fixture. Special reamer	C-3621 C-3621	9 25 15 9 25 15	80 ..	1 ..
17	Inspect	Bench	....	Special gages	F-2172	9 27 15	..	..

duce two hundred motors in a ten-hour working day. The tools are designed on this basis and rates of production are calculated with the view of determining the number of machine tools, jigs and fixtures which must be provided for each operation in order to secure this rate of production. The order in which the tool engineer handles his work is as follows: (1) Planning the order of operations. This includes a consideration of the effect of the design of each part to be machined upon the method of machining. (2) Deciding on what type of machine each operation is to be performed. (3) Selecting locating points on the work for each operation. (4) Designing the necessary jigs, fixtures and tools. (5) Making the tool drawings. (6) Estimating the rate of production that can be obtained for each operation, in order to determine the number of machines and tools that must be provided to produce the required number of parts. As each motor part is taken up, the tool engineer decides upon the best order in which to perform the machining operations and then makes out an operation and tool list, such lists being included in connection with this article for the large parts of an automobile engine. Table I shows the list made out for the piston, the form presented being the same as that actually used by a successful tool engineer. Other tables showing operation and tool lists for important motor parts have been somewhat condensed in order to present the information without taking up an unnecessary amount of space. In all cases, the necessary number of views of the part to be machined are presented at the top of the operation and tool list, to show all surfaces to be finished. In the present case, all finished surfaces have been marked by reference letters in order that they may be readily connected with the data presented in each table. Each operation and tool list gives all necessary information concerning individual machining operations, the types of machines used, the tools with which these machines are equipped, and the estimated hourly production per machine, together with the number of machines required to give a production of two hundred motors in a ten-hour day. The part number of the piece to which the operation and tool list refers is also given on the form to facilitate identification. By looking over these operation and tool lists, it will be evident that the most careful planning has been done to be sure that the method of manufacture adopted is well suited to the requirements of each case.

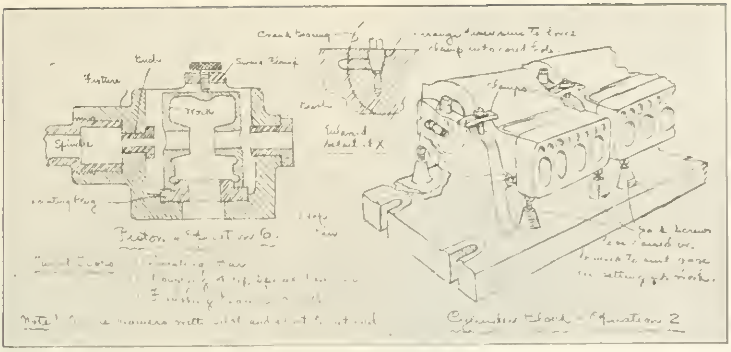


Fig. 1. Examples of Free-hand Sketches made by Tool Engineer to explain his Ideas to Tool Designers, illustrating Operation 6, Table I, and Operation 2, Table III

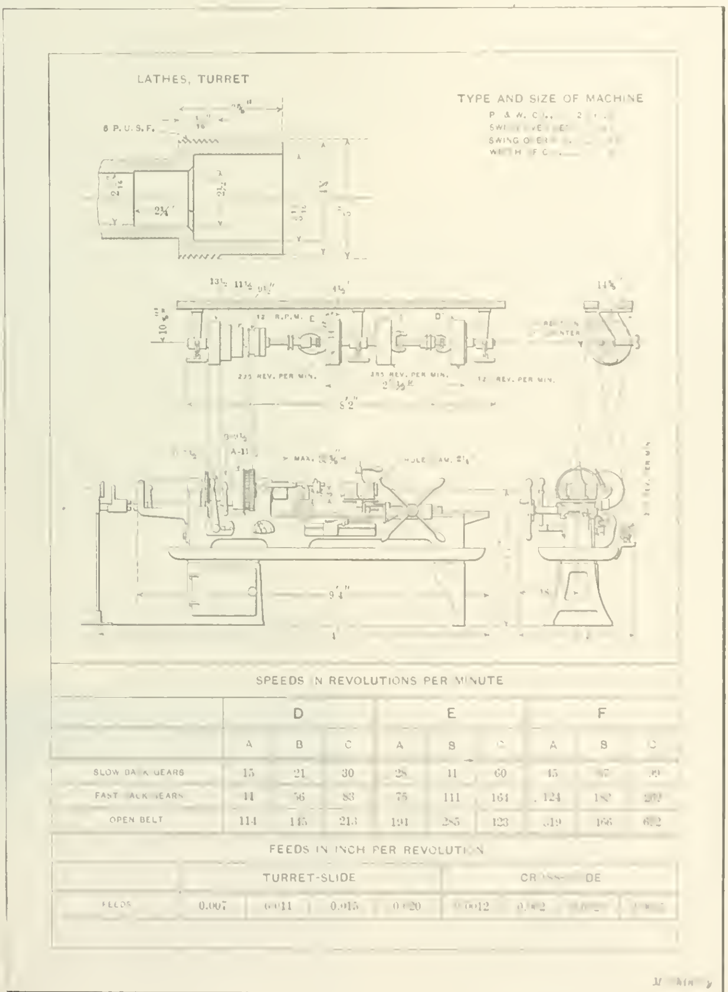


Fig. 2. Sheet from Tool Engineer's Loose-leaf File of Machine Tool Equipment giving Available Speeds and Feeds on Machines and Important Dimensions affecting Design of Tools and Fixtures

TABLE II. SPEEDS AND FEEDS FOR ROUGHING AND FINISHING CUTS

Material	Roughing Cuts		Finishing Cuts	
	Surface Speed, Feet per Minute	Feed, Inch per Revolution	Surface Speed, Feet per Minute	Feed, Inch per Revolution
Aluminum, Commercial	600	0.030	600	0.040
	400	0.040	...	0.030
	300	0.040	...	0.020
Brass, Composition	150	0.030	200	0.030
	120	0.040	...	0.020
	100	0.040	...	0.015
Brass, Yellow	250	0.030	300	0.040
	200	0.040	...	0.030
	150	0.040	...	0.020
Bronze	100	0.030	150	0.030
	70	0.040	...	0.020
	40	0.040	...	0.015
Castings, Gray Iron	60	0.040	80	0.500
	50	0.062	...	0.250
	40	0.125	...	0.125
Castings, Machine Steel	70	0.020	100	0.040
	60	0.025	...	0.030
	50	0.030	...	0.020
Castings, Malleable Iron	80	0.040	120	0.062
	60	0.050	...	0.040
	40	0.062	...	0.030
Forgings, Alloy Steel	60	0.015	75	0.020
	50	0.020	...	0.015
	30	0.025	...	0.012
Forgings, Machine Steel	70	0.020	100	0.025
	60	0.025	...	0.020
	50	0.030	...	0.015
Forgings, Tool Steel	50	0.012	70	0.020
	40	0.020	...	0.015
	35	0.030	...	0.012
Steel, cold-drawn or Rolled	100	0.030	150	0.025
	75	0.040	...	0.020
	60	0.050	...	0.015
Steel, Machine	70	0.020	100	0.025
	60	0.025	...	0.020
	50	0.030	...	0.015

Machinery

After planning the order of operations and deciding upon the type of machine on which each operation is to be performed, the tool engineer is ready to take up the design of jigs and fixtures. When he has decided upon the best method to follow in performing each machining operation, he calls in draftsmen from the tool designing department and explains the general requirements for each tool. The tool designers are experienced men, and much of the detail work is left to their judgment. For instance, the tool engineer will not specify the form of clamping mechanism to employ in each case, as he knows that his assistants in the tool designing department are thoroughly competent to handle this part of the work. But in many cases, where the method of machining is somewhat complicated and the tool engineer feels that there is a possibility of misunderstanding his instructions, he will make a free-hand sketch while he is explaining his ideas to the tool designer. This sketch is taken back to the drafting-room and constitutes the best possible form of memorandum for the designer in carrying out the instructions of the tool engineer.

Application of Free-hand Sketches in Tool Engineering

In connection with the work of the tool engineer, the ability to make good free-hand sketches rapidly is a valuable asset, as previously stated. Much time that would otherwise be required to explain his ideas can be saved by a judicious use of free-hand sketches. These can go into more or less detail, according to the complexity of the idea; but they should always clearly show the principle involved, so that the designer will not be obliged to come to the tool engineer with too many questions. The sketches reproduced in Fig. 1 give suggestions for handling Operation 6, Table I, and Operation 2, Table III, and are excellent examples of the way in which information can be conveyed by free-hand sketches. It will be noticed that all important points are shown on the sketches, so that the tool designer will not be compelled to do anything more than follow instructions.

The usual practice in designing tools for use in machining motor parts and similar work, would be to turn over to one tool designer the operation and tool list, and allow him to proceed with the designing of all tools for machining a particular piece, following the sequence of operations in their proper order. This is the ideal method, but it is subject to variation, depending somewhat upon numerous conditions, such as the number of jigs and fixtures required for machining the piece. When there are a large number of jigs and fixtures to be designed for any one piece, such as the cylinder block, it will be found advisable to have several designers working on the tools simultaneously in order to avoid delay. Another method which is sometimes used in large factories where a number of tool designers are employed is to divide the various men up into groups of three, four or six, and place each of these groups under the control of a capable designer who is also an experienced draftsman. An arrangement of this sort works out very nicely in practice, and relieves the tool engineer of the necessity of answering numerous questions in regard to points on which the tool designers want additional information. Such a group of draftsmen can be assigned to designing the tools for machining one piece for which a number of jigs or fixtures are required, and these men can work together and complete the designs very rapidly.

It is well to note at this point that a mistaken idea of economy exists in some factories in regard to the method of handling the work of tool designing. At certain seasons of the year, when a great number of new fixtures are to be made, a proportion of the drafting-room force is switched off to assist with the tool designing, although these men may or may not be adapted to the requirements of this particular class of work. A man may be a good designer of automobile parts and still be utterly incapable of giving satisfaction on tool design, because of lack of knowledge in regard to the most efficient methods of conducting machining operations and the conditions that must be fulfilled by jigs and fixtures. Such features as the provision of chip clearance, selection of the best locating points, and many other details which would be taken care of instinctively by an expert tool designer would puzzle the draftsman unfamiliar with this class of work, with the result that he is likely to neglect them. On this account it is advisable to secure the services of men on tool design who have had a number of years' experience in the shop, followed by the necessary drafting-room experience to make them proficient. It is poor economy for any concern to employ its regular drafting-room force for this purpose, unless it is well aware of the capabilities of certain of the men along these lines. In addition, the average designer on automobile work does not like to be shifted to tool design, as he prefers to specialize on his own particular line of work. However, this is a mistaken idea on the part of a designer, as he will find that the knowledge gained in tool design will be valuable to him in many ways in connection with other work.

Points to be Considered in Tool Designing

In making the tool drawings, the designer is governed entirely by the operation and tool list and the tool engineer's sketches, together with verbal instructions which he may have received in going over the matter with the tool engineer.

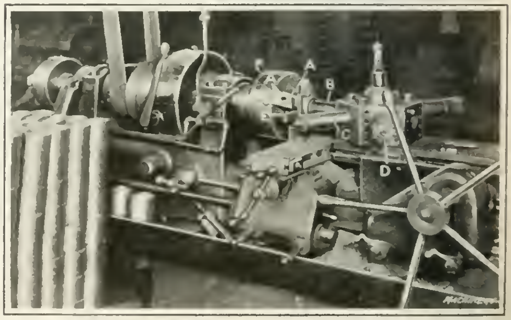


Fig. 3. Bardons & Oliver No. 7 Turret Lathe equipped with Hannifin Three-jaw Air Chuck and Tools for facing Open End of Pistons and boring and reaming Hole at End

In the first place, the design of each tool must provide for securing the required degree of accuracy in the work. When the number of parts to be produced is as great as that in the case under consideration, it is essential for every possible refinement to be incorporated in the design of the jig or fixture in order that there may be as little delay as possible in setting up and removing the work. For instance, the provision of quick-acting clamps may be the means of making a noteworthy reduction in the time occupied in setting up the work. The question of cleaning the fixture or jig should also be carefully studied and no deep pockets should be left in which chips will accumulate and cause trouble in obtaining correct locations. Whenever possible, the parts most subject to wear should be so designed that new parts can be quickly substituted when the old ones have worn beyond the required limits of accuracy, as the time lost in repairing tools is otherwise likely to be a serious matter. The provision of means for clamping the work and holding it in the correct position while being machined should also be very carefully studied; and all clamping devices should be both rapid and convenient to operate, as well as so designed that there will be no possibility of the piece being cramped or thrown out of its true position when clamping. Many of these points are considered, and methods suggested, at the time that the tool engineer outlines his ideas to the tool designer. In making up each drawing, the position of the work should be indicated by either a dotted or a red line, so that the purpose of each part of the jig or fixture will be evident to the toolmaker.

There are a number of important details in connection with the making of tool drawings which are taken care of in various ways, according to the system in vogue at the particular factory where the work is being done. To facilitate the work of toolmaking, it is essential to include on the completed drawing a bill of material, which gives the amount of stock required in making the jig or fixture, with the necessary allowance for finish. When this is done, the completed drawing goes to the ordering-in department, where the order is issued for the various materials needed in the construction of the tool. A still better way to handle this matter is to have the tool designer issue orders for the stock on regular stock cards, which are attached to the tool drawing by clips after the drawing has been completed, thus showing the tool-room foreman what stock is required for the job. Upon completion of the drawing, it goes to the tool engineer, who looks over the general points of construction and features of design, and makes any suggestions which he may deem advisable. After he has approved the drawing, it goes to the checker, who carefully goes over all dimensions to be sure that there are no errors when it is sent to the tool-room accompanied by an order to make the tool. Just exactly why this precaution is frequently omitted in connection with tool drawings it is hard to say, but the fact remains that many of them are allowed to go directly to the tool-room. It follows, therefore, that any errors which occur are either discovered by the toolmaker while doing his work or else they go through without discovery until the fixture is finally checked before it is sent into the shop. Even then, an error may not be discovered unless the work which has been machined in the fixture is inspected to see that it conforms to the requirements of the blueprint of the engine part. In cases where several jigs or fixtures are to be made for machining the same piece of work, it is especially important for the drawings to be carefully checked in order to see that no errors occur. In this particular instance, we shall assume that the drawings have been checked and O. K.'d by the tool engineer, after which they are ready to be sent to the tool-room.

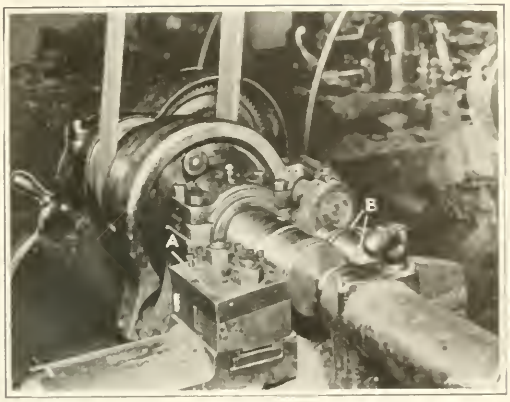


Fig. 5. Cincinnati Lathe & Tool Co.'s 16-inch Engine Lathe tooled up for turning and burnishing Ring Grooves in Pistons

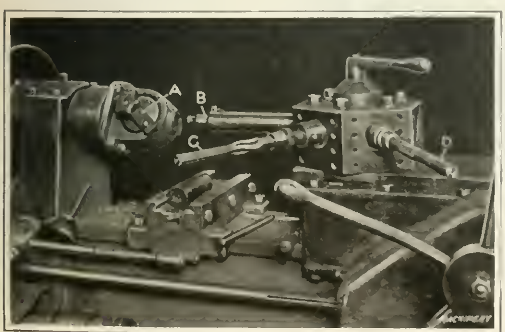


Fig. 4. No. 5 Bardons & Oliver Turret Lathe tooled up for reaming Wrist-pin Hole in Pistons

Making Tool Drawings

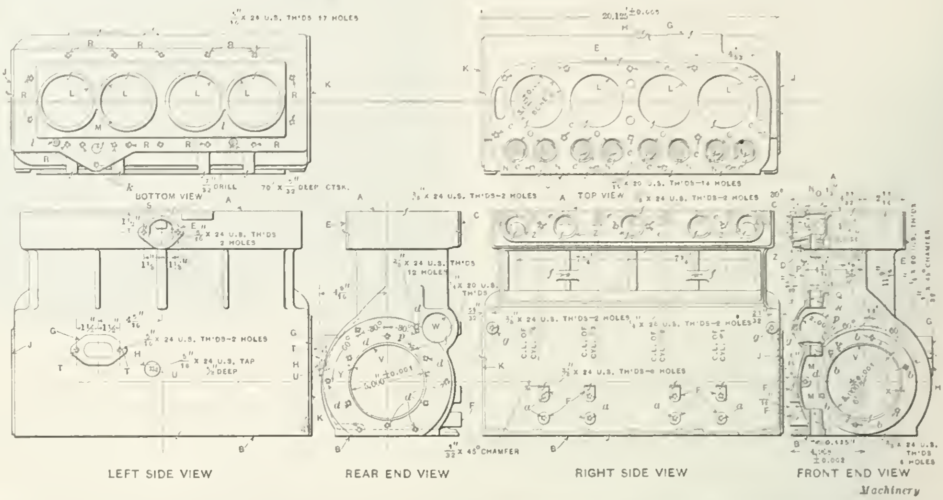
Several methods are employed by different factories in making their tool drawings. One of these is to make the drawings in lead pencil on manila paper, and send them out to the tool-room after they have been varnished and attached to a board. Another method is to use tracing cloth (not paper) on the rough side of which the tool drawing is carefully laid out in pencil. A No. 3 pencil gives very good results in printing and will not smudge appreciably. The objection may be raised that the use of tracing cloth for making tool drawings is too expensive; but it will be found that although the first cost is somewhat greater than when manila paper is used, the convenience and time-saving features will more than offset this difference in cost. It may also be said that a pencil drawing made on tracing cloth will be smudged and made illegible, or that the blueprints taken from such a drawing will not be sufficiently clear. But several of the large machine tool builders in this country are securing excellent results from this system at present, which should be sufficient to vouch for its practicability. The use of tracing paper is not to be commended on account of the wear and tear to which it may be subjected in handling.

There are a number of advantages secured through the use of tool drawings made on tracing cloth. One of these is that blueprints can be made which can be sent to the pattern shop and to the toolmaker, while additional copies can readily be made if, for any reason, other departments may require them. Another advantage is that in redesigning or making over a jig or fixture to meet the requirements of a new model or design, the pencil marks on the tracing can be easily rubbed off and the necessary changes made with very little labor. In addition to this, it may be desirable to keep a record of the original tool drawing, which can be easily done by making a blueprint and marking it "record print." This can be filed in its proper place and referred to at any time.

Use of Filing Systems and Care of Tool Drawings

An excellent system for filing tool drawings and lettering them so they can be easily found is to standardize the various sizes of sheets; for example, 9 by 12, 12 by 18, 18 by 24, 24 by 36 inches, etc. Each of these sizes is designated by a letter, as "A" for the 9 by 12 size, "B" for the 12 by 18 size, etc. It is also advisable to have one letter to designate extra sizes

TABLE III. MACHINING OPERATIONS ON CYLINDER BLOCK—MATERIAL, CAST IRON



Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Pickle to remove sand and scale	Lead lined baths	....	....	..	..
2	Mill top and bottom surfaces A and B, valve port faces C and valve dust plate seat D	20 by 20 inch by 18 foot planer type milling machine	Special fixture; holds eight blocks. Inserted-tooth cutters. Setting up gages	Crankshaft bearing holes and valve chamber	15	2
3	Drill and ream two dowel-pin holes in base (not shown)	Two-spindle 16-inch vertical drilling machine	Drill jig with slip bushings. Quick-change chucks	Milled top surface A and valve dust plate seat D	22	1
4	Mill pad E for water intake pipe	No. 1½ horizontal milling machine	Clamping fixture. Inserted-tooth milling cutter	Dowel holes	22	1
5	Rough-mill seat F for magneto bracket, breather pipe boss G and oil dial boss H	No. 2 horizontal duplex milling machine	Clamping fixture. Inserted-tooth milling cutter	Dowel holes	22	1
6	Finish-mill seat F for magneto bracket, breather pipe boss G and oil dial boss H	No. 2 horizontal duplex milling machine	Clamping fixture. Inserted-tooth milling cutter	Dowel holes	22	1
7	Rough-face ends J and K of cylinder block	20 by 20 inch by 18 foot planer type milling machine	Special fixture; holds ten pieces. Inserted-tooth milling cutters	Dowel holes	20	1
8	First rough-bore cylinder holes L	Four-spindle vertical cylinder boring machine	Work-holding fixture, cutter-heads and bars	Dowel holes	20	1
9	Second rough-bore cylinder holes L	Four-spindle vertical cylinder boring machine	Work-holding fixture, cutter-heads and bars	Dowel holes	22	1
10	Drill, ream and plug cored holes (not shown) at each end of valve chamber	Two-spindle 25-inch vertical drilling machine	Angle-plate fixture with locating pins and clamps	Dowel holes	20	1
11	Finish-bore cylinder holes L	Four-spindle vertical cylinder boring machine	Work-holding fixture, cutter-heads and bars	Dowel holes	22	1
12	Inspect cylinders for finish and diameter	....	Limit gages	....	..	..
13	Drill and ream pump shaft holes M	26-inch vertical drilling machine	Quick-change chucks. Drill jig	Dowel holes	24	1
14	Inspect alignment of pump shaft holes M	....	Gages	....	..	..
15	Bore and face valve seats N and holes O, drill and ream valve stem and push-rod guide bushing holes P and Q, respectively	Eight-spindle vertical drilling machine	Drill jigs and jig plates	Dowel holes	24	4
16	Hand-ream valve stem and push-rod holes P and Q, and test alignment	....	Special reamers. Limit gages	....	5-6	4 men
17	Test water jacket under 60 pounds water pressure per square inch	Special machine	Pressure gages	....	20	1
18	Drill fourteen bolt holes R in base	Sixteen-spindle drilling machine	Special jig plate and fixture	Dowel holes	22	1
19	Drill two holes S in water intake pad, two holes T in breather pipe pad and one hole U in oil dial boss	Eight-spindle drilling machine	Special fixture and jig plate	Dowel holes	25	1
20	Rough-bore hole V for crankshaft bearing and hole W for cam-shaft bearing	Duplex No. 5 boring machine	Fixture	Dowel holes	20	1
21	Finish-bore for crankshaft bearing V and cam-shaft bearing W, face off bearing bosses J and K, and chamfer crankshaft bearing hole at X and Y	Duplex No. 5 boring machine	Combination boring and facing tools	Dowel holes	15	2
22	Hand-ream cam-shaft bearing hole W	Bench	Fixture and special reamers	....	25	1
23	Counterbore ports Z for intake and exhaust manifolds	Five-spindle vertical drilling machine	Special five-spindle drill head jig	Cam-shaft bearing holes, cylinders and faced side of casting	25	1
24	Complete facing ends of cylinder not done in Operation 21	26-inch engine lathe	Faceplate fixture. Raising blocks	Crankshaft bearing holes V	20	1
25	Drill forty-eight holes a, b, c, d, e, f and g in the cylinder block casting from four sides	Special multiple-spindle drilling machine	Work-holding fixture	Dowel holes	30	1

TABLE III. MACHINING OPERATIONS ON CYLINDER BLOCK—CONTINUED

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
26	Tap five holes T, S and U in breather pipe, water intake and oil gage bosses, and spot-face cam-shaft bearing lock-screw holes g	3-foot radial drilling machine	Tapping attachment	Crankshaft bearing holes V	15	2
27	Drill three holes k for holding oil pump and two holes l for holding distributor pipe. Spot-face two holes l	22-inch vertical drilling machine	Quick-change chucks. Plate jig	Top A of cylinder block	20	1
28	Tap fourteen holes a in magneto pads, e in manifold seats, and g in cam-shaft bearing lock-screw bosses	No. 2 automatic tapping machine	....	Crankshaft bearing holes V	15	2
29	Tap twelve holes d in rear end and six holes b in front end of cylinder block	No. 2 automatic tapping machine	....	Ends of cylinder blocks	12	2
30	Tap fourteen holes c in top and seventeen holes R and k in bottom	No. 2 automatic tapping machine	Quick-change chucks	Top and bottom of cylinder block	20	2
31	Drill and tap two holes p for oil distributor tube clip. Hand-tap two holes f for valve dust plate	Sensitive drilling machine with tapping attachment	Quick-change chucks	Finished surfaces on cylinder block	12	2
32	Press eight valve stem guides P into place	No. 5 arbor press	....	....	25	1
33	Hand-ream guide holes P and burr edges and top	Bench	Reamers	....	20	1
34	Hand-seat valves at N	Bench	Piloted valve seating tools	....	20	1
35	Grind in valves	Eight-spindle valve grinder	....	....	12	2
36	Inspect valve seating	Bench	....	....	..	..
37	Wash in hot soda solution to remove grease	Soda kettle	....	....	..	..
38	Assemble valves in cylinder blocks	Arbor press	Fixture to hold down eight valves at a time when inserting locking pins	....		
39	Final inspection	....	Gages and indicators		..	..

which may be necessary in the design of a special machine or an exceptionally large fixture. "X" answers very well for this purpose, and a separate filing drawer should be used for these odd-sized drawings. It is a good idea to put the letter and the accompanying number of the drawing in the lower left-hand corner and again in the upper right-hand corner upside down, so that no matter which way the drawing happens to be placed in the drawer, the number will always be easily seen. A drawing record book should be prepared, containing consecutive numbers under each size and letter; and these numbers should be checked off as they are used. A card file system should also be devised, the cards being arranged numerically by piece-number or alphabetically by the name of the piece, according to the system in vogue in the factory, and the numbers of the drawings which apply to the tools and fixtures on any piece can then be entered on these cards. In this way, a double file is available so that any required tool drawings can be located from their tool drawing numbers or from the name or piece-number of the part on which they are used.

List of Machine Tool Equipment

In the tool engineering and tool design department, a complete list of the machine tool equipment of the factory will be found useful. The requirements will vary according to the machine tool equipment in the factory; but in any case the list should be as complete as possible, and should include the capacity of all machines. In many factories, the tool designer, when at work upon a fixture or jig, is obliged to go out into the factory and measure up the machine on which the fixture is to be used. This is entirely unnecessary when a reference list is kept in the tool engineer's office, as such a list may easily be made to contain all the necessary information for any of the machines in the shop. This list of machine tool equipment may be conveniently kept in a card file; Fig. 2 shows one of the cards from such a file, which gives the dimensions of a horizontal turret lathe. Reference to this illustration will show that the form is so arranged as to give the necessary data on all machines of this type, together with the available feeds, speeds, and general features of construction. There are few ideas which can be applied to tool designing that are capable of saving more time than this system of recording the mechanical equipment of the factory. It requires a certain amount of time and care to compile such a list, and a little work is necessary from time to time to keep it up to date, but the expense involved will be more than offset by the time saved. In the preparation of an index of this kind, outline drawings of different types of machines can usually be found in machine tool builders' catalogues. These outline drawings can be cut out and pasted on a good sized card, say 8 by 10 inches, so that they can be handled without difficulty. If desired, the reference index can be extended to include much other data of value to the tool engineer. This data may take the form of trade journal clippings referring to new developments in machine tools, special tools which have been designed for work similar to that done in the factory, and much other valuable data.

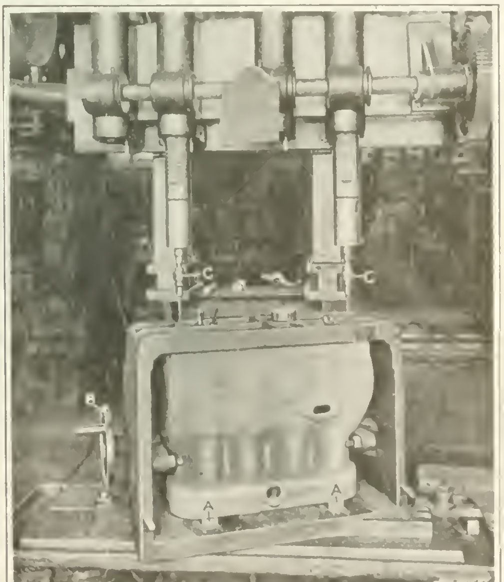


Fig. 6. Two-spindle Foote-Burt Drill Press equipped with Quick-change Chucks and Tools for drilling and reaming Master Locating Holes in Base of Cylinder Blocks

In order to explain the practice followed in determining the best order in

which to perform machining operations, deciding the type of machine to use in each case, and selecting points from which to locate the piece for each operation, examples have been selected for each of the motor parts under consideration, and these will be discussed in detail. The accompanying illustrations show the machines tooled up, with the work in place in the fixtures, and these equipments will be referred to in explaining the conditions which determined the design of the tools along these particular lines.* Using the operation and tool lists on which the sequence of operations has been set down, the tool engineer proceeds to make a study of points which govern the method of performing the machining operations. The selection of suitable locating points for the first machining operation on any piece is of exceptional importance, because it determines to a large extent the accuracy which will be obtained in the finished work. For this reason the greatest care must be exercised in looking after this part of the work. In all cases the locating points should be so selected that there will be little likelihood of any ordinary variations or defects in the castings or forgings preventing the work from being properly located in the jig or fixture.

Estimating Production on Machining Operations

In estimating production on any machining operation, the first points to receive consideration are the type of machine on which the work is to be done, the nature of the tools and fixtures with which this machine is equipped, and the material to be machined. In connection with this work, a comprehensive knowledge of the proper cutting speeds and feeds to use when working on different classes of metal is absolutely essential. A competent tool engineer will have gained this knowledge from experience; but for the benefit of those readers of MACHINERY who are less familiar with work of this kind, Table II has been arranged to show the cutting speeds and feeds to use on various classes of metal met with in manufacturing work. These figures are based upon the use of high-speed steel cutting tools, and the amount of stock removed is assumed to be normal, i. e., from 3/32 to 1/8 inch on a side for the roughing cut and from 0.010 to 0.015 inch on the diameter of the work for the finishing cut. It will be seen that three sets of figures are given in each case for the roughing cut. The upper figures represent the maximum cutting speed and corresponding rate of feed, which should only be used under the most favorable conditions; the next set of figures represents a high cutting speed which can be used except when the metal is exceptionally tough or hard; the lower figures are decidedly conservative and should only be used for estimating purposes when the greatest care is required in machining. For the finishing operation, one cutting speed is given in each case, but three rates of feed are presented, which can be used with the given speed according to the conditions of operation.

In using a table of this kind, it will be well to remember that no tabular matter can be safely accepted as an absolute guide for the cutting speed and feed which can be used on any class of work. In the present case, however, Table II may safely be used as a basis on which to form a fairly accurate estimate of production for all normal classes of work. In practice, it is frequently found that after work has been started in the shop, it is possible to increase production somewhat because the high quality of the material enables a higher cutting speed and feed to be used than those used in the tool engineer's estimate. Conversely, it sometimes happens that the material is of poor quality, and this will naturally result in reducing production below the figure estimated. In compiling Table II, it was assumed that all material except cast iron and yellow brass is provided with a suitable cutting lubricant while machining. In cutting aluminum, some factories follow the practice of working the material dry, while in other factories, a lubricant is used which is composed of equal parts of lard oil and kerosene. It would appear that the use of such a lubricant should be the means of securing a

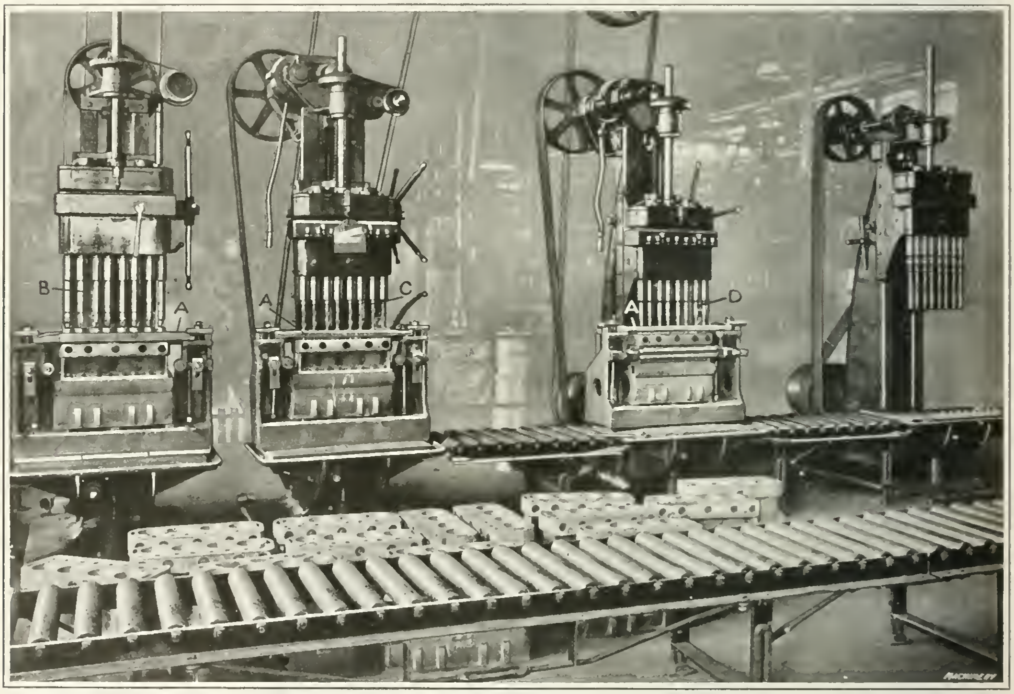


Fig. 7. Foote-Burt Eight-spindle Drill Presses equipped with Fixtures having Interchangeable Jig Plates for boring Valve Port Holes, and drilling and reaming Holes for Valve-stem and Push-rod Guide Bushings in Cylinder Blocks—Note Conveyor System provided to facilitate handling Work

* The machines shown are in use in the Detroit factory of the Maxwell Motor Co., Inc., and we are indebted to this firm for the privilege of making a study of its methods of manufacture, upon which is based much of the information concerning the order in which operations are performed and the methods of machining that are outlined in the operation and tool lists presented in this article.—Editor.

higher finish, and that it would also enable a higher rate of production to be obtained; but in one well-known factory, aluminum is being worked dry at a cutting speed of 600 feet per minute, and very satisfactory results are obtained.

In estimating the amount of time which should be allowed for setting up the work in the fixture, indexing turret machines, changing tools, etc., and removing the finished work, a number of matters must be taken into consideration, and the accuracy of the result will be largely dependent on the judgment of the estimator, which, in turn, is the result of his experience in doing work of this kind. In deciding upon the amount of time required for going through the different movements necessary in the performance of a machining operation, the estimator will often be able to secure accurate information by timing himself with a stop watch while going through a series of "false" motions just as if he were actually doing the work himself. This may appear somewhat foolish to the uninitiated, but it is necessary in many cases for the most experienced estimators to adopt this method in order to reach an accurate conclusion concerning the time required for unusual classes of work. In order to determine the number of revolutions per minute at which the cutter or work should revolve to produce a given cutting speed expressed in feet per minute, the tables presented in MACHINERY'S HANDBOOK on pages 800 and 801 will be found convenient.

The formula for calculating the cutting speed in revolutions per minute at which a piece of work should run can be evolved from the following:

$$\frac{\pi D N}{12} = \text{cutting speed in feet per minute}$$

where D = diameter in inches;

N = revolutions per minute.

This formula can be reduced to the following form:

$$0.262\,D N = \text{cutting speed in feet per minute.}$$

It will be noticed that the constant 0.262 is very close to 0.250, which would be ¼; hence the following formula can be evolved:

$$N = \frac{4\,C}{D} \qquad (1)$$

where D = diameter of work, in inches;

N = number of revolutions per minute;

C = cutting speed, in feet per minute.

This formula is accurate within about 5 per cent, and will be found useful for making rapid calculations in estimating.

In order to show the application of the formula, let us assume that a piece of cast iron 8 inches in diameter is to be machined and that the tool engineer has assumed a permissible cutting speed of 50 feet per minute on the work. He wishes to know the number of revolutions per minute at which the work must revolve in order to give this cutting speed. Then, applying the formula with $D = 8$ and $C = 50$, we have:

$$N = \frac{4 \times 50}{8} = 25 \text{ revolutions per minute}$$

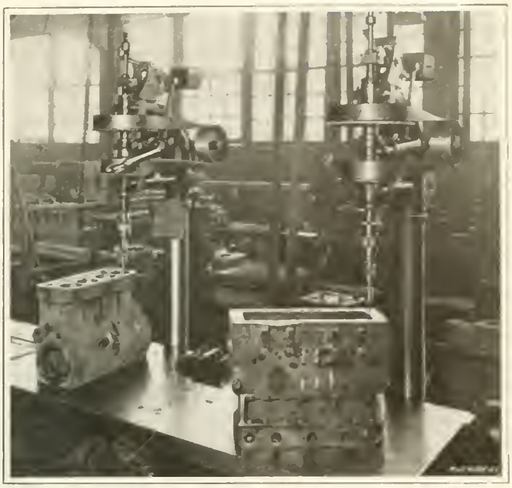


Fig. 9. Garvin No. 2 Automatic Tapping Machines equipped with a Single Table to facilitate handling Work in tapping Fourteen Holes in Top and Seventeen Holes in Bottom of Cylinder Blocks

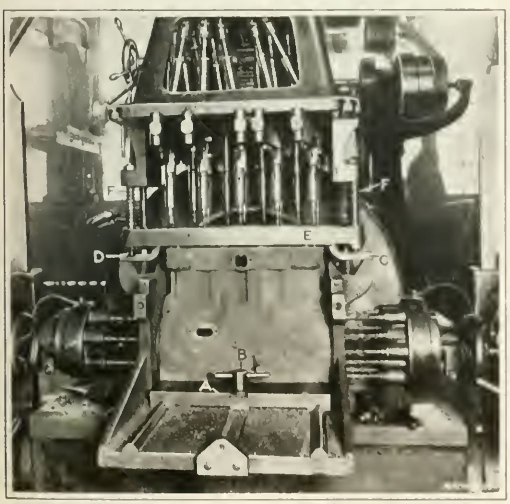


Fig. 8. Special Baush Multiple Spindle Machine for drilling Forty-eight Holes in Cylinder Blocks at a Single Setting—Drills work simultaneously from Four Sides

In the factory, when it is desired to determine the cutting speed at which a piece of work is being machined, the formula can be transposed to give the cutting speed C in feet per minute. In this case the formula would be as follows:

$$\frac{D N}{4} = C \qquad (2)$$

Let it be supposed that a piece of work 8 inches in diameter is revolving at 25 revolutions per minute, and that it is desired to know the cutting speed C at which the work is being machined. Substituting in Formula (2), we have:

$$\frac{8 \times 25}{4} = 50 \text{ feet per minute} = \text{cutting speed.}$$

In addition to determining the cutting speed, number of revolutions, etc., on a piece of work, the tool designer must also take advantage of short-cuts to facilitate calculations for determining the time necessary to take a specified length of cut at a given cutting speed. The following formula will be useful for that purpose. To determine the amount of time necessary to take a cut at a given speed and feed, let

N = speed in revolutions per minute;

F = feed in inches per revolution;

L = length of cut in inches;

T = time in minutes to complete cut.

$$T = \frac{L}{N F} \qquad (3)$$

To explain the use of Formula (3), let it be supposed that a piece of work to be machined has a diameter D of 8 inches, that the speed N is 50 revolutions per minute, that the feed F is 0.025 inch per revolution, and that the length of travel L in taking the cut is 4 inches. Substituting these values, we find the length of time T required to make the cut is:

$$T = \frac{L}{N F} = \frac{4}{50 \times 0.025} = 3.2 \text{ minutes} = 3 \text{ minutes and 12 seconds}$$

In a great many cases, the tool engineer makes many of these calculations mentally in estimating production, although the processes through which he arrives at the conclusions are based on the foregoing formulas. Experience is an important factor in estimating the length of time necessary to do any

piece of work for the reason that so many factors enter into the problem and so many small items have to be considered in addition to the actual amount of time necessary to make the cut.

Incidental Matters Pertaining to Estimating

It is fully as important in estimating production on a given piece of work to take into consideration the various movements involved in operating the machine, setting up the work and changing the tools, as it is to figure the length of time which the machine will actually take in doing the cutting. Some of these points are given consideration in connection with a brief discussion of the performance of machining operations on different types of machines such as turret lathes, vertical boring mills, milling machines and drilling machines. Some of the general points which apply to all classes of machines are as follows:

1. Conservative Estimate of Capacity.—The tool engineer's estimate should always err on the conservative side, as it is better to find that a little more than the required production is produced by a given equipment than that the output is too low. This point, however, must be carefully looked into when too conservative an estimate would involve the purchasing of a new machine tool or group of tools.

2. Setting up Work.—In taking into consideration the time required for setting up the work in a jig or fixture, or on a machine, attention must be paid to the care with which it is necessary to locate the piece in the fixture, the complexity of the clamping devices that have to be operated, and the method of setting up the work. The difficulty of placing the piece in position, owing to its general character and shape, must also be carefully considered in this connection.

3. Removing Work from Fixture.—It is always easier to remove a piece of work from a fixture than it is to set it in place and tighten the clamps; but the fixture often has to be cleaned before it can be used for holding another piece of work. In the case of small fixtures, jigs, etc., which are removed from the table of the machine during use, and which are used on cast-iron work where no lubricant is applied to the cutting tool, the fixture may be occasionally dipped in a soda kettle to clean it out, or an air blast may be used to blow away the dry chips. When the fixtures are used in connection with a cutting lubricant, the lubricant itself can be used to wash out any chips which may have accumulated in places where they are likely to cause trouble. However, this point should always be considered in the design of tools, and taken care of as far as possible by making the tools of such shape that chips will not accumulate.

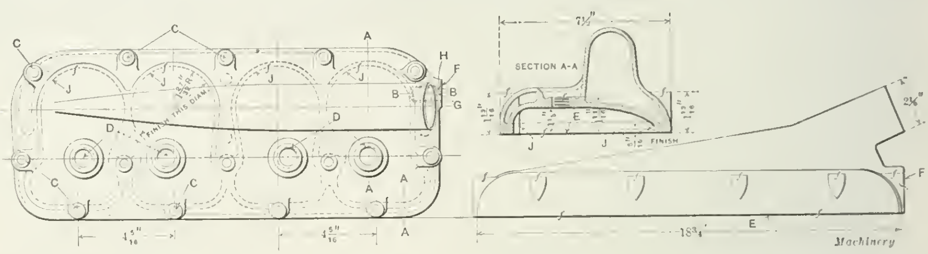
4. Weight of Work.—When the work is small, the weight need not be considered, so long as a man can lift it easily and place it in position without assistance. If, on the other hand, the work is of considerable size and weight, requiring the assistance of a helper in setting it in position, the weight must be taken into consideration in estimating production, because it affects the length of time necessary to handle the piece.

5. Size or Depth of Cut.—This point must always be taken into consideration, as it affects both the feed and the speed that may be employed.

6. Idle Movements of Machine.—In estimating production on any operation in which the machine movements are numerous, these must be taken into consideration and a liberal allowance made to take care of this part of the work. For instance, time must be allowed for the approach of the spindle to the work in a drilling machine and for its withdrawal after the work has been done, as well as the excess movement beyond the actual cut.

7. Setting and Removing Tools.—In certain classes of work, the resetting of sharpened tools and the removing of dull tools for grinding should be taken into consideration, if a close estimate of production is desired. Much depends, however, upon the class of work which is being done and the number of tools included in the equipment. In some cases, a moment's time might be all that would be necessary to make the replacement, while in others, when a large equipment of tools is used, some minutes might be consumed in resetting. In the modern factory, the tool equipment should always be built in duplicate, so far as the actual cutting tools are concerned,

TABLE IV. MACHINING OPERATIONS ON CYLINDER HEAD—MATERIAL, CAST IRON



Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Face-mill fourteen bosses C for hold-down bolts	No. 13 P. & W. single-spindle profiling machine	Simple clamping fixture	Cored combustion chambers in head	20	1
2	Drill holes D for four spark plugs	28-inch vertical drilling machine	Four-spindle drill head. Drill jig	Finished bosses C	60	1
3	Face under side E of head	No. 3 vertical milling machine	Milling fixture	Finished bosses C	15	2
4	Spot-face four holes D for spark plugs	23-inch vertical drilling machine	No fixture used. Fly-cutter with pilot	Fly-cutter pilots in spark plug holes	75	1
5	Drill fourteen holes C from under side	Sixteen-spindle drilling machine	Jig plate	Three locating pads on casting	25	1
6	Mill off face of fan stud boss F	No. 2-B horizontal milling machine	Clamping fixture	Drilled holes in cylinder head	50	1
7	Drill dowel-pin hole G in fan support boss F	11-inch speed lathe	Special holding fixture	Drilled holes in cylinder head	60	1
8	Drill and tap hole H in fan stud boss F	21-inch vertical drilling machine	Tapping attachment. Quick-change chucks	Drilled holes in cylinder head	25	1
9	Counterbore combustion chamber holes J	24-inch drilling machine	Four-spindle drill head	Drilled holes in cylinder head	30	1
10	Tap four holes D for spark plugs	21-inch vertical drilling machine	Tapping chuck. No jig	Set up on milled surface	30	1
11	Wash in oakite	Soda kettle	....	....	..	1
12	Water test at pressure of 60 pounds per square inch	Special testing machine	....	....	..	1
13	Final inspection	....	Gages	....	..	..

so that the minimum amount of time will be lost in replacement or renewal of tools.

8. *Setting-up Time.*—This refers to the setting up of the machine itself for doing the work, and is not ordinarily considered unless the complete time of the machine is not used on one operation and it needs to be set up with different equipments a number of times a day. In cases of this kind, it is necessary to take the matter of resetting tools into consideration when making an estimate. When it is necessary to estimate this time, it should be considered as a total amount and distributed over a lot of pieces in about the proportion that each would consume.

Turret Lathe and Boring Mill

1. *Indexing Turret.*—The time occupied in indexing the turret must be taken into consideration in estimating production on work which is machined in a turret lathe. The time required for running back the turret should also be considered. In estimating this time on hand-operated machines, the best way is for the tool engineer to take some actual examples in the factory and note down results, always taking into consideration the length of the tools used and the distance which they must be withdrawn before the turret is indexed. In one case it might be found that a six-sided turret could be indexed to all its faces in 15 seconds with a certain equipment of tools, while in another case 25 or 30 seconds might be necessary on account of the long distance to be traveled before the index dog is tripped. In the case of a boring mill, the time required for the travel of the head must be allowed for in connection with the other points; and if the machine is of the type that has a turret head, the time occupied in indexing this turret must also be taken into consideration.

2. *Actual Speed of Machine.*—It is easy enough to make an estimate of the time required for a certain cut at a specified speed on a turret lathe or boring mill, and yet it may be found that the required speed cannot be obtained on the machine itself without providing a special drive which naturally would not be done unless production could be increased to a considerable extent, or unless the machine were to be used on one particular job constantly. Hence, the tool engineer, in deciding the cutting speed at which a turret lathe is to run, must at the same time refer to his table of machine tool equipment and select the nearest actual speed at which the machine can be run, and then use this speed in figuring in place of the one called for by the cutting speed desired.

3. *Incidentals.*—Among the incidentals which must be taken into consideration on this kind of estimating are such things as the "dwell" allowed at the end of a counterboring cut to smooth up the surface and obtain the exact depth desired; the changing of speed when it involves something more than the mere movement of a lever; and the changing of tools, as previously mentioned. Some other points may be taken into consideration on certain classes of machines, but those mentioned are the most important.

Milling Machines

1. *Supports for Work.*—The kind of support with which the work is provided must always have an effect on the estimation of milling machine production. In the design of fixtures for use on this class of machine it is always advisable to make the supporting point as rigid as possible, and thus avoid the possibility of chatter. There are some cases, however, when the nature of the work is such that it is difficult to support it properly. If the work is thin, the cuts and speeds, together with the feeds, must be less than if the casting is of a heavy section.

2. *Finish Desired.*—The quality of finish necessary on a piece which is to be milled makes considerable difference in the speeds and feeds that can be used, and must be considered in making an estimate of production.

3. *Diameter of Cutters.*—The diameter of cutters must be taken into consideration for the reason that the feed is, to a certain extent, dependent upon it.

Drilling Machines

Accuracy Required.—This point must be considered in estimating production on drilling operations; and in this connection, the feeds and speeds used must be carefully considered. High-speed drilling, with coarse feeds, cannot be made to produce extremely accurate results with ordinary twist drills, and the nature of the work must always be considered in this connection. It is well to remember that in order to obtain accurate results on drilled work, the speeds should be somewhat higher and the feeds rather fine.

Machining Operations on the Piston

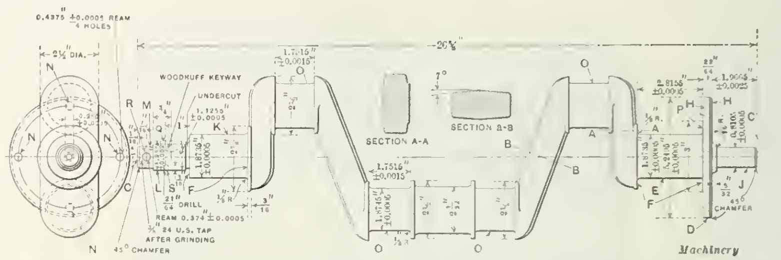
The manner of locating the piston for the first operation is of exceptional importance, because it is made with an internal cored opening which is likely to vary somewhat in its relation to the exterior surface, so that the two surfaces will not be concentric in the rough casting. Naturally, it is important for the piston castings to be machined in such a way that the interior and exterior surfaces will be approximately concentric when the work is finished. If a method of holding from the outside were used in the preliminary machining operation, there would be a probability of the casting having walls of variable thickness, the pistons would not all be of equal weight, and therefore the motor in which such pistons were used would be more or less out of balance unless a method of counteracting this defect were employed. If the piston were located from the outside, there would also be a possibility of the cutting tools for the ring grooves breaking through the walls, if the casting happened to be very eccentric; or if the groove cutting tools did not actually break through the wall, they might at least run dangerously close and leave a thin section which would be unsafe. Taking these points into consideration, the tool engineer decides that the best plan will be to hold the

Fig. 10. Reed-Prentice 21-inch Drill Press tooled up for drilling and tapping Hole in Fan Stud Boss on Cylinder Heads—Note Special Reversing Mechanism for backing out Tap, and Wiard Quick-change Chuck

work by the inner cored surface for the first operation, in order to be sure of producing pistons of uniform weight and thickness of wall.

Having decided upon the locating points for the first operation and all subsequent operations, the tool engineer now decides the best type of machine on which to do the work in each case, the form of holding device to employ, and the tools to use for each machining operation, after which he is ready to calculate the production that will be obtained. For instance, in the operation and tool list for the piston presented in Table I, Operation 3 consists of facing the open end *C* and boring and reaming hole *D*. In deciding upon the locating points for this operation, the tool engineer considers the fact that he has previously held the work by the inside and has roughly machined the exterior surface so that it is approximately concentric with the interior. Therefore it is logical to hold the work for this operation by the machined exterior surface, using a three-jaw chuck with a set of soft jaws *A*, as indicated in Fig. 3. The soft jaws will be bored out to the size of the outside of the piston when the chuck is in place on the machine. Owing to the fact that several tools must be used in performing Operation 3, the selection of a turret lathe seems advisable because the necessary tools can be quickly presented in sequence. The use of roughing and finishing boring-bars, *B* and *C*, and a finishing reamer *D* will be necessary, these tools being held in the turret and presented in the order named. The open end of the piston is faced by tool *E* mounted on the cross-slide.

TABLE V. MACHINING OPERATIONS ON CRANKSHAFT—MATERIAL, STEEL



Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Make center-punch mark at middle of one of center crankpins	....	Hammer and center punch	Inspection	..	..
2	Cut off ends C of drop-forging to reduce crankshaft to length	Special 16-inch engine lathe—double head	V-block fixture with gage to locate work. Extra lathe head. Milling cutters and arbors	Center-punch mark on middle pin	30	1
3	Center ends C	Double-head centering machine	Sliding V-block fixture to accurately locate crankshaft	End bearings and sides of cranks	25	1
4	Rough-turn outside of flange D	16-inch engine lathe	Special driver—"cat-head" type	Centers	30	1
5	Rough-turn rear bearing E	20-inch engine lathe	Special driver—"cat-head" type	Centers	25	1
6	Face down sides F of end bearings	20-inch engine lathe	Locating gage on carriage to enter center-punch mark in crankpin. Double toolpost	Center-punch mark on middle pin	22	1
7	Rough-face sides H of flange D	24-inch heavy-duty engine lathe	Straddle facing tools. Indicator	Centers and finished shoulder on rear bearing	15	2
8	Rough- and finish-turn clutch fit J	20-inch engine lathe	Special driver—"cat-head" type	Centers	15	2
9	Finish-face sides H of flange and under-cut inside of flange	22-inch engine lathe	Straddle facing tools. Special driver	Centers	15	2
10	Rough- and finish-turn front bearing K, gear fit L and threaded end M	20-inch engine lathe	Multiple tools at front and rear of cross-slide to work on all surfaces at once	Centers	17-18	2
11	Finish-turn outside of flange D and rear bearing E	16-inch engine lathe	Special driver	Centers	40	1
12	Drill four holes N through flange D	28-inch vertical drilling machine	Special four-spindle drill head. Jig	Center at bottom and clamp engaging clutch fit J	30	1
13	Turn four crankpins O	21-inch heavy-duty crankshaft lathe	Special tool-holders using high-speed steel cutters	Holes N drilled in flange D	4-5	5
14	Rough-grind crankpins O	Crankshaft grinding machine	Special quick-speed changing mechanism	Centers	10-12	2
15	Finish-grind crankpins O	Crankshaft grinding machine	Steadyrests	Centers	10-12	2
16	Balance	Balancing stand. Grinding stand	....	....	10-12	2
17	Rough-grind rear bearing E	14 by 50 inch plain grinding machine	Special driver	Centers	22	1
18	Finish-grind rear bearing E and face inside of flange D	10 by 50 inch plain grinding machine	Gage for testing finished width of flange	Centers	22	1
19	Finish-grind front bearing K	14 by 50 inch plain grinding machine	Special driver	Centers	22	1
20	Finish-grind outside diameter and outer face of flange D	10 by 50 inch plain grinding machine	Special driver	Centers	20	1
21	Finish-grind clutch fit J, gear fit L, and face-grind gear fit to length	10 by 36 inch plain grinding machine	Special driver	Centers	25	1
22	Ream drilled holes N in flange D	26-inch vertical drilling machine	Special four-spindle drill head. Same type jig as for Operation 12	Center at bottom and clamp engaging clutch fit at top	35	1
23	Mill keyway Q in gear fit	No. 6 hand milling machine	V-block fixture	Front and rear bearings K and E and crankpins O	30	1
24	Drill and ream starting pin hole R	21-inch vertical drilling machine	Quick-change chuck. V-block fixture	Gear fit J and crankpins O	30	1
25	Face clutch fit J to length, and chamfer clutch fit J and flange D	14-inch engine lathe	Files. Gages	Centers	25	1
26	Drill hole S for gear locking screw	21-inch vertical drilling machine	Simple V-block jig. (Accuracy not important)	Crankpins	40	1
27	Drill hole C in starter fit	14-inch vertical drilling machine	Drill jig	Lower center and clamp on gear fit L	50	1
28	Hand-ream flange holes N, starting pin hole R, and hand-tap hole C in end of shaft	Bench	Reamers, tap, tap wrench, vise, etc.	....	35	1
29	Burr shoulders and lap pins O and bearings K and E	14-inch engine lathe	Special lapping handles made of machine steel	Centers	20	1

In estimating production on this job, the tool engineer decides that for the boring operations, a cutting speed of 50 feet per minute can be used, with a feed of 0.040 inch per revolution of the spindle; and that the reaming can be done with hand feed. The length of the cut is $\frac{1}{4}$ inch, and the feed 0.040 inch per revolution, which is equivalent to 25 revolutions of the spindle per inch; the number of revolutions per minute of the spindle is 56. The length of time necessary to make the rough-boring cut would be $\frac{\frac{1}{4}\times 25}{56} = \frac{7}{56}$ minute = 8 seconds. The finishing cut would take about the same length of time, and the hand-reaming possibly 10 seconds. The length of time necessary to set up and remove the work would be 20 seconds, and the added time for indexing the turret, say, 14 seconds. The total then would be 60 seconds, which is equal to a production of 60 pistons per hour. Since the boring tools are working simultaneously with the facing tool on the cross-slide, the work done by the latter may be neglected in figuring the rate of production, as no extra time is consumed.

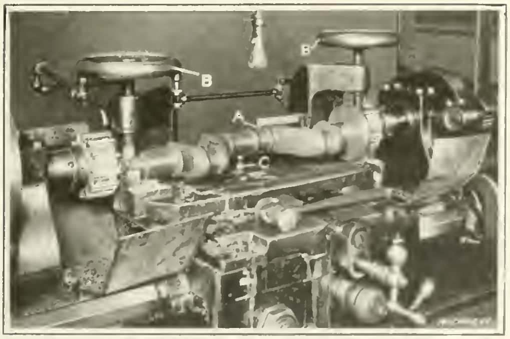
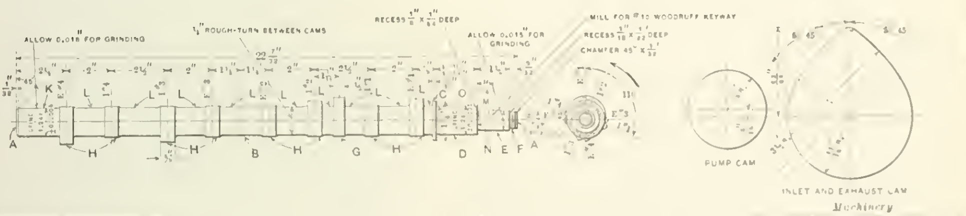


Fig. 11. Greaves-Klusman 16-inch Engine Lathe equipped with Locating Gage to enter Center-punch Mark, Two Headstocks and Milling Cutters for cropping Ends of Crankshaft Forgings to reduce them to Standard Length

Operation 6, Table I.—This is another turret lathe job which consists of rough- and finish-reaming wrist-pin hole *E*. As the open end of the piston has been squared up and reamed to size in a previous operation, this is the logical place from which to locate the work. As a matter of fact, the only object in squaring up the end of the piston and reaming the hole is to provide an accurate locating point for some of the subsequent machining operations. Reference to Fig. 4 will show that the fixture is screwed onto the spindle, and that it is provided with a swinging clamp *A* and hand-screw by means of which the piston is clamped in place after it has been properly located. The piston is first dropped into the fixture in approximately the correct position, after which a piloted bar *B* in the first turret hole is brought up and inserted in the wrist-pin hole. The piston can now be clamped with the assurance that the wrist-pin hole will be in correct alignment. The tools used for rough- and finish-reaming are a four-lipped piloted chucking reamer *C* of the spiral type, and an inserted straight-blade finishing reamer *D*, as clearly shown in Fig. 4.

In determining the production on this job, a liberal allowance must be made for the time occupied in setting up and removing the work, as a certain amount of preliminary aligning is necessary, which requires a little more time than would be necessary on the ordinary type of fixture. The estimate of production for the sequence of movements involved in this operation is as follows: Setting up, locating and removing

TABLE VI. MACHINING OPERATIONS ON CAM-SHAFT—MATERIAL, STEEL



Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Crop ends A to reduce to required length	16-inch engine lathe	Arbors with two milling cutters. Work-holding fixture on carriage	Block on fixture that engages cam on forging	30	1
2	Drill center holes in ends A	Double-head centering machine	Center drills	End bearings	25	1
3	Straighten	Straightening press	....	....	40	1
4	Turn steadyrest bearing B, rough- and finish-turn collar C, front bearing D, gear fit E and threaded end F, and rough-turn at sides of pump eccentric G	Multiple turning lathe	Three multiple tool-blocks	....	25	1
5	Face down sides of cams H, pump eccentric G, collar C and bearings D and K	Multiple turning lathe	Steadyrest and driver. Single tool-block with eighteen tools	....	30	1
6	Turn rear bearing K to grinding size, and turn spaces L between cams	Multiple turning lathe	Multiple tool-holder	....	25	1
7	Mill keyway M in gear fit E	No. 6 hand milling machine	V-block fixture	Intake valve cam for No. 1 cylinder	40	1
8	Rough-grind faces of cams H and pump eccentric G	12 by 32 inch cam-shaft grinder	Special driver with locator in keyway M	Centers and keyway	8	3
9	Heat-treat and test hardness	Hardening furnaces	Hardening boxes. Scleroscope	....	..	
10	Rough-grind front and rear bearings D and K, gear fit E	6 by 32 inch plain grinder	....	Centers	22	1
11	Finish threaded end F	14-inch engine lathe	Center-rest and self-opening threading die	Center and end bearings D and K	4[illegible]	1
12	Finish-grind cams H and pump eccentric G	12 by 32 inch cam-shaft grinder	....	Centers	8	[illegible]
13	Finish-grind gear fit E and shoulder N, front bearing D, face of collar C, rear bearing K and chamfer edge of rear bearing	6 by 32 inch plain grinder	....	Centers	1[illegible]	2
14	Hone edges off cams H and pump eccentric G	....	Oilstones	....	20	[illegible]
15	Final inspection	....	Gages	....	..	..

work from the fixture, 30 seconds. Rough-reaming (at a cutting speed of 60 feet per minute and a feed of 0.062 inch per revolution) would require $\frac{3 \times 16}{240} = 12$ seconds. Finish-reaming would be done by hand, and as only a very light cut is taken it could be safely done at a cutting speed of about 30 feet per minute and completed in about 8 seconds, making the total time for setting up and removing the piece, 50 seconds, or 72 pistons per hour. In connection with this operation, the tool engineer in his preliminary planning decides to make the fixture in such a way that inspection during the process of the work can be easily accomplished. In order to do this, he designs the end of the piston fixture against which the work locates, with a good sized hole in it so that the work can be inspected at any time during the progress of the operation, without withdrawing the tool.

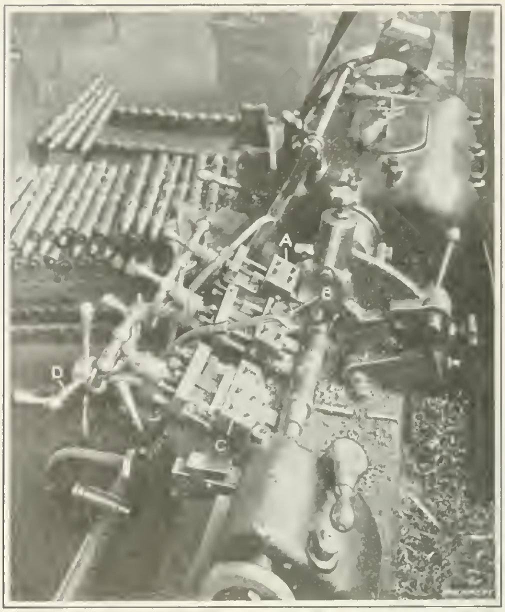


Fig. 12. Fitchburg "Lo-Swing" Lathe tooled up for turning Bearing for Steadyrest; rough- and finish-turning Front Bearing, Gear Fit, Threaded End and Collar; and rough-turning between Cams and Pump Eccentric on Cam-shafts

Operation 15, Table I.—This operation shows the value of past experience on the same class of work, as well as the refinements that are sometimes necessary in order to produce the highest quality of finish. The operation, which is illustrated in Fig. 5, consists of turning the piston ring grooves, and it is necessary to have the sides and bottom of these grooves as smooth as possible in order to insure a close fit between the piston and packing rings and at the same time prevent any trouble which might be caused by the accumulation of carbon or other foreign matter that might lodge on the faces of the ring grooves in such a way as to cause the packing rings to stick. In order to avoid this trouble, the tool engineer decides to apply burnishing rolls in the ring grooves after they have been turned, and thus leave them in an ideal condition. He decides to hold the work on a special nose-piece fitting in the open end of the piston and provided with a driver that engages one of the wrist-pin bosses on the inside of the piston. The tailstock center of the lathe supports the other end of the work, and makes the method of holding very secure.

For this operation of turning and burnishing the piston ring grooves, a special tool-block *A* is placed on the front of the cut-off slide and the tools carried by this block are used to dress off the sides of the grooves before the burnishing tools *B* are used. Hand feed is employed for cutting the grooves and burnishing them to obtain a high quality of finish. For this reason, the time necessary to complete the operation must be somewhat arbitrarily decided by the tool engineer. In deciding the length of time needed for this operation, the method of procedure would be about as follows: Setting up and removing work, 30 seconds; estimated time for finishing cut on ring groove, 20 seconds; estimated time for burnishing the groove, 40 seconds; total time necessary for this operation, 90 seconds, giving a production of 40 pistons per hour.

Machining Operations on the Cylinder Block

In taking up the design of tools and selection of locating points for machining the cylinder block, and in estimating the production obtained, the tool engineer must consider a number of factors that govern the performance of certain operations, and he may deem it advisable in some cases to build special machinery to handle such operations on the cylinder block. The operation and tool list for this piece, presented in Table III, shows the first machining operation to consist of milling the top and bottom surfaces *A* and *B*, surface *C* around the valve ports, and seat *D* for the valve dust plate. In considering the points from which to locate the work during this operation, the tool engineer must consider the probability of variations in the castings. This point is particularly important in a casting of this nature which has a number of cored openings. The method of setting up for the milling operations must be so arranged that important surfaces will be located so that there will be sufficient finish allowance to permit of taking a good finishing cut when machined to the sizes called for.

In this case the crankshaft bearing hole at each end and the bottom surface of the valve chamber are selected as locating points, and the fixture is designed to work from these surfaces. By this selection it is certain that sufficient stock will be left to give a good finish in machining; and also that the inside clearances for the moving parts will be uniform so that there will be no chance of interference. Owing to the variations in the castings, fixed points of location cannot be used and jacks must be utilized in connection with special gages to bring the work up to the proper height for machining. The machine on which the work can be done to the best advantage is a planer type milling machine with three spindles, having a table long enough to hold eight cylinder castings at a time. The fixture must be so designed that the clamps can be conveniently operated, and they must take up very little space longitudinally in order that the maximum number of castings can be set up on the table at a time. The right-hand free-hand sketch in Fig. 1 indicates clearly the tool engineer's conception of the proposed method of handling this operation on the cylinder blocks.

In estimating production on this work, the total distance that the milling machine table travels must be carefully figured, allowing sufficient space between the cylinders for the clamps and taking into consideration the diameter of the cutters used, etc. In this case the distance to be traveled is approximately 176 inches, which includes the space allowed between the cylinders to leave room for clamping. The feed per revolution of the cutter is 0.250 inch and the cutters are 10 inches in diameter; they should revolve at a speed of 24 revolutions per minute, equal to a cutting speed of about 60 feet per minute. An inspection of these points will show the tool engineer that the feed is 6 inches per minute in longitudinal travel of the table. Hence, the length of time necessary to feed the table carrying eight cylinder blocks past the milling cutters is $\frac{176}{6}$, or approximately 30 minutes. Allowing about 12 minutes for a man and a helper to set up the work for another operation and remove the cylinders that have been machined, gives a total of 42 minutes for the eight cylinders. This is approximately one cylinder every 5 minutes, or 120 cylinders per day. As this is in excess of half the production wanted, two machines will be necessary to give the required output. The milled cylinder blocks are removed from the table as they pass out from under the rail; and fresh castings are set up as soon as the return stroke of the table

has been completed, the first casting being placed in the fixture nearest the cross-rail so that the next milling operation can be started at once. In this way the factor of idle time on the machine is partially done away with. It will be seen that one man's time will not be fully occupied in attending to one of the milling machines, and in order to keep him busy, the tool engineer plans to arrange a vertical drilling machine close to the milling machines, so that the operator can fill in with a little work on this machine while waiting for the milling operations on the cylinders to be completed. The work selected for these men to do is indicated by Operation 3 in Table III.

It still remains to provide some fixed point that can be used to locate the work for the majority of machining operations that still have to be performed. For this purpose the tool engineer decides to drill two dowel-pin holes at diagonal corners of the base; and these are used to receive locating pins on the fixtures employed in the majority of the subsequent machining operations. As the holes are a considerable distance apart, it is practicable to use a two-spindle drilling machine, in the spindles of which can be placed quick-change chucks so that reamers can be substituted for the drills after the drilling has been done. It must be remembered that in designing fixtures or jigs for a heavy piece like the cylinder block, the question of operating the jig or fixture and placing the work in position must be carefully considered with a view to making it as convenient and quick as possible. The design should also be worked out in such a way that the operator will not be likely to injure himself by having to pull and haul the work into its proper location in the fixture.

Fig. 6 shows the fixture used for Operation 3, Table III, in connection with which several points of interest may be noted. In order to make the operator's work as easy as possible, and to prevent improper location of the work due to the accumulation of chips in the fixture, the cylinder block is placed on two steel rails or guides *A* and slid back until a pad on the fixture engages a finished face previously milled on the casting. The longitudinal location is controlled by means of the swinging clamp and locator, and it will be noted that one of these clamps is operated through a handwheel *B* conveniently placed. The entire fixture is rigidly clamped to the drill press table. Owing to the fact that the holes are reamed in this operation, in addition to being drilled, the drill bushings are made removable so that they can be replaced by those used for guiding the reamer; and quick-change chucks *C* are provided on the drill spindles to facilitate changing the tools.

In estimating production on this piece, a liberal amount of time should be allowed for setting up and removing the work, not because of the difficulty of clamping it or removing it from the fixture, but because the casting itself has considerable weight and cannot be as easily handled as a lighter one. Time must also be allowed to remove the drill bushings from the jig and replace them by the reamer bushings, and *vice versa;* also, to remove and replace the drills and reamers in the quick-change chucks. Two minutes should be a generous allowance for the movements having to do with the setting up and replacement of tools; and the drilling and reaming operations would be comparatively short, a reasonable estimate being somewhat less than one minute for the two operations. Thus a little less than three minutes would be ample for drilling and reaming one piece, and as the production is slightly more than one piece in three minutes, the tool engineer calls the estimate about 22 pieces per hour, so that one machine is capable of giving the required production.

Operation 15, Table III. This operation consists of boring and facing valve seats *N* and holes *O*, and drilling and reaming guide bushing holes *P* and *Q* for the valve stems and push-rods. The concentricity of these holes is important, and there are a number of them to be machined; also the depth of valve seats *N* is of importance, in order that the seating of the valves may be uniform. Taking all these points into consideration, the tool engineer decides that it will be advisable to employ a gang of drilling machines of the eight-spindle vertical type so that the various operations on the valve holes and push-rod holes can be performed in sequence, without necessitating a change in tools. Fig. 7 shows the way in which the machines were finally set up, and it will be seen that a system of roller conveyors is provided for handling the heavy castings as easily and rapidly as possible. In deciding upon the use of this equipment, a number of points were studied in connection with handling the work—both at the actual time of machining and also before and after performing the operations. Provision of the conveyor system is a case in point, as well as the arrangement of the machines. The conveyor is in the form of an oval, portions of which are seen in the illustration; one side of the oval is unbroken, while the other has four openings to receive the machines. It will be seen that by this arrangement, one or more men can be employed in loading the fixtures or removing the work, while the men at the machines have nothing to do except to attend to the actual machining operations.

In designing the fixtures used for this series of operations, the tool engineer decides to make all the fixtures alike, with the exception of the jig plates *A* which are made removable and interchangeable between the fixtures. This design makes it possible for each fixture to be moved along from one machine to another. At the conclusion of each operation, the plate that has just been used is removed from the fixture, and the fixture is then pushed along to the operator of the next machine, who merely clamps the proper jig plate onto the fixture, when it is ready for use. In regard to the design of tools, the first set *B* consists of combination four-lipped drills and angular countersinks for machining the valve seats, the second set *C* consists of drills for drilling the valve stem bushing holes; and the third set *D* consists of drills for drilling the push-rod bushing holes. In estimating the production on

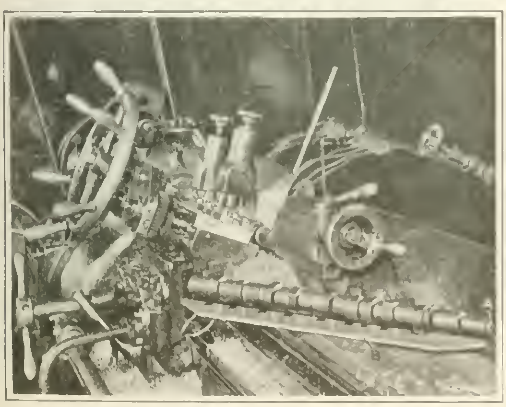


Fig. 13. Fitchburg "Lo-Swing" Lathe provided with Eighteen Tools for facing to Width Cams, Bearings, Pump Eccentric and Collar on Cam-shafts

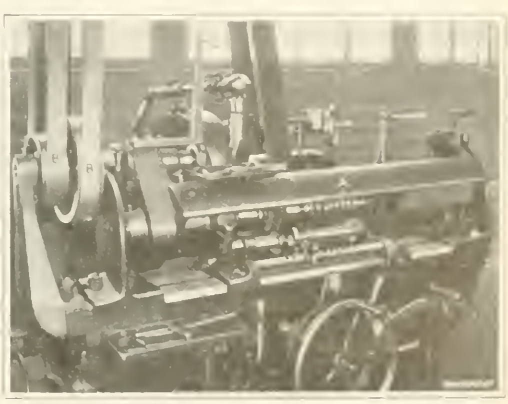
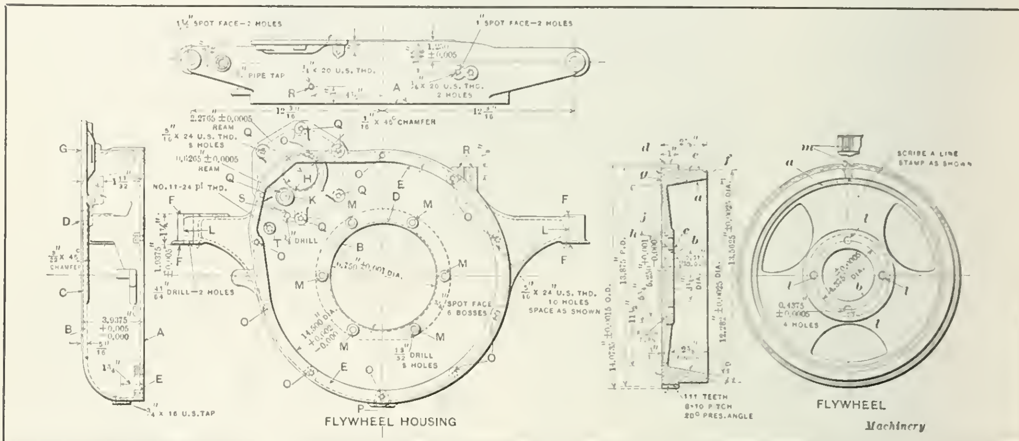


Fig. 14. Landis Cam-shaft Grinder with Special Two-speed Drive to provide for slowing down Wheel to obtain Final Finish when grinding Cams on Cam-shafts

this series of operations, it is only necessary to figure the length of time required for changing the jig plates and for completing the longest operation. Assuming hole Q to be the longest operation, we find that the diameter of the hole is 0.6875 inch, and for a cutting speed of 50 feet per minute, the drills should be run at a speed of about 270 revolutions per minute. The depth of the hole (taking into consideration the drill point) is $1\frac{1}{2}$ inch; and a feed of 0.010 inch per revolution can be safely used on this work. The number of revolutions required to drill the hole would be $1.5 \div 0.010 = 150$. The actual machining time is $150 \div 270$ = a trifle over $\frac{1}{2}$ minute. Considering idle movements of the drill head, $\frac{3}{4}$ minute should be allowed for the actual machining time. Adding 1 minute for setting up the work and $\frac{3}{4}$ minute for handling the fixture, we have a total of $2\frac{1}{2}$ minutes, which is equal to a production of 24 pieces per hour.

Operation 25, Table III.—In planning the sequence of machining operations on the cylinder block, the tool engineer has called for the drilling of forty-eight holes, *a, b, c, d, e, f* and *g* in the cylinder block casting, working from four sides at once. In order to accomplish this operation in the minimum time, a special machine is necessary that is arranged with four separate heads, each of which has a series of drills grouped in such a way that the spacing will correspond to the required location of the holes in the various parts of the cylinder block. This machine is shown in Fig. 8, the locating points for this operation being the dowel holes drilled in the base of the cylinder block. In deciding upon the best type of jig to use for this

TABLE VII. MACHINING OPERATIONS ON FLYWHEEL HOUSING AND FLYWHEEL—MATERIAL, CAST IRON



MACHINING OPERATIONS ON FLYWHEEL HOUSING

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Rough-mill face A of transmission flange	No. 5 vertical milling machine	Clamping fixture	Under side of casting	12	2
2	Grind face A of transmission flange	No. 2 horizontal disk grinder	....	....	25	1
3	Rough- and finish-bore crankshaft bearing hole B, face surface C and counterbore at D	25-inch heavy-duty turret lathe	Clamping fixture on faceplate	Finished face A of transmission flange	12	2
4	Bore inside edge E of transmission flange	25-inch heavy-duty turret lathe	Clamping fixture on faceplate	Hole for crankshaft bearing	20	1
5	Straddle-mill suspension arms F	No. 3 horizontal milling machine	Two fixtures; one at each end of table. Adjustable locators for rough and finished bosses	Inside edge E of transmission flange and suspension arms F	22	1
6	Mill seat G for self-starter box	No. 5 vertical milling machine	Clamping fixture	Inside edge E of transmission flange and suspension arms F	20	1
7	Bore, ream and chamfer hole H for self-starter box bearing	26-inch vertical drilling machine	Quick-change chucks	Face A of transmission flange, suspension arms F and crankshaft bearing hole B	24	1
8	Drill and ream sliding gear shaft hole K	20-inch vertical drilling machine	Quick-change chucks. Jig plate	Starter box hole H, and hole B for crankshaft bearing	30	1
9	Drill hole S and No. 11 hole T, and spot-face hole T	14-inch two-spindle drilling machine	Quick-change chucks. Jig plate	Starter box hole H, and hole B for crankshaft bearing	25	1
10	Drill bolt holes L in suspension arms F	20-inch two-spindle rail drill	Jig	Suspension arms F and face A of transmission flange	30	1
11	Drill six holes M around crankshaft bearing and six holes Q around starter box	Multiple spindle drilling machine	Same type jig as for Operation 8	Same as for Operation 8	25	1
12	Drill ten holes O in transmission flange A	Multiple spindle drilling machine	Drill jig	Crankshaft bearing hole B and starter box bearing H	25	1
13	Drill, spot-face and tap drain plug hole P	20-inch vertical drilling machine	Quick-change chucks. Jig	Crankshaft bearing hole B	20	1
14	Spot-face inside of boss around sliding gear shaft K and around six holes M	20-inch vertical drilling machine	Quick-change chucks. Piloted spot-facing tools	Holes to be spot-faced	25	1
15	Drill control bosses R	14-inch vertical drilling machine	Jig	Hole B for crankshaft bearing and hole K for sliding gear shaft bearing	30	1
16	Tap six holes Q in starter box seat, No. 11 hole T, three holes R in control bosses, and ten holes O in transmission flange	No. 2 automatic tapping machine	Quick-change chucks	....	12	2
17	Wash	Soda kettle	....	....	...	1

TABLE VII. MACHINING OPERATIONS ON FLYWHEEL HOUSING AND FLYWHEEL—CONTINUED

MACHINING OPERATIONS ON FLYWHEEL

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Locating Points	Estimated Hourly Production per Machine	No. of Machines
1	Rough and finish clutch fit a, bore and ream hole b, face inside c of hub, turn two outside diameters d and e, face inside and outside f and g of rim, and put radius on all edges	Semi-automatic chucking machine	Two complete sets of the following tools for each machine, for roughing and finishing: Turret tools turn outside diameters, bore and face flange, and turn tapered clutch fit. Tools at front of cross-slide face edges of rim and starter gear d to width. Tools at back of slide finish same surfaces and chamfer corners	Inside edges of cored holes in web	4	6
2	Counterbore and face fit h for flange on crankshaft, and face surface j around flange fit	No. 6 turret lathe	Turret tools and special work-holding fixture on face-plate	Taper clutch fit	11	2
3	Drill and ream four holes l for crankshaft flange bolts	22-inch vertical drilling machine	Plate jig and drill head	Crankshaft flange fit h	22	1
4	Cut teeth m for starter	Fellows gear shaper	Fixture to hold two flywheels at a time. Fellows gear shaper cutters	Reamed center hole b	8	3
5	Balance	Combination drilling and balancing machine	....	....	10	2

operation, the tool engineer decides that it should be so made that it can be fastened permanently to the drilling machine table. The jig must also be so arranged that the cylinder block can be placed in position without difficulty, and for this reason the locating dowels are placed in a sliding plate *A* that is arranged to slide along a pair of ways so that it can be pushed into position and located by an index pin *B* as indicated, or pulled out for the purpose of loading.

There are several features of importance in connection with this operation, which were carefully studied by the tool engineer in planning this operation. One of these is the provision of a rapid method of clamping the work. The two clamps *C* and *D* of irregular shape, which are seen at the right- and left-hand sides of the fixture, are bolted down tightly onto the top of the cylinder block after it has been pushed back into the position shown. The top jig plate *E* is connected to the vertical spindle head in such a way that the drills are always located in the bushings on this plate. On the under side of this jig plate there are dowels which enter holes in the upper part of the fixture when the spindle head is brought down preparatory to drilling. Coil springs *F* are interposed between brackets on the under side of the head and the top of the jig plate, so that a moderate pressure is exerted during the drilling, and at the same time the drills are allowed to feed down through the plate, the movement being compensated for by the springs. The other three faces of the jig are fitted with the usual form of jig bushings to support the drill.

Reference to the illustration at the top of Table III will show that all holes drilled in this operation are of small size and of comparatively slight depth, so that the actual time occupied in drilling the holes is very small. Considering that 1 inch is the maximum travel of any drill in the group, and that the drill speeds are about 300 revolutions per minute with a feed of 0.010 inch per revolution, about 100 revolutions would be necessary to obtain the proper depth of hole. Hence, the length of time necessary would be $\frac{100}{300} = \frac{1}{3}$ minute = 20 seconds. The movement of the head, setting up of the work, and other incidental movements in connection with handling, can be safely estimated at $1\frac{1}{2}$ minute, or, say, 2 minutes for each complete piece from floor to floor. This would give an hourly production of 30 pieces, which is more than sufficient for the requirements of the case under consideration.

Operation 30, Table III.—This operation consists of tapping fourteen holes *c* in top and seventeen holes *R* and *k* in bottom of cylinder block. As planned by the tool engineer, this operation is done on a vertical tapping machine of the automatic type, two of which are shown in Fig. 9. In order to facilitate handling the work during this operation, the two automatic tapping machines are arranged with a special table, so that the cylinder blocks can easily be pushed along from the spindle of one machine to the other. As there are fourteen holes to be tapped in the top of the cylinder and seventeen in the bottom, it follows that the man who is working on the top of the cylinder should have a trifle more time at his disposal than the one who is tapping the holes in the bottom. Therefore, when this man finishes a piece he turns it over onto the other end, ready for the next man to start work. In figuring the production on this operation, the tool engineer estimates that it will take approximately 10 seconds to tap each hole, back out the tap, and bring the next hole under the spindle, so that the longest operation would be $17 \times 10 = 170$ seconds, or a trifle under 3 minutes. The other man, with only fourteen holes to tap at the same rate, would have 30 seconds to spare, in which time he can turn the cylinder over, ready for the seventeen-hole man. A production of one piece every three minutes from the two machines working on what are virtually separate operations, gives a production of 20 pieces per hour.

Machining Operations on Cylinder Head

Referring to the operation and tool list shown in Table IV, it will be seen that the first operation on the cylinder head consists of face-milling fourteen bosses *C* for the hold-down bolts. The points from which the piece is located in this operation are the cored interiors of the combustion chambers at opposite ends of the cylinder head. The fixture used is of the plate type and has properly located lugs attached at each end to conform approximately to the contour of the cored inside of the combustion chambers. The cylinder head is pushed up against these lugs on the fixture in order to give a location from the cored inside of the combustion chambers. Suitable clamps are provided on the fixture to hold the work down while the bosses are profiled with an end-mill mounted in the spindle of the one-spindle profiling machine, the operator following the bosses without using a forming plate.

Operation 8, Table IV.—This operation consists of drilling and tapping hole *H* in the fan stud boss *F*. Previous to this operation, the cylinder bolt holes have been drilled and the under side of the head has been milled so that in Operation 8 the milled surface and two of the bolt holes near the fan stud boss are used as locating points, studs being provided on the angle-plate fixture to enter the holes mentioned. In order to avoid the necessity for a second setting of the work in drilling and tapping hole *H*, the construction of the drill press was modified in rather an interesting manner suggested by the tool engineer. Referring to Fig. 10, it will be seen that the fixture itself is of the angle-plate type, which is set up on the bed of the drilling machine on a box section of cast iron in order to obtain the proper height. The table of the drilling machine is swung to one side, where it is out of the way. The drilling machine selected for doing this work is a 21-inch vertical machine on which the automatic knock-out

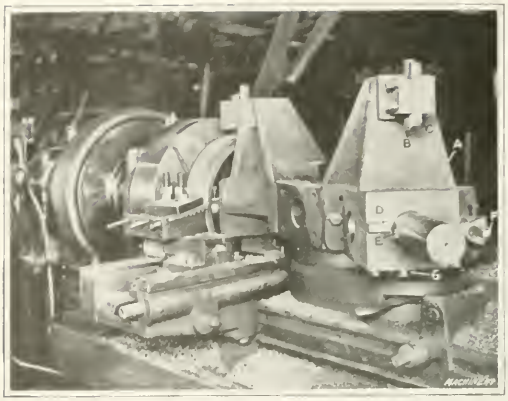


Fig. 15. No. 6 Potter & Johnston "Automatic" tooled up for turning and boring at One Setting All Surfaces on Flywheels except Crankshaft Flange Fit

for the drill feed remains standard, with the exception of the rear end of the stop which is expanded to form a dog that governs the reversal of the tap.

For tapping, an adjustable scale *A* is provided on the machine, which may be set to permit the reversing mechanism to be operated when the hole has been tapped to any desired depth within the range of the tapping attachment, the reversal being obtained by having the dog run off scale *A* so that weight *B* may throw lever *C* to reverse the clutch. The tap is backed out in this way, but it would not be lifted from the work were it not for weight *D*, which is supported by a cable wrapped around the hand-feed shaft, which exerts just sufficient pull to lift the spindle after the tap clears the work. By referring to the illustration, it will be noted that the method of holding the work on the fixture is ingenious; this is accomplished by a single hook bolt *E* having a long head, which is simply swung into place and drawn back against the work. A quick-change chuck is used to hold the drill and tap used for this work.

In estimating the production on this job, the time allowance for setting up and removing the work would not be very great, say 3/4 minute, while the exchange of the drill and tap in the quick-change chuck and *vice versa* should only require another 15 seconds, making one minute in all for setting up the work and changing the tools. A drill 5/8 inch in diameter, running at a cutting speed of 50 feet per minute, should be run at about 300 revolutions per minute to give the required cutting speed; the depth of the hole is 1 1/2 inch and the proper drill feed about 0.010 inch per revolution. Therefore, 150 revolutions would be necessary to drill the hole. This would require 1/2 minute, and allowing about 50 per cent more time than this for tapping the hole, 1 1/4 minute would be the total cutting time on this piece, or 2 1/4 minutes for setting up, removing, drilling and tapping. On this basis it is safe to assume that 25 pieces per hour can be produced on one machine, which is ample for the requirements of the case under consideration.

Machining Operations on Crankshaft

Referring to Table V, it will be seen that the first machining operation on the crankshaft consists of placing a center-punch mark at the middle of one of the center crankpins, which is used to locate the work for subsequent operations. The second operation consists of cutting off ends *C* of the drop-forging to reduce the crankshaft to its proper length. The locating points for this operation are two V-blocks, one at each end of the fixture, in which the small ends of the crankshaft rest. In order to cut off the ends of the shaft in such a way that sufficient allowance for finish will be left on all the points that are to be machined, some locating point is necessary, other than that provided by the rough forging. For this reason, the center-punch mark is placed on one of the center crankpins, the punch mark being so placed (by inspection) that it will allow a sufficient amount of stock to enable all pins and bearings to "clean up" properly. A gage point *A*, hung in a swinging bar mounted on the lathe, as shown in Fig. 11, enters the center-punch mark on the crankpin, when the crankshaft forging is properly placed in the V-blocks. After this location has been determined, the clamp at each end of the fixture is tightened to hold the work down, the operation of these clamps being controlled by handwheels *B*. A jack *C* is also used under the center crankpin to support the overhang of the crankshaft. The machine which the tool engineer decides to use for this operation is somewhat unusual, consisting of a standard engine lathe equipped with two opposed spindles and provision for the attachment of face milling cutters to the end of each spindle. The fixture is mounted directly on the carriage of the lathe in such a way that the cross-feed screw can be used to feed the work past the milling cutters and thus crop the ends off the forging. As the crankshaft is a drop-forging, the greatest care must be taken to see that sufficient stock is left at all points to permit of machining within the required limits.

In estimating production on this job, it is necessary to take into consideration the centering operation, the setting in place and removing of a rather heavy piece, and the tightening and loosening of the clamps on the fixture. The tool engineer decides that about 1 1/2 minute should be sufficient for these movements, so that nothing remains to be figured except the actual time required to take the cut. For this work it is safe to specify a cutting speed of 60 feet per minute, with a feed of 1/16 inch per revolution of the cutters. The length of travel necessary is 1 1/4 inch, and the diameter of cutters, 6 inches. A cutting speed of 60 feet per minute with cutters of this diameter means that the spindle must revolve at 40 revolutions per minute; and as the length of cut is 1 1/4 inch, 20 revolutions of the cutter at a feed of 1/16 inch per revolution would be sufficient to complete the cut. This would require 1/2 minute, making a total time for cutting off each crankshaft 2 minutes, or 30 pieces per hour.

Machining Operations on Cam-shaft

Referring to Table VI, it will be seen that Operation 1 consists of cropping the ends *A* of the cam-shaft to reduce it to the required length, the operation being performed in much the same manner as that just described for the crankshaft. The locating point for this first operation is one of the cams, which strikes against a protruding lug on the fixture to give the required longitudinal location. After the location has been determined in this manner, the work is clamped in the fixture which is similar to the one used for cropping the crankshaft. After this, the milling cutters remove the stock from the ends of the cam-shaft forging.

Operation 4, Table VI.—This operation consists of turning the center bearing; rough- and finish-turning the collar, front bearing, gear fit and threaded end; and rough-turning the

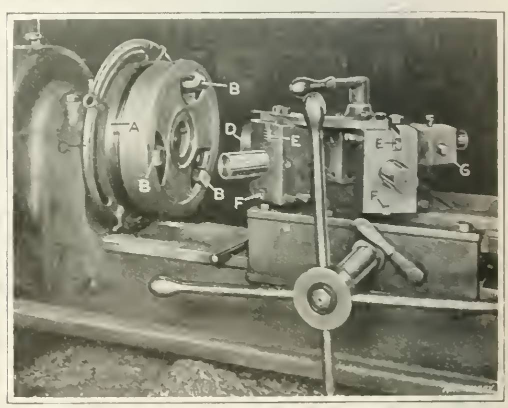


Fig. 16. No. 6 Warner & Swasey Turret Lathe tooled up for facing and counterboring Crankshaft Flange Fit in Flywheels and facing Rim around Flange Fit

cam-shaft forging between the cams and pump eccentric. For this operation the work is located on centers on a multiple turning lathe provided with an arrangement of tools so spaced as to enable them to take cuts over the various surfaces mentioned. The tools for these operations are carried by three multiple tool-blocks *A*, *B* and *C*, Fig. 12, arranged on the slide in such a way that any set of tools may be fed in to the working position by turning the proper handwheel. All the tool-blocks are traversed longitudinally at the same time by turning handwheel *D*, but there is only one set of tools in the cutting position at one time.

In estimating production on this piece, it is necessary to consider the longest cut which has to be taken, this being about 2 inches. The material from which the cam-shaft is made will permit of employing a cutting speed of from 35 to 40 feet per minute for the roughing cut, where the removal of stock is about normal. In order to be conservative, the tool engineer takes the lower figure, with a feed of about 0.020 inch per revolution. The average diameter of the work is 1½ inch, so that 95 revolutions per minute will give the proper cutting speed; and as the length of the cut is 2 inches, it requires 100 revolutions, or a trifle over 1 minute, to complete the cut. For adjusting the tools and running them back out of the way after the cut is finished, ½ minute might properly be allowed, and for setting up and removing the work, about ¾ minute, making 2¼ minutes the time required for performing the entire operation. A production then can be assumed of 25 pieces per hour. The machine tooled up for this operation is shown in Fig. 12.

Operation 5, Table VI.—This operation consists of facing down the sides of the cams, bearings, pump eccentric and collar *C*. A multiple turning lathe is also used in this case, and the work is held on centers as in Operation 4. In this case, a single tool-block is employed, using eighteen tools that are so set as to give the correct spacing for the various shoulders on the cam-shaft; and a large handwheel is employed for feeding the tools down into the work. Fig. 13 shows the equipment, together with a cam-shaft *A* which has just been machined and the gage *B* used for determining the accuracy of spacing of the shoulders on the shaft.

In estimating the production time on this piece, it can properly be assumed that the time for setting up and removing the work will be about the same as for the previous operation, *i. e.*, about ¾ minute. The feed in this instance is by hand and must be rather fine on account of the large number of tools that are working at one time; but the depth to which the tools must be fed is quite small, the greatest distance which any one tool travels being only about ⅜ inch. The speed for a cut of this kind can be about the same as that employed in the preceding operation, i. e., 95 revolutions per minute. Allowing a feed per revolution of about 0.003 inch, 125 revolutions will be necessary to feed the tools in to depth. This would require a trifle over 1¼ minute, which, in addition

Fig. 17. No. 3 Cincinnati Milling Machine for straddle-milling Bosses on Suspension Arms of Flywheel Housings—Work is loaded in One Fixture while Cutters are working on Piece held in Other Fixture

Fig. 18. Reed-Prentice 26-inch Upright Drill equipped with "Magic" Quick-change Chuck, Tools and Jig for boring, reaming and chamfering Hole for Starter-box Bearing on Flywheel Housings

to ¾ minute for setting up, would give 2 minutes, or a production of about 30 pieces per hour.

Operation 8, Table VI.—This operation consists of rough-grinding cams *H* and pump eccentric *G*. The work is held on centers, and the keyway for the cam-shaft gear is used to obtain the correct radial location for the work. In planning this grinding operation, the tool engineer considers the fact that a special cam-shaft grinder is made for work of this kind, and so he takes up the matter direct with a well known builder of cam-shaft grinding machines, allowing this firm to figure the production and submit an estimate on it. In this case, the production was given as 8 cam-shafts per hour for each machine, and so the tool engineer saw that three machines were necessary in order to give the required output. Fig. 14 shows one of the cam-shaft grinders, and this view clearly shows the master cam-shaft *A* with the controlling cams, and other features of interest. Particular attention is called to the special arrangement of the two driving belts and pulleys *B* that have a friction clutch between them which is controlled by the hand-lever *C*; this enables the bulk of the surplus stock to be ground away at high speed, after which the clutch is thrown over to engage the slow-speed pulley for completing the operation. Practically no time is lost in making this change.

Machining Operations on Flywheel

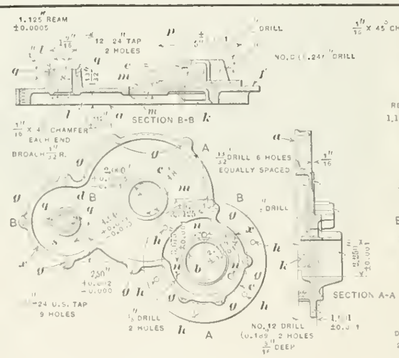
Operation 1, Table VII.—The first operation on the flywheel as shown on the operation and tool list presented in Table VII consists of boring taper clutch fit *a*; boring and reaming hole *b*, and facing inside of hub *c*; turning two outside diameters *d* and *e*; facing front and back edges *f* and *g* of the rim and putting a radius on all edges. It is very important in machining an automobile flywheel to hold the work in such a way that there will be no possibility of its slipping during the process of machining; and as the cuts are usually very heavy, it is good practice to hold the work so that the required driving power can be obtained without setting the chuck jaws up tight enough to distort it. If a method of holding can be so devised that advantage is taken of some

adequate driving surface on the work, much more satisfactory results are likely to be obtained. In the present case, the design of the flywheel lends itself admirably to holding, for the first setting, in a three-jaw geared scroll chuck, the jaws of which can be inserted through the cored holes in the web of the flywheel in such a way that one jaw engages the edge of the cored hole and constitutes an efficient driver. Special jaws are provided for the chuck, which are so designed that they will grip the web in the cored openings and at the same time leave the necessary clearance between the work and body of the chuck so that face *f* of the rim can be machined at the first setting. The jaws must also allow room enough to bore the taper of the clutch fit *a* without interfering.

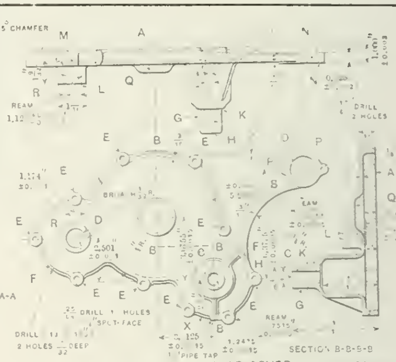
The machine selected for doing this work is a heavy type semi-automatic chucking machine provided with an exceptionally efficient tool equipment which enables it to turn out the work in an unusually short time. Great care was exercised in the design of tools for this operation in order to have as many combinations of cutting tools as possible working at the same time, and thereby lose a minimum amount of time during the machining operations. Reference to Fig. 15 shows the general arrangement of the tools. In developing the design it was decided to arrange special tools on the turret which provide for simultaneously turning the rim to both diameters, facing the inner hub, boring the straight hole in the hub, and boring the tapered clutch fit by means of a generating tool which gives better results than would be obtained with a form tool. The body of tool-holder *A* is bolted on the turret; and it is ribbed to form a rigid support for the overhead tools *B* and *C* that turn the two diameters on the rim, these tools being carried by a special tool-block. The lower portion of tool-holder *A* is carried forward sufficiently to overhang the cross-slide on the machine, and is provided with facing tool *D* for machining the hub, and piloted boring-bar *E* for finishing the straight hole in the hub.

The inside taper-boring tool *F* is arranged in an interesting way, being mounted in a bar which is a running fit in a hole through the body of the tool-holder. A slot in the under side of the tool-holder allows for movement of a stud that extends downward from bar *F* and carries a hardened and

TABLE VIII. MACHINING OPERATIONS ON TIMING GEAR-CASE AND COVER—MATERIAL, CAST IRON



TIMING GEARCASE AND FRONT CRANKSHAFT BEARING



TIMING GEARCASE COVER

Machinery

MACHINING OPERATIONS ON TIMING GEAR-CASE

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Mill face of flange a	No. 5 vertical milling machine	Clamping fixture to hold two castings	Under side of casting	20	1
2	Disk-grind face of flange a	No. 2 disk grinder	....	....	40	1
3	Bore and ream bearing holes for crankshaft b, cam-shaft c and magneto shaft d	28-inch vertical drilling machine	Quick-acting chucks. Special three-spindle drill head	Outside of crankshaft bearing boss and inside of magneto gear housing	25	1
4	Turn outside of crankshaft bearing boss e to diameter of 5 inches and face surface f surrounding boss	30-inch vertical boring mill	Special fixture	Machined holes for crankshaft bearing b and magneto shaft bearing d	30	1
5	Drill ten holes g in flange	Multiple spindle drilling machine	Jig on ways to run out from under spindles. Jig supported on trunnions to swing over for loading	Machined holes for crankshaft bearing b and magneto shaft bearing d	30	1
6	Drill five holes h in front crankshaft bearing flange	24-inch vertical drilling machine	Jig plate fits over 5-inch bearing boss e. Six-spindle special drill head	Turned crankshaft bearing boss e and pin in drilled hole	60	1
7	Spot-face inside of crankshaft bearing hub k	24-inch vertical drilling machine	Fly-cutter with pilot to enter bearing hole b	Turned crankshaft bearing boss e and pilot on cutter	60	1
8	Spot-face inside and outside of cam-shaft bearing boss m	24-inch vertical drilling machine	Piloted spot-facing tool	Cam-shaft bearing hole c and flange a	35	1
9	Spot-face inside and outside of magneto shaft bearing boss l. Chamfer edges of hole d	24-inch vertical drilling machine	Piloted spot-facing tool, chamfering tool and quick-change chucks	Magneto shaft bearing hole d	30	1
10	Drill three holes n in crankshaft bearing boss	14-inch vertical drilling machine	Piloted jig plate and special drill head	Crankshaft bearing hole b and one of drilled holes in boss	60	1
11	Drill hole p in crankshaft bearing oil pocket	14-inch vertical drilling machine	Jig plate to hold work vertically	Crankshaft and cam-shaft bearing holes b and c	40	1
12	Drill two No. 12 holes q in magneto shaft bearing boss	14-inch vertical drilling machine	Jig plate	Crankshaft and magneto shaft bearing holes b and d	60	1
13	Tap nine holes g in flange and two No. 12 holes q in magneto shaft bearing boss	No. 2 automatic tapping machine	Quick-change chucks. No fixture used	....	25	1
14	Broach oil groove s in magneto shaft bearing boss	No. 3½ arbor press	Broach	....	40	1
15	Hand-ream magneto shaft bearing hole d	Bench	Vise. Reamer	....	50	1
16	Drill two dowel-pin holes x in flange a	Two-spindle vertical drilling machine	Jig plate	Crankshaft and magneto shaft bearing holes	50	1

TABLE VIII. MACHINING OPERATIONS ON TIMING GEAR-CASE AND COVER—CONTINUED

MACHINING OPERATIONS ON TIMING GEAR-CASE COVER

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Locating Points	Estimated Hourly Production per Machine	No. of Machines
1	Mill face of flange A	No. 5 vertical milling machine	Clamping fixture to hold one casting	Under side of casting	11	2
2	Disk-grind face of flange A	No. 2 disk grinder	....	....	20	1
3	Bore and ream bearing holes for starter-crank shaft C and magneto shaft D	24-inch vertical drilling machine	Quick-change chucks. Two-spindle drill head	Starter-crank shaft bearing boss and inside of magneto gear housing	22	1
4	Drill ten holes E in flange A	Multiple spindle vertical drilling machine	Jig on trunnions to swing over for loading and drilling	Starter-crank shaft bearing hole C and magneto shaft bearing hole D	25	1
5	Drill two No. 12 dowel-pin holes F in flange	Two-spindle 24-inch vertical drilling machine	Drill jig	Magneto shaft bearing D and starter-crank shaft bearing C	50	1
6	Rough- and finish-mill starter-crank support G, spot-face end H and fillet shoulder K	24-inch vertical drilling machine	Quick-change chucks and hollow milling cutters	Pilot on tool enters bearing C	30	1
7	Spot-face surfaces L and M on magneto shaft bearing boss	28-inch vertical drilling machine	Piloted spot-facing tool	Pilot on tool enters bearing hole D	35	1
8	Straddle-mill starter shaft bearing boss N	No. 1½ milling machine	Fixture for holding work vertical	Finished face of flange A	24	1
9	Bore and ream starter shaft bearing O	24-inch vertical drilling machine	Quick-change chucks	Magneto shaft bearing D and starter-crank bearing C	50	1
10	Drill drain hole X for ⅛-inch pipe tap	28-inch vertical drilling machine with tapping attachment	Quick-change chucks and drill jig	Magneto shaft bearing D and a drilled hole E in flange A	60	1
11	Drill two holes P in starter shaft bearing boss N	18-inch vertical drilling machine	Special two-spindle drill head and piloted jig plate	Starter shaft bearing O	60	1
12	Spot-face all holes E in flange	20-inch vertical drilling machine	Spot-facing tool. No jig used	....	30	1
13	Spot-face clearance Q for end of cam-shaft and chamfer sides L and M of magneto shaft bearing	25-inch vertical drilling machine	No jig	....	60	1
14	Broach oil groove R in magneto shaft bearing	Arbor press	Broach	....	60	1
15	Wash and inspect	Soda kettle	Gages	....	..	..

Machinery

ground steel roll *G* on its lower end. This roll engages a cam plate having a slot of the proper angle to give the required taper to the clutch fit in the flywheel. The cam plate is set over the cross-slide so that the roll will engage with it during the forward motion of the turret slide, thus providing for generating the taper clutch fit with a single-point tool. Two complete sets of turret tools are provided on the machine—one for roughing and the other for finishing—and special tool-blocks are placed at the front and rear of the cut-off slides, which are arranged to act simultaneously with the turret tools. The cross-slide tools face the front and back edges for the rim, and cut the various rounded corners on the rim. This equipment possesses many excellent features of design, and gives an exceptionally high rate of production.

In estimating production on this work, it should be remembered that the speed must not exceed that required for the largest diameter. For this reason, the boring and internal facing operations will really be done at a much slower rate of speed than that which could be used if other tools were not in use at the same time. The largest diameter of the flywheel is about 14¼ inches in the rough state; and as the iron in the castings is of good quality, it would be perfectly safe to assume a cutting speed of 50 feet per minute with a feed of from 0.040 to 0.060 inch per revolution. The length of cut on the tapered inside surface is 2⅜ inches, but as a small amount must be allowed for the sides and ending of the cut, the tool engineer would consider 2½ inches of travel to be necessary. Figuring on this conservative basis, with a feed of 0.040 inch per revolution, the number of revolutions necessary would be $\frac{2.500}{0.040} = 63$. Using a cutting speed of 50 feet per minute, which requires a spindle speed of 13 revolutions per minute, the time needed to make the cut is $\frac{63}{13} = 5$ minutes.

In connection with this operation, it will be noticed by reference to the illustration that a wide tool *D* is used to face the inner surface of the hub, and it naturally follows that this kind of cut must be done with a very fine feed. The amount of stock to remove at this point is assumed to be about 3/32 inch; and it would be an easy matter to arrange the camming of the machine in such a way that a feed of from 0.003 to 0.005 inch per revolution could be used at this time. Always keeping on the safe side in estimating, the tool engineer decides that a feed of 0.003 inch per revolution could be used for taking the facing cut, requiring about 30 revolutions to complete it and occupying 2½ minutes, which, in addition to the 5 minutes consumed in turning, would bring the total cutting time for this operation up to 7½ minutes. The finishing operation, which is performed by the second set of tools, can be done at about the same feeds with a slightly greater speed, say 70 feet per minute, or about 18 revolutions per minute. In taking the finishing cut, the tools would be ground so that a slight drag would be produced in order to leave a smooth finish on the surface of the castings. The time necessary for the finish-turning would be 63 ÷ 18 or about 3½ minutes, and the finish-facing of the hub would require simply a smoothing up operation, taking approximately 1 minute. This makes the total machining time for the second operation about 4½ minutes.

The cross-slide tools used in machining the edges of the rim can be used simultaneously with the turning and boring tools, and the time necessary for their work is somewhat less than that required for the work done by the turret tools, so that this need not be considered in estimating. In summing up the time necessary for taking the various cuts included in this operation, we find that the first cut consumed 7½ minutes and the second 4½ minutes, to which we should add about ½ minute for indexing and other movements of the turret and slide, together with about 2½ minutes for setting up and removing the work. This makes a total of 15 minutes for the entire machining operation and corresponds to a production of 4 pieces per hour. This would normally require five machines to give the desired production, but owing to the fact that breakdowns are likely to occur, and to allow for other manufacturing contingencies such as the grinding of tools and replacements, etc., it would be well to include another machine to insure that the production may be kept up to the required amount.

Operation 2, Table VII—Referring again to the tool and operation list for the flywheel presented in Table VII, it will be seen that Operation 2 consists of counterboring and facing fit *h* for the flange on the crankshaft, and facing surface around the flange fit. It is important for these surfaces to be machined concentric and square with the tapered clutch fit finished in the preceding operation; and so the tapered clutch fit should be used as a locating surface on which to hold the work during the machining operations at the present setting. In order to do this, the holding device which is used must be arranged to draw the work back onto a tapered seat with

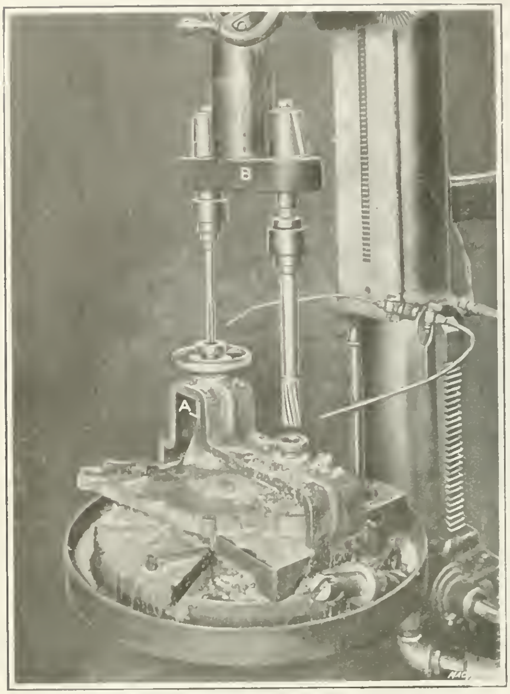


Fig. 19. Cincinnati 24-inch Upright Drill equipped with Sellew Two-spindle Drill Head, Wiard Quick-change Chucks and Tools for boring and reaming Starter-crank Shaft and Magneto Shaft Bearings in Timing Gear-case Covers

a uniform pressure, so that no "cocking" will result. In this instance, the tool engineer decides to use a machine of the turret lathe type, but without automatic features, because the cuts to be made are very short and can be handled to advantage on the regular type of turret lathe.

Fig. 16 illustrates the tool equipment provided for this operation, and the holding device is clearly shown with a flywheel in position on it. This device consists of a special faceplate *A*, with a tapered seat corresponding to the taper of the clutch fit in the flywheel, and three hooks *B* for holding the work, which are operated by the large ring *C*. The design of this device is such that the pressure is equalized on the three hooks, so that the work is drawn back onto the seat with a uniform pressure. On the first face of the turret, there is a disk *D* that will just enter the flange fit in the flywheel, and in setting up the work, this disk is pushed up against the flywheel to hold it on the faceplate until hooks *B* have been tightened. The tools used for this operation are piloted into a bushing in the faceplate, and consist of two pairs of tools *E* and *F* for roughing and finishing the base of the fit and the narrow flange that surrounds it. The final sizing of the fit is done by a single-point tool *G* in the fourth face of the turret, which takes a very light cut, this tool being piloted in the bushing like tools *E* and *F*. Attention is called to the fact that all the tools used in this operation are conveniently adjustable and are also made so that replacement can be effected with little expense or loss of time. It should also be noticed that the roughing tools are serrated in order to break up the chips and make the cutting action easier. This is an important point in the design of roughing tools that are obliged to encounter scale, as it will frequently happen that a tool of this type used for facing work that presents a smooth surface to the tool will be ruined in a very short time when attacking the scale unless the chip is broken by serrating the cutting edges so that the tool will take hold more easily.

In estimating the time necessary for this operation, the tool engineer is obliged to use his judgment as a guide and do very little figuring, because the cuts are so short that it would not be practical to use power feed on the machine. He would consider the fact that the first or roughing tool would be presented to the work and fed in by the spider wheel until the proper depth had been reached, and he would assume that the operator could bring sufficient pressure to bear on the wheel to approximate a feed of about 0.005 inch per revolution of the work. As the depth of the cut is 3/16 inch plus the finish allowance of, let us say, 3/32 inch, it would be safe to assume that the distance traveled is 9/32 inch or 0.282 inch. The cutting speed permissible for a facing operation of this kind should not be over 50 feet per minute, and the diameter at which the cutting tools are at work is approximately 6 inches. The number of revolutions per minute should be about 32 to give the necessary cutting speed. The number of revolutions required is $\frac{0.282}{0.005} = 56$ (approximately). From this, the time occupied is found to be $\frac{56}{32} =$ a trifle less than 2 minutes.

The second operation performed at this setting is very short, only requiring the operator to bring up the second turret tool and shave off the surfaces until the proper depth has been reached. The tool engineer might safely assume that 30 seconds would be ample for this operation. In the final cut the feed is by hand, as in the previous case, and the operation consists of sizing the flange fit diameter with a single-point tool. The cut is very light in this instance and simply requires that care be used in obtaining a smooth cut, so that 30 seconds would be ample. Allowing 15 seconds for indexing between the various cuts on this piece, and a setting up time of 2 minutes for each piece, the total time consumed for this operation would be $5\frac{1}{4}$ minutes, which is equivalent to an hourly production of slightly more than 11 pieces. It will be seen that this production is about half what is necessary, and so two machines will be required to do the work. The equipments used on Operations 1 and 2 on this flywheel are excellent examples of the work of the tool engineer in planning methods of machining to obtain the maximum production.

Machining Operations on Flywheel Housing

Operation 1, Table VII.—In order to produce work of this kind to good advantage, it is necessary that in one of the first operations a large surface should be trued up and put

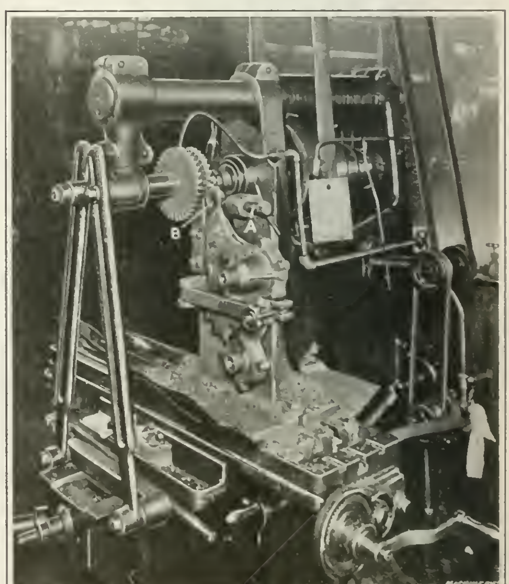


Fig. 20. No. $1\frac{1}{2}$ Cincinnati Milling Machine with Fixture for straddle-milling Starter-shaft Bearing Boss on Timing Gear-case Covers

into condition for use as a locating point. In this particular case, the large flange would form an ideal locating surface for subsequent operations; hence it is well to provide for machining this surface in the first operation. Apparently the most desirable locating point in holding this piece would be the under side of the casting, and the fixture used would contain three fixed points in a triangular formation, together with several adjustable points to form additional supports. Owing to the fact that the only points on which clamps can be placed are the suspension arms and pad for the starter box, additional means of clamping must be used on the side which has no projection. The clamp that appears to be best suited for this purpose is one of the knife-edge swinging type; or the clamp could be made with a pointed set-screw, placed at a slight angle so it will draw the work down onto the fixture. This point could be left to the judgment of the tool designer when laying out the fixture, as there would be no particular choice between the two methods of clamping except in regard to the rapidity of operation.

When deciding upon the type of machine for doing this work, the tool engineer reaches the conclusion that a heavy vertical milling machine having a large cutter to extend over somewhat more than half the piece would give the best results, two cuts being necessary to complete the facing operation. In this case a cutter having a diameter of about 10 inches would be sufficient to cover a little more than half the casting at each cut. The problem of machining this particular casting requires no special attention, except that the method of holding must be very rigid so that chatter will not be produced by the cutter acting against an unsupported surface and causing vibration.

Operation 5, Table VII.—This operation consists of straddle-milling suspension arms *F*. In considering the method of locating and the surfaces from which to hold the work for this operation, the tool engineer decides that one of the locating surfaces must be the finished edge of the transmission flange; and the other important locating points must be the surfaces of the bosses to be milled. The tool engineer decides that a good machine to use for this work is a horizontal milling machine having a table of sufficient length to carry two of the castings at a time. His idea is that the work can be produced very rapidly by using a fixture holding

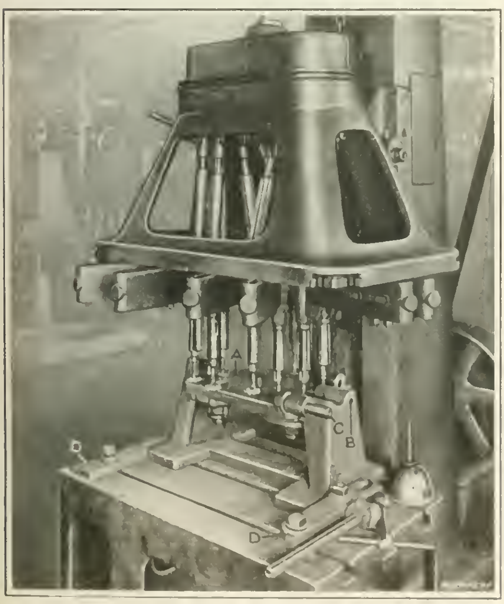


Fig. 21. Baush Multiple-spindle Drill equipped for drilling Ten Holes in Flange of Timing Gear-cases—Note Means for turning over Jig Plate and sliding Entire Fixture out from under Spindles for loading

Fig. 22. Cincinnati 24-inch Upright Drill and Sellew Six-spindle Drill Head for drilling Five Holes in Front Crankshaft Bearing on Timing Gear-cases

two pieces and working from one to the other. In planning this operation, the tool engineer first considers that the suspension arm at each end of the casting must be machined, and that the locating point in milling one of the suspension arm bosses must be the rough surface of the boss on the opposite arm, while in milling the second boss the locating surface must be the previously milled surface of the first boss. The combination fixture is shown in Fig. 17, and this illustration indicates the method which the tool engineer developed for doing this particular piece of work. It will be seen that on the right-hand end of the table, the fixture is so arranged that the rough surfaces of the boss at farthest from the cutter are held by the locating clamps, and these clamps are operated by a handwheel conveniently placed. The fixture at the other end is arranged with a slot cut in a lug *B*, into which the finished boss is dropped to locate the work for taking the cut on boss *C* on the suspension arm at the other end of the flywheel housing.

The work is clamped down on both fixtures by means of a central stud and collar which draw the castings down against the finished face of the flange. The suspension arm bosses on which the cut is taken are supported by means of plungers operated by two handwheels that will be seen on the fixture near the cutters. Attention is called to the fact that the cutter is working downward against the boss on the right, while in making the cut on the left the action of the cutter tends to lift the work. A cut of this kind might easily cause chatter unless suitable provision were made to guard against it in the design of the fixture. This point has been very well taken care of in the present instance by means of handwheels which operate the supporting pins previously mentioned, and by a supplementary clamp *D* on the left, which draws the work down and holds it securely against the lifting action of the cutter so that there is no possibility of spring under the pressure of the cut.

The procedure in milling this piece is as follows: The

operator first takes the casting, places it on the right-hand side of the fixture and machines the first boss as shown in the illustration. He then removes the casting and places it on the section of the fixture at the left, locating the finished boss in the slot in lug *B*. The movement of the table is now reversed and the milling cutter works on the boss on the suspension arm at the opposite end of the flywheel housing. While this is being done, the operator puts a new casting on the right-hand end of the fixture which is free to receive it, and is just about able to set up this piece in place by the time the milling cutter is ready to start working on it. Then the table is again moved over so that the cutters attack the new piece and this procedure is repeated on all the work so that the operation of milling is almost continuous.

In estimating production, the tool engineer decides that he will use a cutter 6 inches in diameter on which he assumes a cutting speed of 60 feet per minute, because of the open nature of the work and the comparatively small amount of surface covered in the machining. A fairly good finish is desired on the bosses, and for this reason a comparatively fine feed would naturally be used. The length of surface to be covered by the cut is a trifle over 2 inches; and the length which it would be safe to use for estimating purposes might be called $2\frac{1}{4}$ inches. The 6-inch cutter revolving at 40 revolutions per minute would produce a cutting speed of 60 feet per minute, and a feed of 0.040 inch per revolution of the cutter would produce a finish of about the quality desired on the bosses. As the cut is 2.250 inches in length and the feed 0.040 inch per revolution, the number of revolutions that would be necessary to make this cut on one end of the suspension arm would be $\frac{2.250}{0.040} = 56$ revolutions which, divided by 40 revolutions per minute, would give approximately $1\frac{1}{4}$ minute as the time required for the operation.

The piece at the other end of the table can now be brought into contact with the cutters and machined in a similar manner. The same amount of time would be necessary for this cut as for the previous one, making $2\frac{1}{2}$ minutes for the double cut. While one cut is being taken, the operator removes the piece just finished, and during the entire progress of the work one piece is being removed from the fixture during every cutting operation, so that in figuring production it is only necessary to consider the entire cutting time for two bosses, which in this instance would be $2\frac{1}{2}$ minutes, which would give a production of 24 pieces per hour. It will be seen that this production leaves no time for the operator to attend to such matters as the removal of a set of cutters from the arbor and their replacement by a new set, or for other contingencies frequently met with in manufacturing. For this reason it would be safer to assume that the production would be about 22 instead of 24 pieces per hour. In any case, one machine would be sufficient to give the necessary production on the flywheel housing.

Operation 7, Table VII.—This operation consists of boring, reaming and chamfering hole *H* for the self-starter box bearing. In deciding on the locating points for this operation, the relation of the starting shaft hole to the center of the crankshaft bearing must be considered, and knowing that this relation must be kept to an exact limit, the tool engineer decides that the locating must be done from the finished center hole in the flywheel housing. The location of the hole to be machined must also bear a definite relation to faces on the suspension arms which have been milled in the previous operation, and so these faces must also form one of the points from which the location must be determined. The surface of the large flange on the casting makes an ideal support for the work during this operation, and the tool engineer is careful in instructing his designer to relieve the supporting surfaces so that a small amount of contact will minimize the chance for chips accumulating on the locating surface. Reference to Fig. 18 will show the general construction of the jig. Attention is called to the method of locating the two suspension arm surfaces by means of cam-operated plungers *A*. The cams *B* on each side of the fixture are operated simultaneously by means of the horizontal link *C* which extends across to connect with a short lever on the lower end of each cam. Both the plungers are carried forward the same amount until they meet the milled surfaces on the bosses. As a center location in the casting is essential, it is necessary to make these two points which bear against the suspension arms in such a way that they will be drawn back out of the way while placing the casting in position. The work can then be slipped onto the central stud and positively located by operating the lever which controls the cam-actuated plungers *A* that engage the pads on the suspension arms. After this, the clamps are tightened and the work is ready for machining. The tools used for this operation are a core drill, counterbore, and reamer, which may be seen in Fig. 18. Slip bushings are provided for the four-lip drill and also for the reamer, but the countersink is used in the open hole without any bushing, because it only takes a light cut.

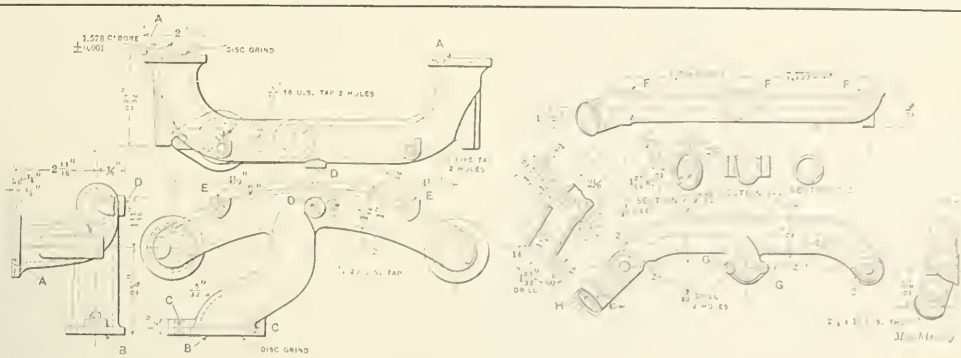
In estimating the production on this work, sufficient time must be allowed for changing the various tools and slip bushings. To facilitate the exchange of tools, the spindle is fitted with a quick-change type of chuck. The diameter of the hole to be bored is $2\frac{1}{4}$ inches and the thickness of the web through which it passes is 1/4 inch. A cutting speed of 50 feet per minute would require the core drill to run at about 90 revolutions per minute; and a feed of 0.020 inch per revolution would be feasible for use in taking this cut. It would be safe to assume that the total distance through which the drill passes will not be over 1/2 inch, including the chamfer on the end of the drill, so that the number of revolutions necessary to complete the cut would be $\frac{0.50}{0.020} = 25$, which is equivalent to about 17 seconds. The chamfering operation would simply require the tool to be lowered into the hole and given a slight movement with the feed lever to "break" the sharp edge of the hole, the estimated time for this operation being 10 seconds. The reaming cut in cast iron could also be done by hand in a very short time, the estimate being about 10 seconds. Allowing 10 seconds for each interchange of tools during this series of operations, 10 seconds for each removal and replacement of bushings and 40 seconds for setting up and removing the work, we would have as a total a little over 2 minutes for each piece. A certain amount of time should also be added to this for the movement of the spindle and the cleaning out of the jig from time to time, so that it would seem to be safe to give a production of $2\frac{1}{2}$ minutes or 24 pieces per hour on the machine. Under these conditions it would be found that one machine is sufficient to give the necessary production.

Machining Operations on Timing Gear-case Cover

Operation 1, Table VIII.—In studying the design of this piece, it would be apparent that the first operation should consist of taking a milling cut across the face of the flange *A*, to provide a locating point for subsequent operations; and the question will immediately arise as to whether the piece could be held securely during this milling operation. In looking over the outline it will be seen that the arm containing bearing *O* could be used for holding down one portion and that knife-edge clamps could be applied below the milled surface at other points around the contour. As this operation is the only one that would be likely to cause difficulty in clamping, the conclusion would at once be reached that the casting could be used in the condition shown without the necessity of employing any additional holding lugs. In determining the point from which to start the work, the irregular face *A* of the flange is selected because it is the only continuous machined surface of any size on the piece. As the piece is of cast iron and the flange of irregular shape, it is evident that it can be machined to good advantage with a large inserted-tooth mill mounted on a vertical milling machine.

Operation 3, Table VIII.—The logical way to decide upon the next operation (after flange *A* has been milled and ground) is to note that there are two holes in the piece which act as bearings and that the location of these holes in relation to each other is important. In addition, it must be

TABLE IX. MACHINING OPERATIONS ON INTAKE AND EXHAUST MANIFOLDS



Intake Manifold

Exhaust Manifold

MACHINING OPERATIONS ON INTAKE MANIFOLD—MATERIAL, ALUMINUM

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Disk-grind port flanges A and carbureter flange B	No. 2 disk grinder	....	....	50	1
2	Counterbore intake ports A	24-inch vertical drilling machine	Adjustable V-block fixture	Outside of ends of pipe	60	1
3	Drill two holes C in carbureter flange. Drill hole D in side of manifold	18-inch two-spindle vertical drilling machine	Jig with bushings in three sides. Two-spindle drill head	Finished flanges and carbureter port B	50	1
4	Drill two holes E	18-inch two-spindle vertical drilling machine	Same jig as that used for Operation 3	Finished flanges	50	1
5	Tap holes C, D and E	No. 2 automatic tapping machine	Quick-change chucks. Same jig as for Operations 3 and 4	Finished flanges	20	1

MACHINING OPERATIONS ON EXHAUST MANIFOLD—MATERIAL, CAST IRON

Operation No.	Operation	Type and Size of Machine	Tools, Fixtures and Gages	Location Points	Estimated Hourly Production per Machine	No. of Machines
1	Grind faces of flanges F	No. 2 disk grinder	....	....	90	1
2	Counterbore ports F	28-inch vertical drilling machine	Special three-spindle drill head. V-block fixture	Outside of pipe	60	1
3	Drill two holes G in center flange F	24-inch vertical drilling machine	Special two-spindle drill head. Fixture with pilots to enter ports F	Counterbored ports F	60	1
4	Bore, countersink, hollow-mill and thread end H	28-inch vertical drilling machine	Quick-change chucks. Opening die	Counterbored ports F	20	1
5	Air test at pressure of 60 pounds per square inch	Special testing machine	Pressure gages	....	..	..

borne in mind that the shafts which pass through these holes carry gears, and these gears must have clearance inside the case. The surface of flange A which has been previously milled and ground to a nice finish should be used as a primary locating surface on which to rest the piece, while the rough surface of the casting inside of the gear-case near bearing D should be used for the secondary locating point in a horizontal direction. Suitable pins or studs can be easily arranged in the fixture so that the work can be quickly located against them. A third point of location is provided by a bell-mouthed bushing that screws down onto the top of the boss surrounding the starter-crank shaft bearing C. This is clearly shown at A in Fig. 19. In this case, clamping the work would present no difficulty whatever, as the piece rests on a finished surface and the clamps can be conveniently placed around the outline of the casting. The type of machine upon which the work is to be done must now be decided upon, and this would ordinarily call for the use of a two-spindle drilling machine with adjustable spindles; or an upright single-spindle drilling machine having sufficient power to pull two drills of the required size could be used, equipped with a drill head made up to give the correct center distance between the drill spindles. The tool engineer decides to use a 24-inch vertical drilling machine for the reason that there are more of these machines in the factory than the other type of machine, and the special drill head B can be made up without difficulty. The fixture will be made in such a way that the bushings are of the slip type, with the exception of the screw bushing A, Fig. 19. This brings up another point in the design of the tools, which is the removal of the drills and their replacement by reamers during the process of the work. An opportunity is here given for the tool engineer to make use of a quick-change type of drill chuck, which allows the drills to be quickly replaced by the reamers and *vice versa*.

In figuring production, it must be remembered that two tools are used in each hole, *viz.*, a four-lipped core drill and a finishing reamer. The depth of the longest hole is $1\frac{3}{4}$ inch, which, considering the rough state of the casting and the angular point of the drill, may be considered as a 2-inch run for the drill. A cutting speed of 50 feet per minute can be safely assumed for this material, and as the largest hole is a trifle over 1 inch in diameter, the speed must be 200 revolutions per minute. A feed of 0.020 inch per revolution could be employed were it not for the fact that simultaneously with this drilling of the cored hole the smaller hole must be drilled from the solid, which would require the use of a twist drill and a feed of 0.007 inch per revolution. As these two tools are working at the same time it would, of course, be necessary to make the feed of both drills the same as that required for the small hole, *i. e.*, 0.007 inch per revolution

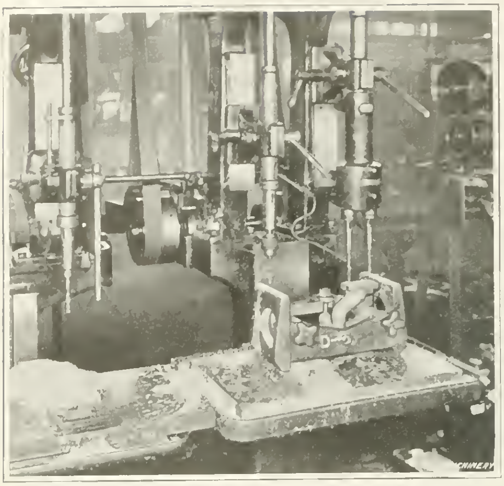


Fig. 23. "Avey" Two-spindle Drill Presses and Sellew Drill Head for drilling All Holes in Intake Manifolds without requiring Work to be reset in Fixture

The long hole would require $\frac{2}{0.007} = 286$ revolutions to complete the drilling operation. Then, $\frac{286}{200}$ = approximately 1½ minute, which is the time required for performing the operation. In preparing for the reaming operation, it is necessary to change the tools in both spindles, and for this purpose quick-change chucks are employed so that the work can be done rapidly. The tool engineer allows 15 seconds for making the change of tools, 20 seconds for performing the reaming operation, and 40 second for setting up and removing the work. This brings the total time necessary for one complete operation up to 2 minutes, 45 seconds, which gives a production of about 22 pieces per hour.

Operation 8, Table VIII.—The tool engineer has as yet made no provision for machining surfaces *N* on each side of the starter shaft bearing *O*, and it would be well to machine these surfaces at this time in order to provide an accurate machined surface against which the drilling may be done. Consequently, it would seem advisable to straddle-mill this boss, using the finished surface *A* of the flange as a locating point, so that the relation between the finished inner side of the boss and the flange will be uniform. In order to hold the piece in such a way that the boss will be in the correct relation to the cutter, it is necessary to build the fixture so that the piece will stand up almost on end, having the starter shaft bearing boss at the top. The design of the fixture presents no particular difficulty except that it must be built very substantially on account of its height, so that no chatter will be produced by the cut. The milling cut taken at this time is not particularly heavy; hence a No. 1½ milling machine is selected for doing the work, as the power required is not excessive. This fixture is shown in Fig. 20. It will be seen that a backing-up screw *A* is placed directly behind boss *B* which is being faced on both sides, so that the work will be adequately supported against the cut, and thereby chatter will be prevented.

In figuring the production on this piece, it can be safely assumed that the cutting speed at which the work should be done is 50 feet per minute, because the material is cast iron; and as the cutter is 6 inches in diameter it would require 34 revolutions per minute to obtain this cutting speed. The travel of the table must be about 2¼ inches in order to complete the milling operation; and a feed of 0.040 inch per revolution would be about right for this operation, owing to the fact that the work stands very high above the table and the feed cannot be heavy. The number of revolutions necessary to complete the cut will be $\frac{2.250}{0.040} = 56$, and as the cutter is revolving at the rate of 34 revolutions per minute, 1 minute, 40 seconds is required. Allowing about 45 seconds for setting up and removing the work, and 5 seconds for returning the table to its position after making the cut, the total time consumed would be 2½ minutes, giving a production of 24 pieces per hour. Consequently, one machine only need be used.

Machining Operations on Front Bearing and Gear-case

Operation 1, Table VIII.—Referring to Table VIII, it will be seen that the first operation on this piece consists of milling the face of the flange *a*, and in considering this operation, the tool engineer first determines the point from which the work should be located. He considers that it is advisable to mill the face of the flange in the first operation so that a reliable surface can be obtained for locating the work in subsequent operations. As the casting is in the rough, it must be supported on three points which are fixed, and other adjustable supports must be provided to hold the work under the points where the milling operation is taking place. In general construction, a fixture for this purpose will be designed on somewhat the same lines as that used for the gear-case cover, so a detailed discussion of the matter is unnecessary.

Operation 5, Table VIII.—This operation consists of drilling ten ⅜-inch holes *g* in the flange. In determining the method of locating the work, the tool engineer considers the fact that the holes in the flange which are to be drilled in this operation should be located in a certain fixed relation to the magneto-shaft, cam-shaft, and crankshaft centers. But as it is not practical to arrange a fixture with studs for each of these three points, the crankshaft and magneto-shaft bearing holes *b* and *d* are selected because they are the farthest apart. In addition to these points, the previously milled surface of the flange would naturally be the surface on which the work should be clamped. Having selected the locating points, the tool engineer would next consider the machine to be used, and in this case a multiple spindle drilling machine would naturally be selected.

As previously mentioned, the logical way in which to hold the work would be to locate it on two studs and clamp it against the finished surface of a jig plate in which the drill bushings would be mounted. But, as the drilling should be

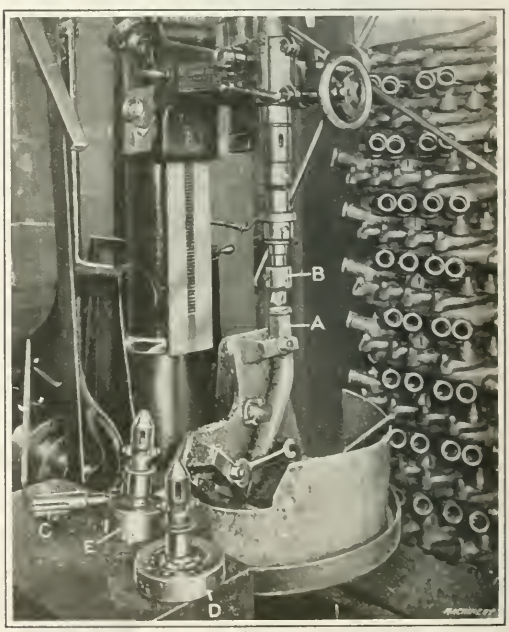


Fig. 24. "Aurora" 28-inch Upright Drill equipped with "Wizard" Quick-change Chuck and Tools for drilling, countersinking, hollow-milling and threading End of Exhaust Manifolds

done from the side toward the finished surface of the work, it is apparent that it would be rather awkward for an operator to place the piece in position on the fixture, because it would have to be held on the under side of the jig plate. The operator would be obliged to lift the piece up into position, and hold it there during the clamping operation. In order to avoid this difficulty, the tool engineer decides to make the fixture as shown in Fig. 21, mounting the jig plate *A* on trunnions *B* so that in loading, the work can be placed directly on top of the jig plate and clamped in position, being afterward revolved to the position shown and located by the knurled pin *C*. Furthermore, it would be rather difficult to set up the work on the fixture while it is directly under the spindles, and so straps *D* are placed on the drilling machine table, which act as guides for pulling out the jig from under the spindles and pushing it back again. In this way the operator can load the fixture without difficulty, and a suitably arranged stop can be provided so that it can be pushed into the proper position with little trouble.

In figuring production on this piece, it must be remembered that the drilling operation takes place against the clamps and, furthermore, that there are ten drills acting simultaneously so that the accumulated pressure exerted is considerable. Reference to the view of the work shown at the upper left-hand portion of Table VIII will show that nine holes are drilled with a 3/8-inch tap drill and one with a 13/32-inch drill. The cutting speed can be safely assumed to be 50 feet per minute, which for drills of this size would be equivalent to 440 revolutions per minute. In order to minimize the effect of the pressure of the cut in drilling, the tool engineer decides that a feed of 0.005 inch per revolution will be about all that can safely be used. The total length of the drilled hole is 1.500 inch, which divided by the feed would give $\frac{1.500}{0.005} = 300$ revolutions or approximately 45 seconds as the time occupied by the drilling operation. Allowing in addition to this, say 15 seconds for the raising and lowering of the drill head, and 1 minute for setting up and removing the work, the total time will be 2 minutes for each piece, which is equivalent to a production of 30 pieces per hour.

Operation 6, Table VIII.—This operation consists of drilling five 13/32-inch holes *h* in the front crankshaft bearing flange. In locating the work in the drill jig, the turned crankshaft bearing boss *c* is selected by the tool engineer for the reason that the position of the holes to be drilled must bear a definite relation to the surface of this boss. It is feasible to rest the work on the finished surface of flange *a*, and to use a plate type of jig *A*, Fig. 22, that can be dropped over flange *c* and that has a dowel-pin which enters one of the previously drilled holes, thus making the location both positive and simple. In order to facilitate handling the jig, a generous sized handle is attached in a convenient place, as shown in Fig. 22. A special type of drill head *B* having spindle distances correctly spaced to do this work is used for the drilling operation. The machine is a 24-inch vertical drilling machine, to which the drill head may be attached without difficulty.

In figuring production on this operation, the cutting speed can be assumed to be 50 feet per minute, making the speed at which the drills must be rotated approximately 440 revolutions per minute. In this particular case a little more feed can be used on the drills than in the previous operation because the work is more firmly supported and there is no danger of springing it. Under these conditions the tool engineer might assume that the feed can be 0.007 inch per revolution, while the distance which the drill must travel is about 5/8 inch. Hence, $\frac{0.625}{0.007} = 89$ revolutions to complete the drilling; and this means that the drilling time would be somewhat less than 1/4 minute. Allowing 45 seconds for setting up the work and for the various movements of the spindle, production could safely be figured at 1 minute for each piece or 60 pieces per hour. This is very conservative, and as a matter of fact considerably over this number of pieces could readily be produced.

Machining Operations on Intake Manifold

Operation 1, Table IX.—The first operation on this piece consists of disk-grinding port flanges *A* and carbureter flange *B*, the principal requirements being that these surfaces should be smooth and free from tool marks. For this reason the disk-grinding process is selected by the tool engineer as being most suited to this class of work. The material of which the intake pipe is composed is aluminum, which is easily cut and can be polished to a highly finished surface.

Operations 3 and 4, Table IX.—Operation 3 consists of drilling two holes *C* in the carbureter flange, and drilling hole *D* in the side of the manifold. Operation 4 consists of drilling the two 1/4-inch holes *E* in the side of the pipe. The tool engineer, in planning the work on the intake manifold, decides that these two operations can be profitably combined by designing a suitable drill jig and making use of some of the multiple spindle drilling machines which are included in the factory's machine tool equipment. The logical place from which to locate the work for these drilling operations is the finished end flanges and the carbureter flange. In order to handle this work to the best advantage, the drill jig is made in such a way that all the holes in the two operations mentioned can be drilled without removing the piece from the jig, by simply turning it over on its sides. In order to obtain high production, a special drill head, having spindles properly placed for spacing holes *C* in the carbureter flange, is used for this part of the drilling, as shown in Fig. 23. It will be seen that the second spindle on the machine can be used for drilling hole *D* in the side of the pipe by merely turning the jig over on one side. After this hole has been drilled, the position of the jig is reversed and it is then slid over onto the table of the next drilling machine. One spindle on this machine is shown at the left of Fig. 23. The machine has two spindles which are so placed that the correct spacing for the two holes *E* is insured, and as the holes may be drilled simultaneously a high production is obtained.

In estimating production on these two operations, it is safe to consider that the cutting speed for aluminum is from 400 to 600 feet per minute, 400 being conservative while 600 is high production. In all of the drilling operations on the intake manifold, the spindles are hand-operated and the speeds are so high that the time necessary to do the actual drilling is very small indeed. For example, in drilling the carbureter flange holes the drill diameter is 13/32 inch, which at a cutting speed of 400 feet per minute would require that the drill be run at a speed of 3500 revolutions per minute. It can easily be seen that if a depth of about 1 inch is required, such as that in the flange hole, and if the feed is assumed to be about 0.005 inch per revolution, then $\frac{1.000}{0.005} = 200$ revolutions which, at a speed of 3500 revolutions per minute, means that the length of time necessary to perform this operation would be about $3\frac{1}{2}$ seconds. Allowing about $3\frac{1}{2}$ seconds for each of the two other drilling operations, would bring the total amount of time for machining up to about 10 seconds. Allowing $\frac{3}{4}$ minute for setting up and removing the piece and 15 seconds for the incidental movements connected with turning the jig on its side and moving it from spindle to spindle, the total time for the operation on this piece would be 1 minute, 10 seconds, which would give an hourly production of slightly over 50 pieces or about double the amount required. Two machines used as indicated will both be required, although their time will not be fully occupied, so that they could be used for other operations if convenient.

Machining Operations on Exhaust Manifold

Operation 1, Table IX.—This operation is performed in the same manner as the first operation on the intake manifold, i. e., by disk-grinding the faces of flanges *F*.

Operation 4, Table IX.—This operation consists of boring, countersinking, hollow-milling and threading end *H*. Previous to this operation, the counterbored holes *G* in the flanges *F* have been machined, and so these holes can be used with the finished faces of the flanges as locating points for the operation now to be performed. The next point to be decided in

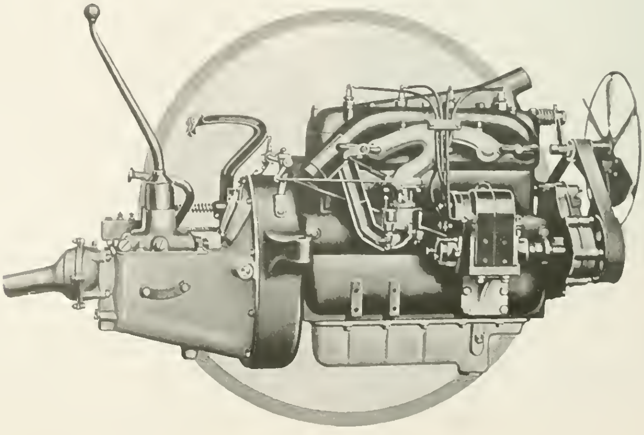
regard to this operation is the type of machine on which the work should be done. In this case, the casting is of such a shape that it seems advisable to stand it up on end in a fixture that will simply act as a holding device. Fig. 24 shows an illustration of the fixture with the work *A* in position, and the various tools are shown either in the spindle or on the table beside the machine. In order to make the exchange of tools used in machining this end of the exhaust manifold, quick-change chucks are utilized so that there will be a minimum loss of time. A 28-inch vertical drilling machine is selected as being most suitable for this operation, both on account of the cost of the machine and convenience in operating.

In estimating production, the tool engineer considers that the cutting speed for all operations except threading should be about 50 feet per minute, and as the diameter of the work at this point is 2 inches, the cutting tools should revolve at 100 revolutions per minute. The tools comprise a combined chucking or four-lip drill and countersink *B* which is shown in the spindle in Fig. 24, a reamer *C*, a hollow-mill *D*, and a die-head *E* which is of the opening type. These tools are used in the sequence mentioned, the length of time necessary for each cutting operation being estimated herewith. The combined four-lip drill and countersink running at 100 revolutions per minute is fed into the hole at a feed of 0.015 inch per revolution to a depth of 1¼ inch. As a matter of fact, the tool engineer would figure as if the depth of cut were about 1½ inch, in order to take care of variations in the length of the casting and also of the countersinking operation. The number of revolutions necessary for this operation would be $\frac{1.500}{0.015} = 100$, which is equivalent to 1 minute. In addition to this, the countersink would be fed in by hand to the proper depth, taking from 5 to 10 seconds, which makes the total time 1 minute, 10 seconds. The reamer is next inserted and the machine slowed down to about 50 revolutions per minute, after which the reamer is fed into the work by hand. An allowance of about 15 seconds would be made for this operation. The hollow-mill is now placed in the spindle and the speed changed to 100 revolutions per minute with a feed of 0.020 inch per revolution. The length of cut here is about 1/2 inch plus, say, 1/8 inch for variation, making 5/8 inch in all. The number of revolutions necessary for completing this cut would be $\frac{0.625}{0.020} = 31$, which is equivalent to 20 seconds.

The threading operation is now performed with the opening die-head *E*, and the speed of the spindle is slowed down to produce a cutting speed of about 20 feet per minute, which on this diameter would require 40 revolutions per minute of the spindle. As the pitch of the thread is 13 per inch, and as we have considered that a length of about 5/8 inch is necessary, it would require about 10 revolutions of the die-head to produce the thread. The time necessary to do this portion of the work would be 15 seconds. During the process of this work, it is necessary to change the tools four times and some of the tools are somewhat heavier and more difficult to handle than others. An average allowance of perhaps 10 seconds for each change would call for 40 seconds for all the changes, which should be ample. In addition to this, an allowance of 40 seconds must be made for setting and removing the work and 20 seconds for the movement of the spindle up or down preparatory and subsequent to the cutting operation. Consequently, the total time necessary for producing one piece in this operation would be 3 minutes, 40 seconds. As this time, however, could be cut down by an operator after he has become thoroughly familiar with the work, and as the time allowances are very generous and the cutting speeds conservative, the tool engineer estimates that one machine will be sufficient to give the required production of 20 pieces per hour.

Conclusion

The information in this article comes under three main heads: First, the procedure in planning the best order in which to perform machining operations; second, the conditions which govern the design of jigs, fixtures and special tools to obtain a high degree of efficiency in manufacture; and third, the principles which govern the estimation of production on any machining operation, after the equipment for that operation has been designed but before it has been made. For the purpose of discussion, certain important parts of an automobile engine were selected and the method of procedure followed in preparing for the manufacture of these parts was explained in detail. This was a natural course to follow because the scientific planning of operations and designing of all equipment required to obtain a given rate of production has been carried further in the automobile industry than in most other lines of manufacture. But in case the fact has not already been grasped by the reader, attention is called to the fact that although this article concerns itself with the manufacture of certain automobile engine parts, all of the principles described are general in their application and can be used by men who are called upon to devise methods and design equipment for use in the manufacture of many other classes of interchangeable parts.



RECENT LEGAL DECISIONS INVOLVING MACHINERY

Claim for Breach of Warranty Disallowed

(Kansas) The plaintiffs assisted a machinery company in selling an engine to one of the defendants, for which he gave notes to the sum of $2305. The plaintiffs guaranteed the machinery to work satisfactorily, and purchased the notes given to the vendor. The engine proved defective and the purchaser made repeated complaints, and, after certain efforts by the plaintiffs to adjust it, they advised the purchaser to see what he could do with it by giving it further use. Long after this, with their consent, he traded the engine toward a new one and took up the old notes with the ones sued on, which he secured by a mortgage covering the new engine. This was some two years after the execution of the original notes, and when giving the new notes he was told by the plaintiffs that he would finally be allowed for the time he had lain idle with the old engine. In an action on the notes last given, he sought to recoup damages for breach of warranty of the old engine, claiming that he was forced to expend $1400 for the hire and rent of an engine for the time when the engine purchased was not working.

The court refused to allow defendant's claim for damages on the theory that his giving the new notes two years after the original engine had been delivered operated as a case of acquiescence and estoppel. The court could not understand why any damages agreed upon between the parties were not deducted at the time of executing the second notes. *(Muenzenmayer v. Hood, 155 Pac. 918.)*

Selection of Dangerous Way of Handling Machinery

(Pennsylvania) Where an experienced operator of a defective machine for punching holes in steel boxes took hold of the bottom of a box to remove same, thereby placing his hand under the die, though there was a safer way of which he knew to remove the box by taking hold of the side, he was guilty of contributory negligence, precluding recovery for injuries caused by the unexpected repeating of the machine. *(Fritchle v. Steel City Electric Co., 96 A. 1083.)*

Cannot Recover Cost of Making Tests

(New York) Where a contract for the equipping of a pier with machinery provided that, when the equipment was sufficiently completed to require the occupation of the electric generating plant, the contractor should furnish a competent crew to operate the plant for the period of six days, during which time proper tests should be made, the contractor could not recover from the city for coal and labor used in operating the plant to make the tests. *(N. E. Const. Co. v. City of New York, 112 N. E. 53.)*

Machinery Not Covered by Lien

(Kansas) Machinery purchased for use in a mill, intended to be permanently fastened in place by bolts, does not ordinarily become a part of the realty until the physical attachment is accomplished. And where such machinery is sold under a contract reserving title in the vendor until payment is made, it does not become subject to a mechanic's lien, notwithstanding the fact that the contract is not recorded until after the lien has accrued and the machinery has been deposited in the building, provided such record is made before it is set up and fastened in place. Such was the holding in St. Mary's Machine Co. v. Iola Mill & Elevator Co., Kansas Supreme Court.

The St. Mary's Machine Co. sold two gas engines to the Iola Mill & Elevator Co., under a written contract providing that title should remain in the vendor until the purchase price was paid. Payment was not made, and the seller brought replevin for the engines, which, in the meantime, had been set up and bolted to concrete bases in a building erected by the buyer. Caroline Frantz, who by a sheriff's deed had acquired title to the building, intervened and claimed the engines as a part of the real estate. The plaintiff recovered and Caroline Frantz appealed to the Supreme Court, where the judgment was affirmed. *(St. Mary's Machine Co. v. Iola Mill & Elevator Co., 155 Pac. 1076.)*

Recovery of Price of Machinery

(Kentucky) Where a contract of sale of machinery merely permits the buyer to return it if it is not as warranted, and does not provide that it shall be deemed to fulfill the warranty unless returned, he may, though it does not satisfy the warranty, retain it, and recoup his damages for the breach, in an action by the seller for the price. Unless machinery sold is absolutely worthless for every purpose, though it is useless to the buyer, he must return it, or offer to return it, before he can recover the price. *(Hauss v. Surran, 182 S. W. 927.)*

"Simple Tools"

(Kentucky) It is interesting to know that our courts have arrived at a definition of such tools as are known as "common" or "simple" tools. Justice Turner of Kentucky in Hoskins v. Louisville & N. R. Co. says that "simple" tools are such tools as are so simple in their nature that any one of ordinary intelligence may safely use them without any instruction or assistance. The court went on to say that an employer is not bound to inspect such tools before putting them at the disposal of a servant for use in work. If they are used by a servant who is injured by their defective condition, the case is clearly one of contributory negligence on such servant's part. *(Hoskins v. Louisville & Nashville R. Co., 181 S. W. 352.)*

Trademark

(New York) Justice Weeks of the New York Supreme Court defines a "trademark" to be one's commercial signature, a word, symbol, or device by which the wares of the owner are known in trade. *(Star Co. v. Wheeler Syndicate, Inc., 155 N. Y. S. 782.)*

* * *

RECOVERING OIL FROM WASTE

It is interesting to note the effect that a new apparatus has in a foreign country. An English newspaper publication recently published the following in regard to an apparatus recently installed by the Lancashire & Yorkshire Railway Co. in Bradford, England, for the recovery of oil from waste. The innovation evidently attracted much attention and the local U. S. consul considered it of sufficient interest to contribute the item to the *Daily Consular Reports* where it was reprinted. Centrifugal apparatus for recovering the oil in chips, waste and rags is an old story here:

> In a large works, or where there is much machinery running, the quantity of oil that is absorbed by waste rags and wipers in the course of a year is considerable, and with oil at war prices, any method of recovering even a portion of it is worth considering. An apparatus has been in use by the Lancashire & Yorkshire Railway Co. among others, by which it is claimed that 90 per cent of the oil and grease held in the pores and on the surfaces of waste rags and wipers used in keeping machinery clean is recovered. The arrangement is a skillful adaptation of the steam turbine and centrifugal or hydro-extractor as it is sometimes called. The centrifugal consists of an outer containing fixed cylinder and an inner perforated cylinder which is made to revolve at a high speed. The material to be dried is placed in the perforated cylinder and when the latter is revolved, the material to be dried is carried by centrifugal force against the perforated wall of the cylinder, any fluid which it contains being carried through the perforation into the outer containing cylinder, from which it is drawn off. The apparatus is driven by small steam turbines and the exhaust admitted into the revolving cylinder helps to loosen the grease and facilitate its extraction.

* * *

CHANGE IN TYPE OF HEADS OF SET-SCREWS

The National-Acme Mfg. Co., Cleveland, Ohio, has adopted a standard for the height of heads of set-screws in accordance with the following rule: *The height of head of standard set-screws shall be equal to three-quarters the diameter of the body.* These dimensions will be used for all sizes of set-screws carried as standard stock by the company. But until 1917 either the old or the revised style of heads may be considered regular and will be furnished at standard prices. The company will urge the adoption and use of the U. S. standard thread on cap- and set-screws and the virtual elimination of the V-thread.

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TOOL ENGINEERING

The leading article of this number deals with tool engineering in motor car engine manufacture and is similar in treatment to that on the military rifle in which the methods and organization required for manufacturing rifles were described. In this article, the organization of the tool engineering department of a motor car factory is described and the analysis of manufacture of the engine is carried out for all its principal parts. The types of machines and tools are specified and the operations are named in order of performance.

The chief value of articles of this sort is that they bring together the means and methods generally known and apply them to the solution of given problems, carrying the work through from its inception to conclusion. No one needs to be told that articles of this nature are rarely found in technical publications or that the publication of an assembly like this is of great practical value. There is no doubt about it. It is one thing to know a number of related and unrelated facts and quite another to be able to bring these related and unrelated matters together to form a useful whole. The weakness of trade literature generally is that it consists mostly of scraps of information useful in proportion to the experience of the readers. Inexperienced readers get many ideas and much help from reading technical publications, but we propose to give them more than valuable ideas and useful facts. We shall in these articles give the plans which may be taken complete—modified or extended, as the case may require—and applied to manufacturing practice. Undoubtedly there is need for this industrial preparedness work which will serve to educate mechanics in planning efficient and systematic manufacturing operations. To ambitious men these articles mean opportunity to learn and to get on in the world.

* * *

BALL BEARING SPINDLES IN MACHINE TOOLS

Ball and roller bearings are being used in machinery of all kinds with gratifying results, but comparatively few anti-friction bearings have been used for the spindles of machine tools. The conservatism of machine tool builders and users, and the high cost of the bearings required to insure dependable and satisfactory results have been the reasons. The machine tool designers claim that ball bearings for lathe spindles are practically unnecessary, as the friction loss is so small as to make little difference in the power consumption, and that the high cost of anti-friction bearings and the danger of breakdowns are good reasons for not using them.

It is true that the apparent friction loss in a lathe spindle bearing is small and that the resulting power economy would not pay returns on the difference in the cost of plain bearings and anti-friction bearings. But this feature of machine design has another aspect to which designers, builders and users of machine tools may profitably give earnest attention. It has been shown by tests that a ball bearing spindle may be made freer from chatter than a plain spindle working under the same conditions of load, and as everyone knows, chatter is the foe of efficient metal cutting. The moment the work or tool begins to chatter, rapid deterioration of the cutting edges begins. The tool will soon break down and require removal and grinding. The loss of time resulting from regrinding the tool and resetting is an appreciable factor in the day's production.

Excessive chatter is usually noticeable when work is being done while held on a faceplate or in a chuck and without tailstock or steadyrest support. Then the whole pressure of cutting is transmitted to the spindle and spindle bearings. When the work has considerable overhang the pressure of the cut on the front spindle bearing is considerably increased by the leverage of overhang. Under such conditions the average mechanic would not think of trying to take a heavy cut with an ordinary engine lathe unless he provided either steadyrest or tailstock support. But if he were able to dispense with these supports, much time would often be saved in chucking the work and removing it when finished.

Tests on lathes built with extra heavy spindles and ball bearings adequate for the work designed have shown that the spindle possesses remarkable anti-chatter characteristics. The reason is not obscure. They are due to general rigidity and the elimination of excessive friction in the bearings. When a lathe of ordinary design with plain bearings is subjected to the test of turning a piece held in the chuck with the end projecting several inches, the pressure of the cut is often sufficient to break down and squeeze out the oil film between the spindle and the bearings. The result is metal-to-metal contact and excessive frictional resistance. Chatter begins in the headstock bearing itself, and being transmitted to the work is intensified, with the result that the tool point speedily breaks down. In view of this unsuspected cause of machine tool inefficiency our conservative machine tool builders and users may find that they were mistaken in their estimate of the lack of possibilities of ball bearings in machine tools. Efficiency of cutting may be so greatly increased that no user who counts cost and return on investment can afford to purchase a lathe or other machine tool without anti-friction bearings on the work-spindles.

* * *

THE USE OF SOFT METALS IN MACHINERY CONSTRUCTION

Every mechanic is familiar with the use of babbitt for the bearings of machines, but the use of soft or low melting point alloys for uniting machine members is not so well known, although it has been practiced for many years. Not long ago it was common practice in the manufacture of low-priced drilling machines to fit certain brackets and pads to the sides of the column by pouring babbitt between the brackets and the column while the brackets were held in a suitable fixture. In this manner, the brackets were located in the proper position and provided with a secure bearing on the column without the chipping, filing and squaring up that were inseparable from the ordinary hand process. In the manufacture of certain shop furniture, the cast-iron shelves are made with cored holes in which the pipe legs are placed, while the shelves and legs are held in a fixture. Then a low-melting alloy is poured around the pipes in the cored holes, and when it solidifies the shelves and legs are firmly united, making a cheap and durable construction.

The use of type metal to secure bearing bushings in cored machine castings, while the bushings are lined by mandrels supported in a jig, is apparently a new development in machinery construction and one that has wide application. It permits castings to be converted into machinery with slight expense for machine work. The cast-iron bushings are bored, of course, and they may be babbitted if babbitted bearings are required. The type metal used to secure them in place is of a lower melting temperature than babbitt. Brass or bronze bushings may be secured in the same manner.

It would be interesting to trace out the history of the use of soft metals for securing machinery parts in proper relation. In the early days of steam engineering, salammoniac mixtures were used largely in engine building for the purpose of making joints and uniting parts that are now generally assembled by pressure or shrinking in. Many other examples could be cited in which cements and alloys have been used for securing machine members. These have been looked on as cheap makeshifts unworthy of advanced practice, but the low-melting hard alloy may become a revolutionary factor in the design and construction of many kinds of machinery.

* * *

AN APPEAL FOR BETTER PATENTS*

BY OTTO ABDT

It is a well-known fact that comparatively few of the six hundred patents issued in this country each week ever net their owners a cent. The reason for this, however, is not so well known. The majority of those who flock to the Patent Office to protect their ideas do not know, and they are paying a dear price for worthless literature because of this ignorance. They want patents, and patents they get; but patents are like eggs, for there is just as much difference between patents and *good* patents as there is between eggs and *good* eggs, and it takes a practiced eye to separate the good from the bad. Very often the inexperienced inventor has that unlimited confidence and faith in his brain child which is not unlike that which parents have in their human offspring. A well meant or kindly word of criticism of his invention is quite likely to roil his dignity if not to arouse his enmity. He is notedly suspicious and bears an unenviable reputation for lack of business acumen. None know his faults better than the patent attorney and, notwithstanding a general impression to the contrary, the attorney has very little opportunity to take advantage of him. There are exceptions, of course, but most of them, if traced to the core, will disclose the fact that complaints of this nature lie mainly with the inventor himself.

The attorney's fees are small, and fixed, and unless agreed upon to the contrary he cannot afford to make exhaustive searches and expend any great amount of thought in planning claims for the average case. He leaves the judgment of procedure to his client for the reason that the client is expected to be capable of judging what features of his invention he wants to protect; but the inexperienced client is inclined to shift the burden of his troubles to the attorney's shoulders. The attorney obtains a patent for him and there his interest in the case ceases. If it infringes another patent it is not his fault, and if it is unsalable it is not his fault. He has acted according to the instructions of his client who only too often blames the attorney because he has a worthless patent on his hands. Very often he openly accuses his attorney of sharp practice in this case, and the risk of becoming a victim of the predatory is not a thing of the past by any means. Just so long as he chooses to remain a simple, unsophisticated soul, he is likely to suffer from this source; but if he understands the rules of the Patent Office and a few ins and outs of the game he is fairly well protected.

The average inventor is a delicate customer to handle and guide properly. He scents conspiracy at every hand and is given to brooding over things he imagines will happen to him and deprive him of his rights. His path is usually strewn with disappointments. If he is given a patent, no matter how his claims may read, and oblivious to his liability to infringement should he attempt to manufacture the particular thing he believes he has patented, he is a happy man. His friends then flock to him and pay homage to the superior knowledge his invention proclaims him to possess; but when he tries to dispose of his patent at the fabulous sum he thinks it is worth, he soon becomes disappointed and his friends lose confidence in him. His next move is to curse those to whom he thinks his invention should prove valuable, because they tell him, politely enough, but nevertheless convincingly, that they do not care for it. He suspects these very rejections are handed him for the purpose of misleading him and that these people are going to steal his invention outright. He does not know that if it were as valuable in their eyes as he assumes it to be it would have been snapped up before the forms were cold from its issue. Neither does he know the risk large companies would assume if they attempted to appropriate the object of his patent.

It is as true of patents as other assets—they will not sell unless they are worth something to someone other than the owner. And what one is worth is not necessarily determined by the ingenuity displayed in a mechanism nor by its simplicity, but in its practical demonstration, the scope of the claims, the cost of manufacture, and the market. These are essential to a salable patent. Most of the really valuable inventions comprise a new way of producing an established product—something that has demonstrated its demand by continued usage. The invention of a new thing requires educating the public to its usage; a market must be created for the product, and it must be in keeping with present-day perfection and scope of manufacture. In this case the prospect is based on theory from the beginning, and unless backed by considerable capital and engineered by experts is likely to end disastrously. It matters little how good a prospect may look from an inventor's viewpoint; the people are the judges of what they want and are not easy to convince. Substitutes for the real thing are regarded with suspicion by a desirable class of trade, and no one knows this better than the manufacturer who strictly fulfills the public's demand for quality. He is not bothered by the new things that appear on the market and goes steadily on, leaving the mushroom novelties that spring up in his path to make the best of their short lives, for they serve only to strengthen him.

A patent on an improvement does not, as a rule, net the inventor anything because the thing improved has a prior right within the limits of its claims and covers the improvement during the life of the original patent, thus preventing the manufacture and use of the improvement. Claims for an improvement are limited, of course, only by the state of the art in which the improvement is made, and in an established art of long standing it is a mighty good improvement that cannot be avoided by the manufacturer. Whether or not he can do this is about the first thing he considers when a patent or an idea is sent to him for consideration, for it is seldom that anyone not connected with a concern in a capacity that will allow him thorough familiarity with what is required in the way of improvements can develop anything which cannot be avoided to advantage. It is not human nature, having the means at command, for one to buy a thing that he can make himself better than others can. So the manufacturer does not steal the invention or the idea, as the inventor is inclined to think; but if he finds that it embraces certain desirable features, he investigates the claims, becomes familiar with their limits and, in nine cases out of ten, finds they are easily avoided in attaining a better result. He is entitled to do this, and it is considered poor business to waste an opportunity of this kind. In a way it seems rather small to take advantage of an inventor like this, but if the inventor does not first become familiar with the rules of protection the government offers him, and does not spend an adequate amount of thought regarding the essentials which will make his invention a good one, he cannot expect anything else.

A glance through almost any issue of the *Patent Office Gazette* will convince those of a practical mind that many subjects of patents are things that are really old and have not seemed of enough importance to certain users to pay for

* For additional information on patents and allied subjects, see "Who Owns the Patent Rights?", February, 1916, "What Is a Patent Worth?", January, 1916; "The Patent-Bee," October, 1914, and articles there referred to.

getting a patent on them. If traced to the real inventor they would prove useless to the patentee. But to illustrate the impractical tendency of many others, one has but to turn to the patents issued on non-refillable bottles. Mechanical ingenuity is here displayed on an elaborate scale. The inventors seem to have lost sight of the fact that a bottle, whether refillable or not, would have to be made for a cent or two in order to meet present-day commercial needs. They have, in most cases, failed to take into consideration how bottles are blown, and that a hand manipulation to set diaphragms inside a blown bottle would be prohibitive in most cases; yet devices of this nature which would cost at least a dollar to produce are very common in these patents. Even if a perfect non-refillable bottle could be produced at an expenditure of one cent more than the standard open-necked kind, it is open to question whether the big users of bottles would consider its adoption. The present method of molding a trademark in bottles effectually prevents competitors exchanging them, and makes a bottle commercially useless to all but the original filler. To say that the glass companies would unanimously adopt the non-refillable type is mere conjecture. One company might get control of it; but if it did not continue with the open-necked bottle also, the competition would be likely to be embarrassing. It is doubtful if the largest users of bottles, such as breweries and dairies, would ever consent to the increased expense entailed by using the non-refillable bottle even at the price they pay for the open-necked kind. At present, they use bottles over and over again, but the life of the non-refillable type ends with the first filling, and it is obvious that the consumer would be the victim. Undoubtedly there would be a great demand for a practical invention of this kind; but "practical" in this case is rife with the elusive qualities of perpetual motion.

Take novelties: If it be an extravagant toy, the sale is limited to people of means and wealth, and just how far this extravagance is carried determines the bounds of this limit, and the dies and tools required for its manufacture might be too costly to consider the thing commercially profitable. Then, too, the ever-changing attitude of the public toward novelties might cause the thing to be placed upon the market prematurely or it might be too late. Novelties which are simple, attractive, and are adapted to economical production are sometimes very profitable; but the skill required in marketing things of this kind is a big factor in their success or failure. The inexperienced person will do well to make arrangements with novelty manufacturers on a royalty basis, rather than to attempt to manufacture himself.

Machinery is still another consideration of the inventor. Here he indulges his ingenuity to the greatest extent, and many seemingly good inventions are idling out their lives because they are covered by a basic idea and themselves take the form of improvements. Better that some of the inventors of these machines had restrained their impatience and nursed their ideas to perfection that they might have the chance they deserve at the expiration of the basic patent. Of course the ridiculous is found here, too. As an example of what one can still expect, the writer has had two requests lately to pass judgment on perpetual motion machines. The simple souls who are laboring to solve this impossible thing are still unaware that the government refuses to allow patents on machines of this class. It is an impossibility to convince those unfamiliar with the laws of mechanics that the thing is impossible, and useless to try.

A patent is, in sense, a license to make, use, and sell the thing for which the patent was issued, within the boundaries of the United States and territories thereof; but in reality is likely to prove a ticket to the courts if the patentee is not thoroughly acquainted with what really belongs to him, and he usually is not. Patents overlap in a maze of interferences, and only an expensive procedure, prohibitive to the average inventor, can safely determine whether a patent is operatively independent of others or not. This fact is a boon to the predatory capitalist who feels at liberty to appropriate anything to his own needs that looks good to him without consulting the party of the second part. The original invention in any new art requires no more ingenuity than is necessary to improve the art in some instances, and if this improvement can be made in a different way, it should be admitted. If the latter invention should be limited to details, why not all? The basic inventions are usually obsolete after a few years, yet they are allowed to demand a royalty from devices vastly superior and of which the pioneer could have had no conception. The government grants the right to make and use the thing patented, but at the same time it hands out the patent with the admonition, "I give you permission to make and use the thing, but you go over and fight Jimmy Green, and if you whip him, provided no one else shows up who wants to fight you, you will be safe."

We want better patents! Inventors want protection that protects! But in view of present conditions it is impossible for the inventor to do more than improve his knowledge of the game and not leave everything to his attorney whose interest lies within his profession and is limited to the size of his fees. It is often good policy to pay the price of his expert opinion, and, too, a second thought will sometimes save the price of a worthless patent. One would hardly attempt to enter the banking business without any knowledge of banking, nor enter the insurance business without knowing anything about it; but it seems that many try improvements in more complicated lines than either of these with a mistaken idea of what is really required. Opportunity is rife for the inventor, but he will have far greater success if he familiarizes himself with all the details he can master of this complex and fascinating profession.

* * *

DETERIORATION OF FIREBRICK LINING*

A mixture of fireclay and water, having no binding strength, is not a proper material to use in laying firebrick. Firebrick of a quality best suited to meet the furnace conditions is generally selected without careful consideration of the permanent adhesive quality of the material to be used in the joint. The maintenance of furnace firing is a large item in the cost of production; not only must the cost of repairs or renewals be considered, but also the decreased production owing to the time lost. Usually the falling of an arch, the bulging of a wall or excessive cutting away of a portion of the interior of a furnace can be attributed to a defect in the joint. The fireclay disintegrates or falls out, allowing the heat to work in between and attack the lining, thus shortening its life. Very often an arch is lost owing to the clay becoming loosened around one of the roof bricks and falling, resulting in weakening the whole structure. Fireclay does not support the bricks. It works loose from expansion and contraction and permits small particles to work in between, gradually widening the spaces until the openings are large enough to admit the circulation of the gases, and resulting in ruining the structure.

* * *

DRILLING MACHINE SPEEDOMETERS

The highest efficiency of twist drills is obtained when the revolution speed and feed are correctly proportioned for the work in hand, whether it be steel, cast iron, brass or other metals. One who has given much attention to the design of drilling machines and who has long supervised their use in manufacturing, advocates the use of speedometers attached to each machine, by which operators may instantly determine the actual revolution speed. Then, if a table is provided which gives the proper revolution speed and feed for each size of drill, there can be no good reason for not running the machines at their highest efficiency. It is difficult, however, to obtain a reliable speedometer having the range required. A low-priced instrument usually is not reliable, and if not reliable, it is worse than none at all. Reliable instruments, having the range required, are high-priced and might in some cases cost as much as the drilling machine itself. Evidently, there is an opportunity for someone to work out a low-priced, reliable and wide-range speedometer for drilling machines and other machine tools.

* Extract from paper "Tests of High-temperature Furnace Cement," by W. S. Quigley, read before the Philadelphia Foundrymen's Association, May 3, 1916.

MACHINING A THIN BRASS WASHER

In response to a query regarding machining the brass cast washer shown in Fig. 1 at *A*, the following method is suggested. The washer is to be turned to 2¼ inches outside diameter and 2 1/64 inches inside diameter and faced to a thickness of ⅛ inch. The machine best suited to this class of work is a hand screw machine having a cone-driven spindle capable of high speed, or a brassworker's lathe having a turret head. Referring to Fig. 1, the work *A*, being in the rough state, can be held to advantage in a step chuck *B* which is operated by the collet closing mechanism at the rear of the spindle. The movement of the collet closing lever causes the portion *C* of the chuck to move forward in such a way that the tapered chuck piece *B* is closed down on the work, thus holding it firmly. This chuck piece is split on the periphery in three places, 120 degrees apart, so that the contraction caused by closer *C* moving forward will result in a uniform radial movement of the split portion of chuck piece *B*. It will be seen that the chuck piece is bored out to receive the work *A* in such a way as to allow a portion of the work to stand out beyond the face of the chuck so that it can be faced without interference.

The tool used for boring and facing is held in the turret by the stem *L* which enters one of the turret holes. The body *D* of the tool is cut away at *E* and grooved to allow the tools *F* and *G* to be positioned as shown. The tools are clamped in place by the strap *H* which is operated by a collar-head screw *K*. It will be seen that tool *F* can easily be adjusted for diameter and that facing tool *G* can be so placed that it will start to cut at the proper time after the boring tool has finished the hole. The upkeep on a tool of this kind is good and replacement can quickly be made in case of breakage.

If a number of washers of this kind are to be machined rapidly but without close limits of accuracy, one tool such as that shown should be sufficient to do the work. If, on the other hand, a very nice job is needed, both roughing and finishing tools can be used. In the first setting of the work the hole is bored and one side faced, leaving the outside to be turned and the other side faced in the second setting. Fig. 2 illustrates the method of holding the piece for the second setting, using a special nose-piece *C* mounted on the spindle. To this nose-piece is attached stop collar *D* having a projection which comes against the work *A* and gives the longitudinal location. This projection is slightly smaller than the outside diameter of the work so as to permit the turning tools to pass by in machining. The part *B* is split in three places in a similar manner to the chuck portion shown in Fig. 1. A tapered hole at *F* permits expansion of part *B* by a movement of the plunger which is operated by the collet closing mechanism. In order to prevent any tendency to move forward, collet *B* is held in sleeve *E* by a nut and washer in the spindle (not shown in the illustration). When the taper plug *F* is pushed forward, member *B* expands and grips the inside of the work.

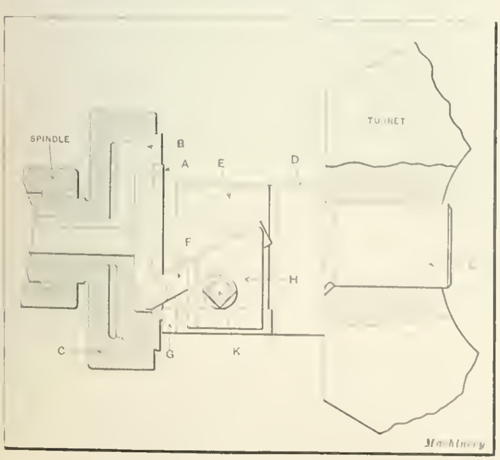


Fig. 1. Tooling used for First Setting on Thin Brass Washer

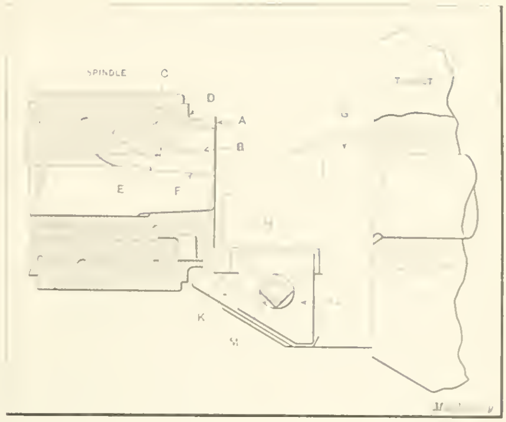


Fig. 2. Tooling used for Second Setting on Thin Brass Washer

The tool recommended for this setting of the work is of a box type having an outside turning tool *K* and a facing tool *H*, both of which are secured in place by clamp *L* and collar-head screw *M*. In general construction this tool is similar to that used in the first setting of the work, and the holder *G* is held in the turret in the same way. In this case, as in the preceding, the inside finish desired would determine whether one or more tools were necessary for the operation. In machining yellow brass, it would be safe to assume a cutting speed of 200 feet per minute without lubricant. The tool should be ground according to the quality of the metal and should be kept keen in order to produce a nice finish. Speaking generally, the softer the metal which is to be cut, the greater "hook" will be required on the cutting lip of the tool.

By using the type of tool illustrated herewith work of the kind mentioned can be produced at the rate of about 120 pieces per hour, allowing for both roughing and finishing cuts in each setting of the work.

A. A. D.

* * *

With a little horse sense, a broken tap can be made as good as new by means of a grinding wheel. A mechanic was handed a broken tap and asked to put it in good working condition. He squared up the end of the tap on the face of an ordinary tool grinding alundum wheel. Then he ground the relief or chamfer. * * * A little skill is required to cut a radial relief and keep the cutting edges of the lands even. Radial relief and even height of the lands are the two main things to look out for when putting an old tap in good condition. The tap should be held lightly against the face with the wheel turning toward the cutting edge of the tool. This gives an edge that is free from burrs and is slightly better than one ground with the wheel running in the opposite direction. The tap must be held firmly enough so that it will not accidentally turn, carrying the cutting edge against the wheel and thus grinding it off. The operator should keep turning it slightly so that a little more will be ground off the back of the teeth and a radial relief obtained. There is always more or less danger of drawing the temper, and particular attention should be given to bearing lightly when grinding and to using a free and cool cutting wheel. The second important thing to look out for is that all lands are left even—the same radial height. If they are not even, the tap will not start true. A pretty good method of testing out a tap to find if the lands are even is to turn it about two-thirds through a nut and look at it from the opposite end. It can readily be seen whether or not all the lands are at work. * * * The length of the relief is another important consideration and one on which opinions differ. Ordinary plug taps are made with chamfer tapered four or five teeth back. Opinions have been expressed that for general use a tap ground back six threads works better and lasts longer than one ground back only four.—*Grits and Grinds.*

MANUFACTURE OF HACKSAW BLADES

STEEL USED, MACHINING OPERATIONS, HARDENING, STRAIGHTENING, AND TEMPERING

BY FRANK M. SHAW*

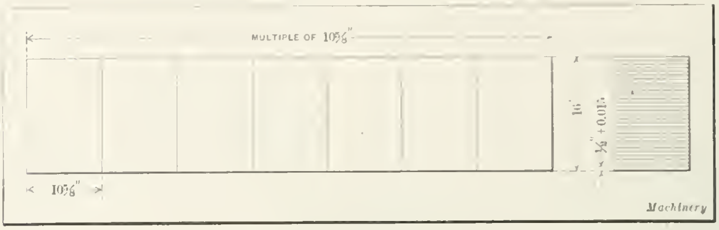


Fig. 1. Diagram showing how Sheet Steel is cut up into Saw Blade Blanks

THERE are good and bad features in nearly all manufactured products, and this is particularly true of hacksaw blades. The buyers of hacksaws are governed by different standards in deciding upon the type of blades which they will use. Those who follow the most far-sighted policy select that type of blade which will do the greatest amount of work for each dollar expended, but there are other customers who are governed entirely by considerations of price, and still others who try to select blades with reference to both of these features. This makes it necessary for the hacksaw manufacturer doing business on a large scale to make blades of various qualities which are produced from different grades of steel; and there are three grades of steel commonly used in the manufacture of hacksaw blades. These are conveniently designated as Nos. 1, 2, and 3; No. 1, which is a tungsten steel, is the best grade; No. 2 is a high grade of carbon steel, and although not so tough as No. 1 steel, it still makes a good saw blade; No. 3 steel contains just enough carbon to enable it to be hardened. It is natural that steels of various compositions are used by different hacksaw manufacturers, but in practically every case the No. 1 steel contains rather more than 1 per cent of tungsten. It is also important for the gage of the steel to be absolutely uniform. Saws made of such material and given the proper heat-treatment are exceptionally tough and long-lived. The No. 2 steel is also required to be of uniform gage, and some steels of this grade contain small percentages of chromium and vanadium. Saws of this material properly made and heat-treated will give good results. In addition to the usual metal containing a small percentage of carbon, the No. 3 grade steel may be of the composition called for by grades Nos. 1 and 2, but such steel has been sold under a No. 3 classification because its gage is not uniform. At best, the saws made from No. 3 steel will be short-lived because the small percentage of carbon makes it difficult to properly harden the blades, while a lack of uniformity of the gage will result in rapid destruction of the saw, even though the composition of the steel is such that it can be heat-treated to the best advantage.

Despite the shortcomings of blades made of No. 3 steel, many users of hacksaws claim that carelessness on the part of their employes makes it desirable to use such blades, because in any case they will be broken as a result of carelessness before they have been in use for a sufficient length of time to be worn out. The writer believes this argument to be fallacious, as a fair test will clearly prove that saws made of No. 1 steel will do an amount of work under average factory conditions that will much more than offset the difference in price. In this connection it should be mentioned that hacksaw blades that are used in power machines are seldom made of any other grade but No. 1 steel.

When received at the factory, the steel is packed in boxes containing about 700 pounds of metal which is in the form of plates 16 or 18 inches wide, and of any length which is an even multiple of the length of the saws which are to be made. For instance, if the steel is to be cut up into blanks for 10-inch blades, the plates will be 16 or 18 inches wide by some multiple of 10⅝ inches long. The extra ⅝ inch provides for waste which is unavoidable in trimming up the ends of the blanks. It has been mentioned that it is highly important for the steel plates to be carefully rolled in order for the thickness to be quite uniform; otherwise, blades made from this steel will have a tendency to bind in the work, and this will result in their rapid destruction. For the best hacksaw blades the maximum variation in thickness must not exceed ± 0.001 inch, but in some cases the variation actually ranges from 0.0035 to 0.005 inch, and steel of this kind could only be used for No. 3 blades even though its chemical composition would enable it to be properly classified as No. 1 or No. 2 steel.

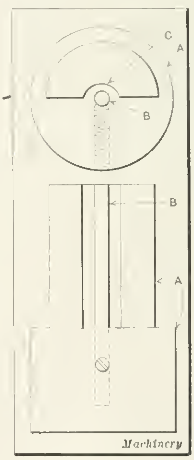


Fig. 2. Piercing and Trimming Die used for finishing Ends of Saw Blade Blanks

In fabricating the steel plates into hacksaw blades, the first operation consists of cutting the metal into strips of the desired length, *viz.*, 10 5/8 inches, 12 5/8 inches, etc. These strips are subsequently cut up into saw-blade blanks which run lengthwise of the strip. This is important because in the process of rolling the steel plates, the fiber of the metal is drawn out in a longitudinal direction and the best results will not be obtained unless the fibers run right through the saw blade. The blanks are cut about 0.015 inch over size to allow surplus metal for milling them to the correct width.

A power shear is used for cutting up the steel plates and this machine is equipped with a stop-bar supported by two side bars, the arrangement being such that the position of the stop-bar can be set to suit the size of saw blades which are being made. The idea will be best understood by reference to Fig. 1, which shows in diagrammatical form the way in which the plate is first cut up into sections and the manner in which these sections are cut up into saw-blade blanks. Referring to this illustration in connection with the statement made concerning the stop-bar on the shear, it will be evident that the stop must be set to provide for cutting blanks of different lengths, and in the case of the blanks illustrated the setting will be for cutting off lengths of 10 5/8 inches. The side bars which support the stop-bar are graduated

Fig. 3. Cross-section of Milling Cutter used for cutting Teeth of Saw Blades

* Address: 94 Dunmoreland Ave., Springfield, Mass.

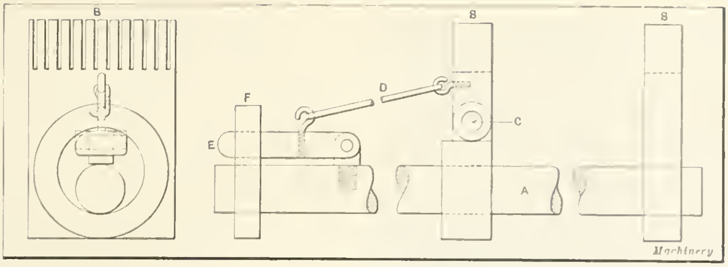


Fig. 4. Frame used for dipping Saw Blades into Lead Bath

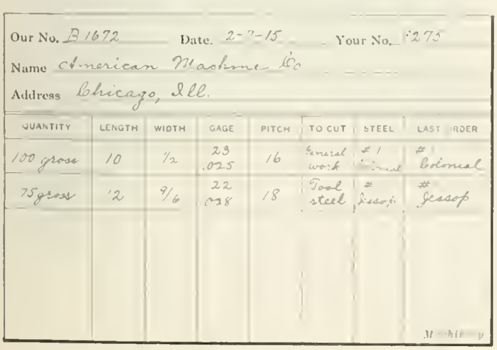
for different standard lengths of blanks which have to be cut. The holes are punched in the ends of the saw-blade blanks at the same time that the ends of the blanks are rounded to the required shape. For this purpose the press is equipped with a set of combination piercing and trimming dies of the form shown in Fig. 2, and different dies have to be provided for the different sizes of blades. The piercing punches on these dies are rather easily broken, but they may be renewed at slight expense. Fig. 8 shows a close view of the die on an E. W. Bliss punch press arranged for stamping and piercing the ends of two hacksaw blades at a time; but the machine only works on one end of the blade at each stroke and the work is fed into the die by hand. Three methods are used for punching the holes and trimming the ends of the blanks so that they will be of the correct shape and length. The slowest method consists of punching and trimming one end at a time, and when this plan is followed the rate of production will be just about one-half that which is attained by the use of more efficient equipment which provides for operating on both ends of the blades at once. The presses used for working in either of these ways may be operated by the usual form of foot-treadle, and the stock fed into the die by hand. Naturally such equipment compares very unfavorably with presses provided with automatic feed and dies which operate on both ends of the blanks at the same time. Using the latter form of machines, an operator of average efficiency can turn out from seventy-five to one hundred saws per minute.

Practically all hacksaw blades have milled teeth, and the machines on which the milling operation is performed are usually provided with duplex fixtures so that the cutters can be working on blanks held in one side of the fixture while the saw blades are being removed and fresh blanks substituted at the other side. Each section of the fixture has a capacity for holding about three gross of blades 0.025 inch in thickness, and the time required to mill the teeth in this number of blades is about fifteen minutes. Fig. 7 shows a Hendey milling machine set up for milling the teeth in hacksaw blades. This illustration clearly shows the arrangement of the multiple milling cutter, which is composed of a number of sections assembled on an arbor. The milling cutters are made with staggered teeth and are furnished in sections 1 inch wide; they are made of high-speed steel and often cost in excess of $500 per set. As hacksaw blades are made in a number of different pitches, i. e., 6, 8, 10, 12, 14, 16, 18, 24 and 32 teeth per inch, it will be seen that a complete stock of cutters for use in hacksaw manufacture represents quite a large investment. A set of cutters will mill from 200 to 225 gross of saws before having to be resharpened.

In sharpening the cutters great care must be taken to do the work under exactly the correct conditions, as many cutters have been ruined through the carelessness or inexperience of the operator causing him to take too heavy a cut or to do the work with a wheel that is too hard for the purpose. A 6-inch "saucer shaped" wheel is used which is 30 grain, J grade. The cutters are placed on an arbor, as shown in Fig. 3, and care must be taken to place the cutters on this arbor in the proper order, because the teeth are staggered and they must be correctly located in relation to each other so that the grinding will be done properly. Great care must also be taken to see that the radius of the cutter is constant from end to end. For this purpose a simple form of surface gage is used which is 1 inch wide, i. e., the same width as each section of the milling cutter. This gage is placed on the table of the grinding machine and a tissue paper feeler is used to test the accuracy of the cutter from end to end. If the least discrepancy is discovered it must be corrected by "touching up" the part of the cutter which is found to be in error, or by tapping it lightly with a lead hammer if it is found that the section of the cutter under test is held too high on the arbor. When the sharpening has been completed, the cutters are ready to be sent back to the machine for further service.

The angle of the teeth of hacksaw blades varies considerably, each manufacturer having a standard which he believes to be the best. For example, saw blades are made with tooth angles of 50 degrees and 55 degrees. It will, of course, be evident that the milling cutters are made with teeth of the same angle, and in performing the milling operation care must be taken to set the cutter at exactly the required height; should the milling cutter be lowered too far the saws will be milled in such a way that their width will be below the standard size. The milling cutters are lubricated with mineral lard oil.

After milling, the saws are removed from the fixture and placed in trays on which they are transferred to the setting department. In setting the saw teeth, use is made of a machine shown in Fig. 9, which is provided with two wheels that have teeth meshing with each other. The pitch of these teeth is the same as the pitch of the saw teeth to be set,



Our No. B 1672 Date. 2-7-15 Your No. 275

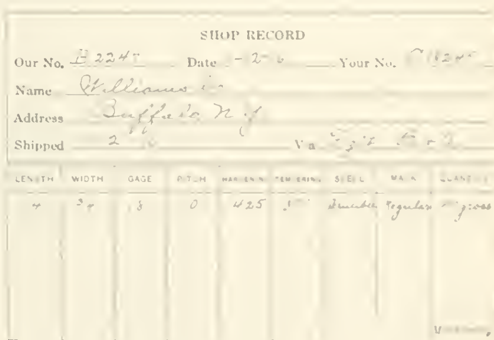
Name American Machine Co

Address Chicago, Ill.

QUANTITY	LENGTH	WIDTH	GAGE	PITCH	TO CUT	STEEL	LAST ORDER
100 gross	10	1/2	23 .025	16	General work	#1 [illegible]	# Colonial
75 gross	12	9/16	22 .028	18	Tool steel	# Jessop	# Jessop

Machinery

Fig. 5. Form of Cards used to record Orders received for Saws



SHOP RECORD

Our No. [illegible] Date [illegible] Your No. [illegible]

Name Williams [illegible]

Address Buffalo N. Y.

Shipped [illegible] Via [illegible]

LENGTH	WIDTH	GAGE	PITCH	HARDENING	TEMPERING	STEEL	MARK	QUANTITY
[illegible]	[illegible]	[illegible]	[illegible]	425	[illegible]	[illegible]	Regular	[illegible] gross

Machinery

Fig. 6. Form of Cards used for recording Orders that are being filled

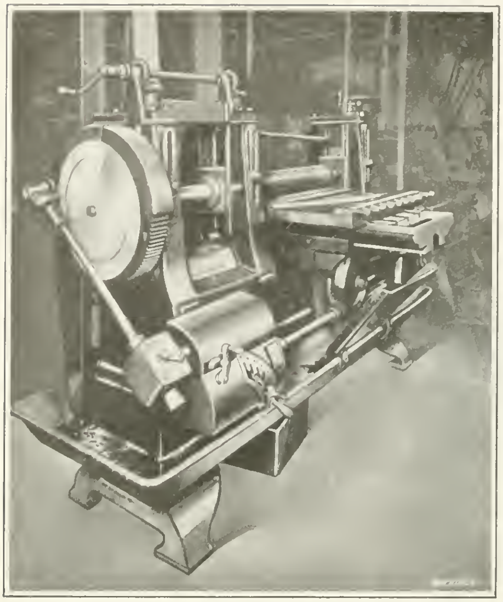


Fig. 7. Hendey Milling Machine equipped for milling Teeth in Hacksaw Blades

and the position of the upper wheel is adjustable to provide for obtaining the desired amount of offset for the teeth of the saw. The illustration makes the use of the machine so clear that further description is unnecessary. The setting of the saws is a very important matter, but although accuracy in the performance of this operation is absolutely necessary, there are a number of different styles of setting which give satisfactory results. The regular alternate form of setting generally used consists of offsetting alternate teeth an equal amount in opposite directions. Another method of setting is to have every third tooth left on center, with alternate teeth offset in opposite directions. Still another method is the alternate full and half setting, in which two teeth are given a slight offset while the next two teeth are given a full offset. Saw blades with thirty-two teeth per inch are commonly provided with a double alternate set, *i. e.*, two teeth are offset alternately in each direction. Examples of each form of setting are shown in Fig. 10. The amount of setting or clearance given to the teeth also varies in the products of different manufacturers of hacksaw blades. In connection with the work of setting it will be of interest to know that about ninety gross of 12-inch saws can be set in a ten-hour working day, and it is possible to operate the setters for about a day before they become sufficiently dull to require grinding.

After the saw teeth have been set, the blades are placed in trays which consist of boards 5 feet long by 4 inches wide provided with notches to support the blades on edge. They are placed in these trays with all the teeth facing the same direction to facilitate inspection. Every saw is inspected to determine its straightness, correct set, and accuracy of the punched end holes. A few saws from each batch are also tested in a machine to ascertain their cutting qualities both as regards speed and endurance; and flexible-back saw blades are also tested for hardness with a file.

Blades which have satisfactorily passed inspection are ready to be stamped with the manufacturer's name, and at the same time that the stamping operation is performed the teeth at each end of the saw are rolled flat for a distance of 1 inch. The marking dies are carried on rolls between which the saw blades pass, and similar plain rolls are used for straightening the teeth at each end of the saw blade. The marking is only done at one end. About thirty gross of saws can be stamped per hour.

After stamping, the saws are ready to be hardened and this can be accomplished by several methods. The use of lead baths is quite common and these may be used in different ways. One method is to place the saws in frames and then dip them in molten lead at a temperature of about 1400 degrees F.; after the blades have been left in the bath for a sufficient length of time to reach the required temperature, they are quenched in oil.

Fig. 4 shows the frame in which the saw blades are supported for hardening by this method. It will be seen that the frame consists of a bar *A* which is about 6 feet in length. The saw blades are held in notches cut in plates *B*; one of these plates may be adjusted back and forth on bar *A* to provide for holding saw blades of any required length. It will be seen that one of the plates *B* is pivoted at *C* so that it may be allowed to swing over to release the work from the notches. In loading the frame with saw blades, this hinged plate is allowed to swing toward the fixed plate at the end of the bar, after which the saw blades are dropped into the notches, and pins are slipped through the holes at each end of the blades. The frame is then tightened by pulling link *D* forward so that bar *E* may slip through the notch in plate *F*, in which position it is secured by a latch. After the frame has been loaded in this way it is immersed in a lead bath which is usually about 36 by 12 inches in size and 8 inches deep. The work is left in the bath a sufficient length of time to come to a temperature of 1400 degrees F., after which the frame and work are immersed in oil. After being given sufficient time to cool, the frame is removed from the oil and put aside to drain, after which the saw blades are removed. Held in this way, the saw blades are kept straight so that trouble from distortion is avoided. This is known as the "wet lead" hardening process.

In contradistinction, there is the so-called "dry lead" hardening process, which is carried on by placing a number of saws in tubes made of a special alloy. These tubes are mounted on a sort of ferris wheel which revolves over a pot of lead in

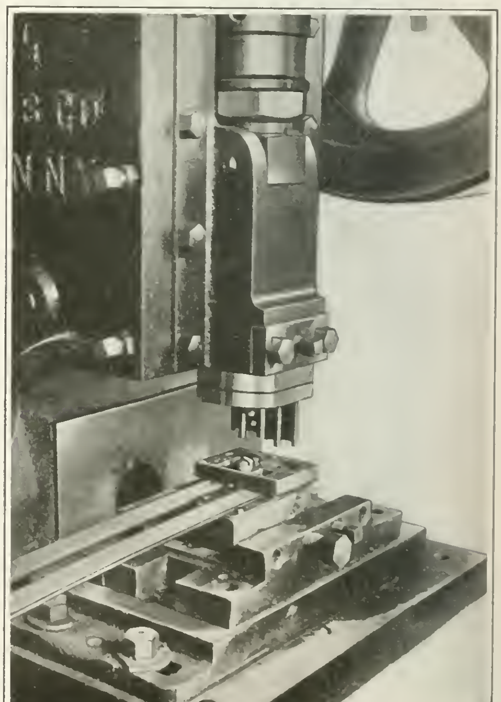


Fig. 8. Close View of Die used on E. W. Bliss Press to punch One End of Two Blades at Each Stroke

ANALYSIS OF DIFFERENT ALLOYS CLASSIFIED AS NO. 1 SAW BLADE STEEL

Tungsten, Per Cent	Carbon, Per Cent	Manganese, Per Cent	Silicon, Per Cent	Chromium, Per Cent	Vanadium, Per Cent	Sulphur and Phosphorus, Per Cent
0.55	1.10	...	0.20	0.80	...	0.020
2.00	1.25	0.50	...	0.25	0.25	0.025
1.15	1.15	0.20	...	0.25	...	0.020
1.75	1.00	0.40	0.20	0.20	...	0.025

Machinery

which the lower tubes are submerged, the temperature of the lead and speed of rotation of the wheel being such that the saws will have time to attain the required temperature. Although the heat is derived from the molten lead it will be evident that the saw blades do not come into actual contact with it. A better finish is said to be obtained in this way.

Still another method of hardening calls for the use of a furnace about two feet long which is provided with gas burners at intervals of one inch; the saws are passed over these burners, and as they emerge from the other end the steel is quenched by a stream of oil which flows onto it. In using this method the blades are linked together so that they may be drawn through the furnace. A variable-speed mechanism is provided for drawing the blades along, so that the speed may be regulated to meet the requirements of hardening saw blades of different thicknesses; and an idea of the rate of production will be gathered from the fact that about eighteen 8-inch saws, 0.025 inch in thickness, can be hardened per minute.

After large blades for power machines have been hardened it is sometimes necessary to straighten them, and this is usually done by hand just after the saws have been removed from the quenching bath and before they have cooled. Barring exceptional cases, the saws can be straightened satisfactorily in this way. Several methods are used for hardening flexible or so-called "soft-back" saw blades. One of these consists of heating the saw for a distance of about 1/32 inch

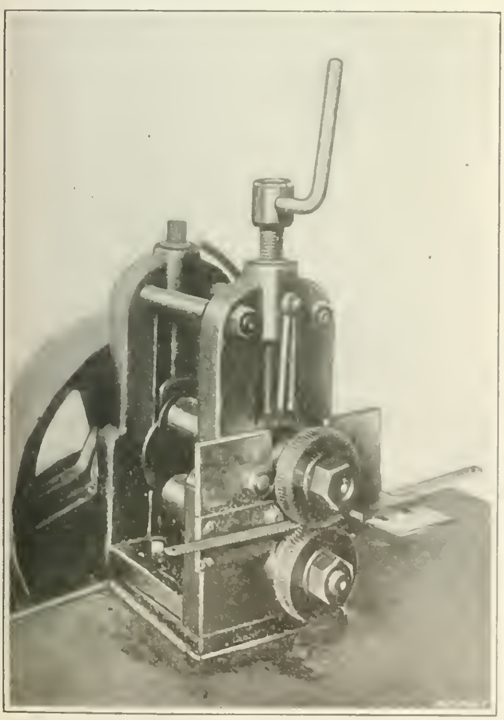


Fig. 9. Close View of Setting Rolls on Machine used for setting Teeth of Hacksaw Blades

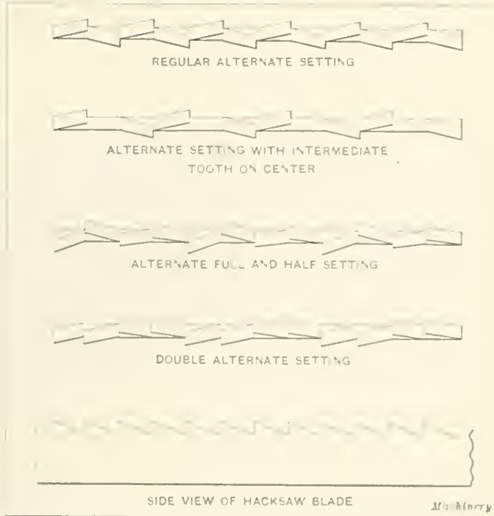


Fig. 10. Diagram showing Standard Methods of setting Hacksaw Blades

below the teeth and then quenching it with a cold blast of air. Heavy iron plates protect the work at both sides to prevent the backs of the blades from being heated to a hardening temperature. The saws are run through the machine with the teeth up, and the temperature is carefully regulated to the required degree.

Regardless of the method in which the hardening operation is performed, all types of saw blades are tested for hardness before being shipped. For this purpose the test is made on a saw from each batch, which is tested in order to make sure that the desired cutting qualities and toughness have been obtained.

After hardening, the saws are packed in pans and tempered in oil, the temperature to which the oil is raised depending upon the work which is being handled. For instance, saws made of No. 1 steel, 21 gage, having fourteen teeth per inch, are generally tempered at 390 degrees F., while the same saws with thirty-two teeth per inch have their temper drawn at a temperature of 415 degrees F. To remove the oil after tempering, the saws are tumbled in sawdust, after which the ends are "blued," which means that the metal is softened at this point by heating the steel with gas flames. About thirty gross of 21 gage saws may be blued per hour; from the bluing machine the saws are taken to the packing room where they are first inspected for hardness by noting the color, and then counted into dozen lots. After this they are wrapped or wired together and packed in boxes containing one-half gross, which are labeled to show the length, width, thickness, pitch and grade of the saws. Records of all saws made in the factory are kept on the forms shown in Figs. 5 and 6.

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ELECTRICITY ON THE FARM

The telephone is doing much to relieve the isolation of farm life, and the automobile is also contributing to the same end. Where good roads exist the automobile puts a farm ten miles out of town practically as near as was one two or three miles out before its advent. Another factor that is making farm life more agreeable is the isolated electric power plant. Complete gasoline power units are now sold for $250, having a capacity of 750 watts, or enough to supply thirty 25-watt lamps. They generate a low-voltage current—32 volts—and are always ready, as a storage battery forms part of the system. Hence, it is not always necessary to run the engine when light or power is needed. With this little power plant, every well-to-do farmer can provide his own electric light at low cost, as well as power for operating household machinery, grinders, etc.

THE METRIC AGITATION

CHANGES INVOLVED IN SUBSTITUTING METRIC SYSTEM FOR ENGLISH METHOD OF MEASUREMENT

BY LUTHER D. BURLINGAME*

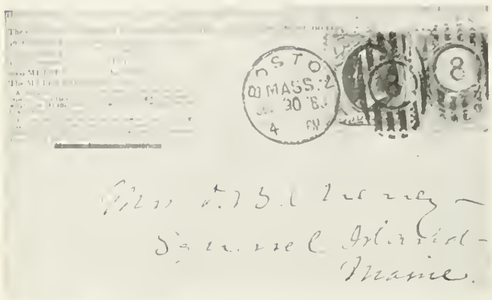


Fig. 1. Reproduction of an Old Envelope used to advertise the Metric System

ATTENTION is now being directed to a document, "The Metric System in Export Trade," prepared by S. W. Stratton, director of the Bureau of Standards, which is a report to the International High Commission, meeting in South America, relative to the use of the metric system in export trade. Having been published as a Senate document, it is being given wide circulation at the expense of the government.

This report was prepared with the apparent purpose of influencing legislation so as to bring about, by compulsory means, the adoption of the metric system in this country. In the opinion of experienced men, and especially those acquainted with the details of the requirements of the industries affected, such a change would, by breaking away from fundamental standards and having two standards in use in our shops instead of one, result in great confusion and enormous expense; and all this with no commensurate gain; indeed, with the saddling on our industries of a system in many ways less satisfactory than the one we should lose.

Dr. Stratton's report, while exaggerating the advantages of the metric system, especially as to stimulating the development of our foreign trade, minimizes its objections and the difficulties of making the change. It is the purpose of this article to discuss the points raised in Dr. Stratton's report and to show why we should not sacrifice the established standards of this country; to cite some of the reasons why the plan to make the sole use of the metric system compulsory in this country in the near future, as urged by him and embodied in the measure now before Congress, would be detrimental; and to show why the measure should be opposed by those having at heart the best interests of this country and its industries.

It is not the intention in this article to go into a general discussion of the whole metric question; and while much might be said regarding the objections and serious difficulties of changing other standards involved besides those for linear measures, this discussion will be confined to the latter, as it is in the changing of linear measurements that our industries will be most vitally and seriously affected.

In considering the question of changes in linear measurements bare mention will be made of many matters of great importance, such as land and nautical measurements, board measurements, measurements used in connection with railroads and in the textile industries, and an infinite number of other details, such as sizes of window glass, camera plates, automobile tires, etc.; but attention will be directed to the effect of the change on the mechanical trades principally, such a change being of the most vital interest and concern to the manufacturers and mechanics represented by readers of MACHINERY. The general question of a change from our present system of linear measurements to the metric system will be considered, as well as the use of this system in foreign trade, as Dr. Stratton has repeatedly stated that any moves for partial use, such as in the departments of the government, or for foreign trade, are but stepping-stones to complete adoption, and would be abortive unless followed by complete adoption.

In the report to the International High Commission five objections to the adoption of the metric system are mentioned and discussed by Dr. Stratton with the purpose of showing that they are trivial and should not stand in the way of making a change, of which (as claimed by him) the resulting advantages would more than offset the objections. The objections which he discusses are:

1. The difficulty of having two systems in use instead of one.
2. The cost of changing.
3. The loss of workmen's present familiarity with values represented in customary terms.
4. The loss of basic standards, or if old standards are maintained, the expression of their values in metric equivalents.
5. The loss of the present uniformity in the English-speaking world.

The various points in connection with the foregoing will be discussed in the order named.

Two Standards Instead of One

Dr. Stratton urges in answer to the first objection that we already have the two systems, and that therefore it is too late to consider this objection. He cites a number of American manufacturers who are claimed by him to be using the metric system, thus proving that the two systems are being used together voluntarily and without difficulty. Among these manufacturers, he names the Brown & Sharpe Mfg. Co., the Pratt & Whitney Co., etc., and in so doing gives to the commission, to Congress, and to the public an entirely wrong impression. The Brown & Sharpe Mfg. Co. does not use two systems in its manufacturing in any sense whatever, but instead uses only the system based on the inch. I understand the same is true of the Pratt & Whitney Co. Furthermore, it would be looked upon by the officials of these and other leading manufacturing concerns as a great calamity if the metric system should be forced upon their shops and their workmen, and yet they are listed in the report as examples showing how easily the metric system can be adopted. The inclusion of these names in the list given in the report is no doubt based on the fact that these companies make measuring tools having metric dimensions for the market; this, however, furnishes no ground whatever for any such misleading statement as that made in the report. Metric tools, such as micrometer calipers, are made with the general dimensions based on the inch, and when metric lead-screws are made for machines to go to countries which have adopted the metric system, diameters and lengths are made to customary English measurements. The cutting of the metric thread is simply a matter of gearing up the thread cutting machine by the use of translating gears to give the required lead, and no workman in the shop needs to know anything whatever about the metric system to do the work.

The fact that the needs of foreign trade can be met in this way practically without using the metric system in our American shops, has been used as an argument by pro-metricists that, because work can be readily done in such a way, the metric system could easily be adopted by us. Such a view, however, simply shows ignorance of the fundamental difficulties involved in making a change to the use of the metric system. Some years ago, Dr. Coleman Sellers, in a paper before the American Society of Mechanical Engineers, explained some of the difficulties of using the metric system in an American shop. This paper was prepared as a warning to American manufacturers against metric legislation, which was then pending, and Dr. Sellers based his conclusions on twenty years' experience with the metric system at the works of

* Industrial Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

William Sellers & Co., Inc., Philadelphia, Pa., where the system was introduced with the expectation that advantages would be found in its use, and an earnest effort was made to find such advantages. In this paper Dr. Sellers says:

> I propose to show why, after nearly twenty years' use of the metric system of measurement, I record my opposition to any enforcing legislation in this direction, because the metric system is not well adapted to the practice of the machine shop.

This company's use of the metric system was made in a department separate from other lines of manufacture, and Dr. Sellers explains why its use, when found to be disadvantageous, was not discontinued. He says: "Precisely the same reasons why we cannot change our general system into the metric hold against our giving up the metric system in the departments where it is in use"; and realizing the serious disadvantages of this condition, he urges American manufacturers to hold to their present system, and to "encourage the uniformity so desirable, rather than to attempt to make all things new, but in no respect practically better, at so frightful a cost."

If we should make a change affecting the departments of the government, such as the War and Navy departments, and if our factories were producing material for these departments, and war should come upon us during the transition from one system of measurement to the other, it can readily be seen what confusion and loss would follow and what a serious handicap the use of two systems would be in effectively prosecuting a war, the successful issues of which are now so well understood to be dependent on the mechanical industries. Even though the metric system was legalized in this country fifty years ago, and efforts have been persistently made since that time to bring it into use in the daily lives of the people, it has not come into use in any such sense as to warrant the statement made by Dr. Stratton to the effect that we now have two systems in use, or the further statement made by him that the metric system is used one hundred times as much today as it was a few years ago. Judging by the sale of metric tools in this country, as shown by the orders of large tool manufacturers, there has not been any relative gain in the use of such tools. In fact, the contrary seems to be true, in spite of the periodic efforts made by the pro-metricists to force the system to the front. In many American shops where they are doing work in the metric system, such as munition work for countries which have adopted this system, the dimensions are translated into English equivalents; in other cases gages are used, by means of which any knowledge of metric measurements on the part of the workman is unnecessary.

The claim that the metric system has been increasing in use is an old slogan of those who are urging its adoption, as will be seen from Fig. 1, which shows an envelope used in the early 80's to advertise the Metric Bureau of Boston. On this envelope is the statement, "The adoption of the metric system is now making rapid progress in this country." The use of the inch as a standard of measurement is as yet so nearly universal in the shops of manufactories throughout this country that it is believed to be entirely incorrect to say that "we now have two systems in use."

Cost of Making the Change

Dr. Stratton makes a comparison between the cost of measuring tools in the English and metric systems, and because he finds that the metric measuring tools are no more expensive than the measuring tools based on the English system, takes the position that the cost of making the change would be negligible. The real cost of making the change is thus ignored. Just the single item of changing the figures on drawings to give the metric equivalents, even if the dimensions were not changed to integral metric sizes, would be an immense task involving the probability of many serious errors. In one case which comes to mind, where the system of numbering parts in the factory was changed for only a part of its product, the cost of changing the drawings and records was found to run into many thousands of dollars. This change, however, was trivial in comparison with what would be involved in changing drawings alone to the equivalents in the metric system; and even after the drawings are changed, the expense has just begun. Fig. 2 shows how just one portion of a drawing typical of ordinary conditions would be changed if the metric equivalents were used, and all mechanics will admit that this half-way change would be entirely unsatisfactory, even aside from the first cost of making the change.

Many thousands of dollars worth of special tools are required in the ordinary process of manufacturing machinery.

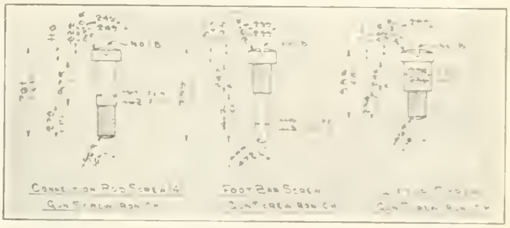


Fig. 2. Appearance of a Drawing changed over from English to Metric Measurements

Among these are special measuring gages which have the sizes stamped on them, as illustrated in Fig. 3, which shows a set of tools for the small needle-bar clamp guide :t for a sewing machine. If the company making the machine of which this is a part should adopt the metric system, it would mean that all these dimensions would have to be expressed in metric units instead of thousandths of an inch, and it can be readily seen what it would mean to remark these tools. If the actual dimensions should be changed to integral metric units, as pointed out by an able defender of our system—Henry R. Towne—to be the only logical way to adopt the metric system, even this cost would be multiplied many times, and interchangeability for repairs, etc., would be sacrificed.

The further cost resulting from the necessity of providing new basic standards, the handicapping of the skill of workmen, etc., will be mentioned under a later heading. Any attempt to revise the literature, especially the technical literature of the English-speaking people, while an utter impossibility, would, even if partly done, involve heavy expense.

The individual cost to the workman would also make a considerable item, as it would be necessary for him to invest in a new supply of measuring tools to replace such as are now in his kit which depend upon linear graduations. These cases cited are but suggestions of the items of cost involved, which, as pointed out by Dr. Sellers, already quoted, would be "millions on millions." To show that this is not mere generalizing, I quote further from Dr. Sellers' report:

> In regard to what is involved in each shop size, in a money point of view, I will give but a single example The inquiry to our own tool-room keepers for a list of the separate devices used in producing one size, *viz.*, $1\frac{1}{4}$ inch, brings to me the names of 129 articles or sets of articles, such as drills, reamers, gages, boring-bars and cutters, taps of all kinds for all sorts of uses, hardened mandrels, etc. These pieces, costing many hundred dollars, represent one size only. They tally with and belong to the dimension marked $1\frac{1}{4}$ inch in many thousand places on drawings which have been accumulating for years, to patterns loading down our pattern lofts, to gear wheels interchangeable over a continent, and to the output of our factory for years.

The Workman's Handicap

The workman's handicap in the loss of dexterity when using an unfamiliar system of measurement is an important point to be considered in the adoption of a new system. Workmen who have had years of experience dating back to their apprentice days have become familiar with the inch and its subdivisions. They not only know the fractional sizes of the inch as they do their A. B. C.'s, but have worked to thousandths of an inch and other fine measurements until a knowledge of these measurements has become ingrained in their experience. Prof. John E. Sweet strongly emphasized the loss which an abandonment of our present system would bring in this respect to our workmen, and he further said:

> The men who deal in ideas wish to dictate to the men who deal in things; the mathematician wishes to fix things

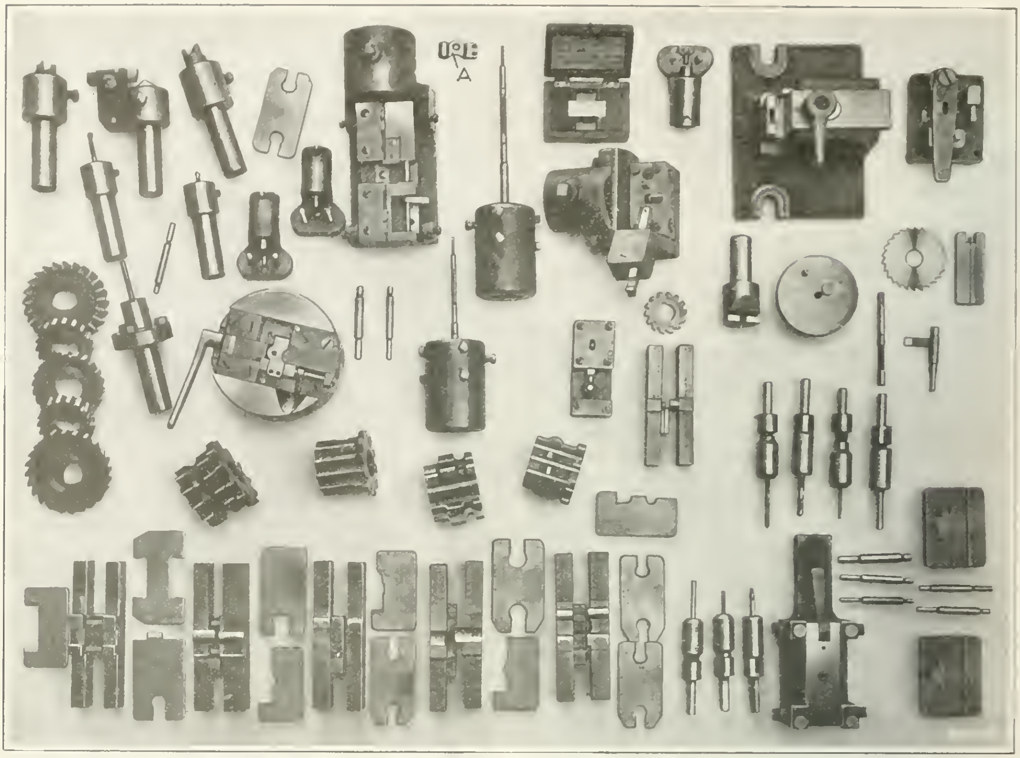


Fig. 3. Tools and Gages used in the Production of the Needle-bar Clamp Guide on a Sewing Machine

for his convenience at the expense of the convenience of the workmen, while there are one hundred workmen to every mathematician. The mathematician gains nothing in money, while the workmen will be put to millions in expense, and will not only receive no benefits, but so long as our present system exists and so long as things now made to endure are required, the double set of tools must remain; and it will be necessary for everyone reading an old book to translate the figures in order to comprehend or make use of the results.

He points out also that for a time, in many cases, the figuring will be multiplied tenfold, on account of the two systems in use side by side.

Loss of Basic Standards

The use of basic standards has laid the foundation for interchangeable manufacture. A pro-metric advocate, Hon. James H. Southard, ex-chairman of the house committee on coinage, weights and measures, admitted this in his report to Congress, although advocating the metric system. He says:

> In no other country has the construction of machinery reached a degree of perfection superior to that of our own, a result principally due to the system of interchangeable parts. The latter may be said to be a product of American ingenuity, and to be the greatest single advance in modern machinery. It has for its essential features a uniform standard of length and accurate length-measuring instruments. This work has been done upon the basis of the "inch" system.

The inch is today the standard of measurement used for the great majority of mechanical work of the world, not only in America, the British Empire and Russia, but also to a considerable extent in most metric countries; and we are asked to give it up as something which can be easily laid aside and in its place to substitute another unit. In discussing this question with mechanical men, it does not seem that it should be necessary to go into detail to show how serious a situation such a change as this might bring about. One or two illustrations, will, however, be given to suggest what points would be involved.

Let us take as an example a milling machine spindle having a standard arbor on which is mounted a gear-cutter for cutting gears of 6 pitch. The upper sectional view *A* in Fig. 4 illustrates how this is made at the present time. If the metric system is adopted, either one of two methods of procedure can be followed: first, to retain all the present interchangeable standards and express them in metric dimensions as shown at *B;* or second, to change these standards to integral metric sizes, in which case they will not interchange with machines already in use. It can be seen at a glance that either method would be very objectionable, if not entirely impractical.

As now made and illustrated in Fig. 4, there are, besides innumerable dimensions, at least nine standards involved. There is a No. 11 taper shank which is 1/2 inch taper per foot, 1 1/4 inch diameter at the small end, fitting in the milling machine spindle. This has a collar with a flattened section fitting in a 1 1/2-inch slot in the spindle. The arbor itself is of standard 1 inch diameter. It has a sleeve running in an outer bearing 2 1/16 inches in diameter. The nut on the end of the arbor is tapped 1 inch in diameter, ten threads to the inch to fit the arbor, and is flattened to 1 5/16 inch to fit a standard wrench. There is a standard keyway in the arbor, and standard cutters with standard keyways fit upon this arbor, the illustration showing a 6-pitch gear-cutter, which, in itself, is part of a system of gearing based upon the inch. The thread on the end of the spindle is 4 inches diameter, three threads per inch, and receives standard tools, such as inserted-tooth cutters. A cap-nut also fitting on this thread is used to hold the arbor in place. All these standards are important, and it is absolutely necessary that they be maintained, in order to secure interchangeability.

Now the metric advocates tell us how easy it would be, if we do not desire to change these standards, to simply express them in metric terms, and to work to these metric equivalents instead of to our present sizes. Fig. 5 illustrates what kind of figures our American workmen would be expected to work to in order to comply with this condition. A

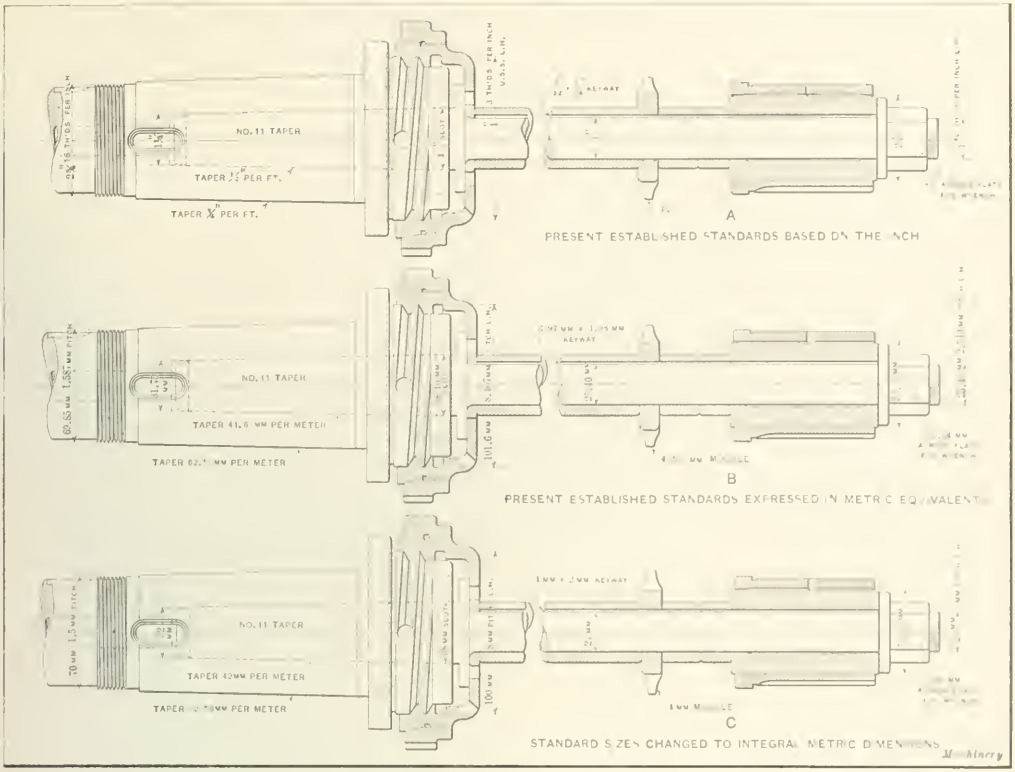


Fig. 4. Diagrams showing Difficulties experienced in changing over Milling Machine Spindle to Metric Measurements

glance at these figures will indicate how objectionable this would be. It is, however, the best attempt, after several trials, to do this "easy" job, which is for the purpose of making our work simple and saving time. The draftsman who made this drawing said, "If this is a sample of what we would have to do, I hope the change does not go through." Even if we should break away from all present standards and adopt integral metric sizes, as shown at C in the illustration, with the enormous additional first cost (though we put this great burden on our manufacturers), it would in itself be a serious handicap in competing for world markets, and we would have a much less satisfactory system after the change had been made, besides having sacrificed interchangeability. It is understood that several attempts have been made to adopt metric tapers for the holes in spindles of milling machines, drill presses, etc., but it was found that the standards for these based on the inch have become so fully established that even metric countries use them.

The gear-cutter on the arbor shows clearly that the system of gearing based on the inch is not commensurate with the system based on the millimeter, and this is further illustrated by Fig. 5, where in a pair of 8-pitch gears it is shown that with a given ratio of teeth, a change of system would require also a change in center distance if the gears were cut by the metric system. This would have to be changed quite materially if cutters of 3 millimeters or 3.5 millimeters module were used; and unless special cutters of 3.25 millimeters module were made, the change would be so great as to require redesigning and making new patterns for the housing in which the gearing is mounted, on account of the change in center distance, which even in the latter case would be changed more than 1/8 inch. This difficulty would also be present in the use of hobs for worm-wheels. The change in cutters and hobs would mean a large investment in even the average shop. The cutters sent out today can be used on any milling or gear-cutting machine because of having standard holes and keyways, whereas, by changing to metric sizes this advantage would be lost.

Millions of gears are being cut every year and are made interchangeable on the basis of the inch. A new gear can be cut to replace a worn or broken one or to add to a set already in use in a distant part of the country, even if the mating gear were made many years ago. The cutters for milling these gears are made in sets, and each shop adds to its stock as required. The introduction of the metric system would mean starting at the beginning, and accumulating a new set of cutters; and a century would not see the end of the confusion and expense which might be caused by such a change.

In order to maintain the interchangeability which we now have, it would be necessary, in addition to our present set of cutters, to have a set with the holes based on the inch to fit our present arbors, but with the pitch of the cutter made to the metric or module system; besides this, it would be necessary to have a set fully in the metric system, including the hole; and to be complete, another set would have metric holes in the cutters and be of diametral pitch based on the inch, so that our present style gears could be cut in the new machine. It might be said that this would make plenty of business for the makers of gear-cutters, but it would be a serious burden for the users, there being not only the cost of cutters but also the danger of mistakes, delay and annoyance, and there would be no advantage in any respect whatever over our present system, either in making calculations or doing the work.

Few manufacturers make their product through all stages from the raw material and each is dependent on other manufacturers for supplying many of the partly finished details, such as chucks, transmission chain, finished shafting, grinding wheels, etc., made ready to go on machines built otherwise by them; and any change that did not take effect simultaneously in all these co-related lines would lead to misfits, delay and annoyance. Even if these were avoided, it would

require the doubling up of stock. This is illustrated by the use of grinding wheels. Standards for the holes in grinding wheels, where such a large stock must be carried to meet the needs, not only of different shapes, but also of varying grains and grades, would be sacrificed.

Other examples may be found in the diameters of shanks which fit the holes in screw machine turrets and in the width of standard T-slots in which many fixtures and tools fit interchangeably. Dr. Stratton says, "Where a size is not most efficient, it should be changed," here again showing lack of appreciation of the question involved, *i. e.*, the question of standards. Any one of the metric screw thread standards may be fully as efficient as the U. S. standard; and a metric width of T-slot may be as efficient as our present standard, but it is the breaking away from the standard which causes the trouble, and not the question of efficiency.

At the Brown & Sharpe works there are between five and six thousand different kinds of screws, studs, etc., carried in stock, representing many millions of parts constantly on hand. These are used interchangeably throughout the various lines of manufacture and for repairs to machines made in some cases generations ago. It is not evident how a change in these can be effected "simply" and "easily" and in "a short time, with small expense," as so glibly pointed out by pro-metric advocates, yet this is but a drop in the bucket compared with what we would have to go through if the change were to be made. Here again the suggestion to use metric equivalents instead of really changing the sizes would be absurd, especially in the light of the pro-metric argument that a change to that system would simplify our work.

Loss of Present Uniformity

The loss of uniformity between nations now using the inch as standard is the last one of the objections which Dr. Stratton so completely sweeps out of the way. This objection is the one dealing with the uniformity which we now have with all other English-speaking people, as well as with great nations that are not English speaking — uniformity which would be lost if we should abandon our present system. He points out that because there are now some differences in weights and measures among these nations, it is not important to try to keep such uniformity as there is. Any mechanic who stops to think will realize what practically complete uniformity there now is among the English-speaking nations in matters pertaining to the mechanical trade. The difference in screw threads is almost the one exception, and even here both systems are expressed in terms of the inch, and their relation is readily understood.

Dr. Stratton says that because "English exporters are using the metric system in export, it is an equally cogent reason why we should do the same." This is an implication that England is using the metric system in export trade in some way different from what we are, and that we should pattern after her. As I understand, England is using the metric system in foreign trade in just the same way that we are; *i. e.*, wherever the interests of her manufacturers dictate in producing or advertising goods which will be acceptable to her foreign customers, she uses the metric system without legislation or compulsion, and that is just what American manufacturers are now doing, have been doing in the past and desire to do in the future. Dr. Stratton further says, "If manufacturers and customers in metric countries can prepare products acceptable in the United States and England with their different standards of measures, it is incredible that America cannot reciprocate to meet the essential demands of metric countries by such reasonable use of metric terms in making or marking our products." Does Dr. Stratton mean by this to imply that these metric countries are using the English system of measurements when producing goods to send to America, and that imports into this country from metric using countries are being manufactured by the English system? Evidently not. And there is no more reason why we should, generally speaking, make our goods in the metric system to meet the needs of our foreign trade than that foreign manufacturers should make theirs in the English system to meet the needs of our trade.

One statement of Dr. Stratton's is very true, to the effect that "in using the metric system to promote the export trade with metric countries, common sense should take the practical turn of deciding how far its use is profitable." It is believed that our manufacturers and engineers are quite as competent to apply the test of common sense in this matter as theorists and legislators, and that they have been and will continue doing so as occasion demands, without the need of meddling legislation. I have before me a Brown & Sharpe catalogue of 1867 published in the French language, in which dimensions are listed in millimeters. Brown & Sharpe catalogues in French, German and other languages have been available when needed since that time.

Henry D. Sharpe, treasurer of the Brown & Sharpe Mfg. Co., said in a recent letter to *Current Affairs*, dealing with the relation of metric legislation to our foreign trade, "Instead of such a change being of benefit to our foreign trade, it would mean confusion to our home manufacture and use, placing a burden on us which would be a serious handicap in our competition for world markets"; and he further says: "The American manufacturer has never found any difficulty in obtaining this trade when he wishes to, as far as the matter of the metric system is concerned. He will make the pertinent dimensions of his goods to the metric system or any other system to suit the foreigner."

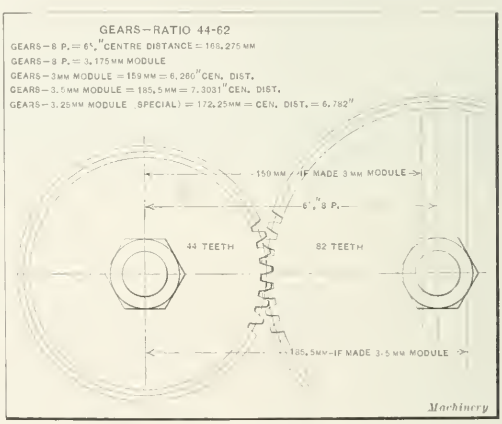


Fig. 5. Diagram showing Changes involved in Ordinary Spur Gears by the Use of Metric Measurements

Secretary McAdoo, in his communication commenting on Dr. Stratton's report, while endorsing the view that we should adapt ourselves to the needs of our customers, truly says, regarding the adoption of the metric system, "I am aware that it would be the work of generations, and would involve endless complications, if not waste, to change our present system for domestic use"; and the *Iron Trade Review* has said, editorially, "It has been demonstrated time and again that the expense to the manufacturers of this country, and particularly to those engaged in the machinery and metal trades, of changing from the English to the metric system would be enormous, not to say prohibitive, and without any compensating advantages."

After we had been all through this great upheaval, what would we have to show for it? I am among the many who believe that for the mechanical trades, and for use in the shops, we would not have in the metric system as convenient a system as we now have. The millimeter, the unit generally used in the mechanical trades where the metric system is in use, is so small that it must usually be expressed in many figures. The reason for its use to the exclusion of other units is to avoid confusion in the use of decimal points that would arise in using centimeters, decimeters, etc., and also to avoid the use of a multiplicity of units; so that the lesser of two evils is chosen. Even when compared with our fractional sizes which may sometimes use nearly as many figures, the metric sizes are not as easily carried in mind. Thus, 384 millimeters is not as easily carried in the mind as 9¾ inches, while 354

millimeters or even 350 millimeters would be much harder to remember than 9 inches.

There is no unit in the metric system as convenient as the inch, and there are no subdivisions of the metric unit as convenient for use as hundredths and thousandths of an inch, to say nothing of the fractional sizes, quarters, eighths, sixteenths, etc., so familiar to every mechanic. Another advantage of our present system is that it is adapted for either binary or decimal division. This is a convenience to the draftsman who, using binary divisions when scaling his drawing down, can make it one-half, one-quarter, or one-eighth size, according to the requirements—a convenience lacking in the metric system—and by using decimal divisions and multiples of the inch when it suits his needs, the draftsman has a full decimal system with all the advantages in calculations, etc., claimed for the metric system.

A number of years ago MACHINERY said editorially, in corroboration of this view: "So far as the use of the metric system in the machine shop is concerned, we believe it is not and never can be as convenient as the English system. The inch subdivided into one-half, one-quarter, one-eighth, etc., is an extremely convenient unit for proportioning machine parts, and when divided into a thousand parts, fulfills all requirements for the most delicate and accurate work."

The advocates of the compulsory adoption of the metric system in this country must be given credit for persistence and ingenuity in devising ways, often insidious in their character, to start an entering wedge for the adoption of this system. Ten years ago it was by proposing to make the system compulsory in all departments of the government. Now it is to secure action in South America which will pledge this nation to overthrow its present system. This is no idle fear. I quote from a report of the Committee on Coinage, Weights and Measures, to Congress, regarding the action taken a number of years ago by the first Pan-American congress recommending the adoption of the metric system.

The report says: "The other nations, parties to the conference, with scarcely an exception, have honorably proceeded to put in force in their respective limits the metric system then adopted. On what principles of international honor can the United States, the originator of the conference, stand alone in refusing or delaying to abide by its action?"

It is believed that the mechanical interests should take warning from the past methods of the metric propagandists and that they should see that no legislation is sprung upon them unawares. It is further believed that an earnest protest should be made from all these mechanical interests against any compulsory legislation affecting the standards of measurement in our shops.

* * *

TANDEM MILLING FIXTURE

With the idea of increasing production, the tandem milling fixture shown in Fig. 1 was designed by the W. H. Nichols Co., Waltham, Mass. The parts for which this fixture was designed are the small malleable iron, tabulating-machine cam levers shown to the right in Fig. 1. These cam levers are located from pins in holes that have previously been drilled and reamed in a drill jig. The width of the slot must be machined to close limits, as well as the width of the lug, which is straddle-milled, and it is important that the milled surfaces be exactly at right angles with the holes.

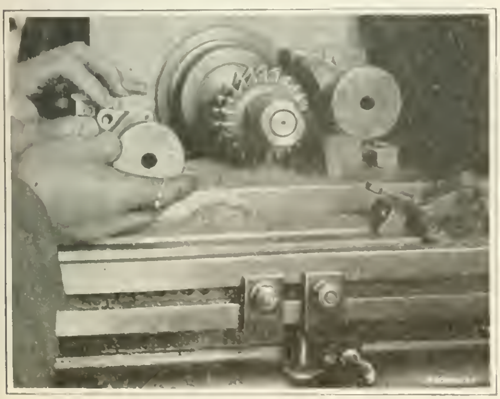


Fig. 1. Tandem Milling Fixture for facilitating Production

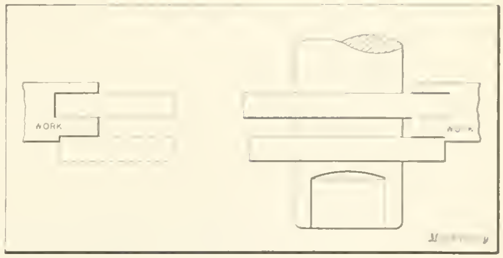


Fig. 2. Diagram showing Relation of Work and Cutters

The operation of this fixture is as follows: While the cutter is milling the lever in the right-hand end of the fixture, the operator removes the lever which has previously been milled from the left-hand end of the fixture and replaces it by an unmilled lever, tightening up the hand knob as shown. By this time, the other milling operation has been completed and the advance of the table has been stopped by the feed trip. The operator then feeds the table by hand close up to the left-hand end of the fixture, throws in the power feed and loads the right end of the fixture. Thus the operation is practically continuous. A plan view of the arrangement of cutters and work is shown in Fig. 2.

It is customary to run the cutters at a speed of approximately 64 R. P. M., with an advance of the work of 0.017 inch per revolution of the cutter, which is approximately 3 inches in diameter. Under the conditions stated and by the use of this fixture, one operator has machined as many as eighty levers per hour and will average approximately 720 levers per ten-hour day. These production figures speak for themselves. It is safe to say that this fixture should nearly double the output obtained with the ordinary single fixture. V. B.

* * *

Although the diamond wheel is the most efficient means of truing grinding wheels, there is perhaps no more unknown quantity as regards durability and dependability in such general use among mechanics than the average diamond used for truing wheels. This is due largely to the fact that bortz are of natural formation. Moderate priced stones, especially the brown bortz, have much to recommend them over the more costly stones. The diamonds generally used for wheel truing are of five classifications: brown bortz, gray bortz, Jagersfontein, Ballas and black carbon. These five may be obtained in various sizes and qualities. Of the five classes, the grays and browns are the cheaper grades, while the Jagersfontein, Ballas and black carbon are more costly. Between the grays and browns there is not much difference. The gray stones are harder, and this might be a recommendation to some, but besides being harder, they are also much more brittle. They will stand far less shock than the brown bortz, and as there is not much difference in cost, the latter seem preferable. The brown bortz have certain properties that recommend them above the others for grinding wheel truing: (1) They are sufficiently hard to withstand reasonable wear. (2) They are obtainable in shapes that lend themselves to proper setting. (3) They are not as brittle as some bortz, especially gray bortz. (4) They are not as expensive as Jagersfontein, Ballas or black carbon. (5) If the stone proves to be soft, the loss is not as great as would be the case with a more expensive diamond. (6) The less experienced purchaser may detect flaws more readily in the brown bortz than in the other kinds. (7) Diamonds may be easily ruined by careless use, and this is true of the expensive as well as the cheaper grades.—*Grits and Grinds.*

TESTING LEE-ENFIELD BAYONETS

GENERAL REQUIREMENTS—GAGES USED WHIP TEST—COMPRESSION TEST BEND TEST—HARDENING

BY JOHN J. RALPH*

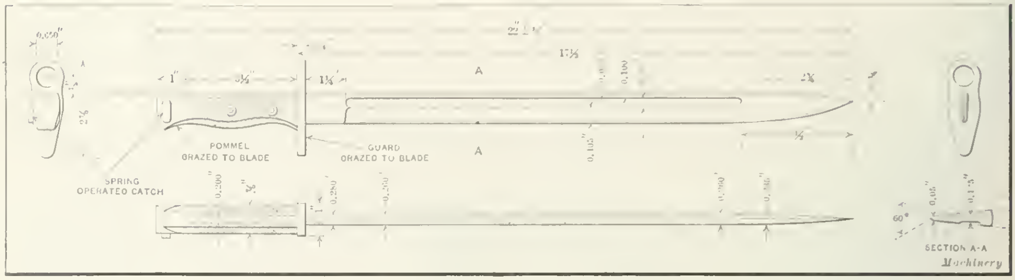


Fig. 1. Bayonet for Lee-Enfield Military Rifle

Among the earliest war orders were those for rifles and bayonets, yet these were not received in this country until five months after the war started. These first orders were accepted by the larger arms manufacturers and necessitated new factories and organizations. In the majority of cases, the companies to whom the contracts were let were more or less unfamiliar with the requirements of government manufacture, with the result that the work produced and offered for acceptance was far below the standard until severe lessons through rejection forced a change in methods, gages, and even materials in some cases. The general lack of specific knowledge of the class of work necessary on military rifles and bayonets is largely responsible for the tremendous losses which have been incurred by a number of companies. In some cases many orders have been executed at an actual loss where profits should have been great if manufactured under proper methods and supervision. The essential features to be observed in this class of manufacture are thorough mastery of the technical problems involved, careful planning and designing preliminary to actual work, and provision of the highest class of tool equipment and gages used in testing the work.

Bayonet Specifications

Fig. 1 shows an approximately correct drawing of the bayonet used on the Lee-Enfield military rifle, and a summary of the specifications is given herewith.

Sword bayonet must conform to pattern and standard gages, subject to limits given in drawing and conditions of specifications.

Quality of material must be as specified, and where not specified, quality and workmanship to be the best possible.

Bayonets subject to inspection during and after manufacture. If one-quarter of the delivery is inferior to pattern or contract specifications, the whole consignment is liable to rejection.

Material, crucible steel, carbon 0.90 to 1.10 per cent; phosphorus and sulphur to be below 0.02, and manganese low. To be hardened in oil, through oil in water, or in water, at the manufacturer's discretion.

General Requirements

Each blade is inspected for size; each hardened and tempered blade is given a 3/4-inch compression test and a striking test. One blade in each two hundred is given a 2 1/2-inch compression test, and if not satisfactory, others are tested or the entire lot is returned for further treatment, at the option of the manufacturer and inspector. After this, the blades are given the inspection mark and returned for finishing. The permissible variations in blade lengths are 1/4 inch; other dimensions 0.010 inch, except rifle engaging device which must be within limits of + 0.002 or — 0.005 inch. The specifications for finish call for the blade to be sandblasted; the guard, handle, pommel, and catch heavily browned; the screws oil blackened, and the black walnut grips linseed-oil treated. After this, the blades are given tests for final finish, size, workmanship and physical tests.

* Address: 156 Blossom St., Fitchburg, Mass.

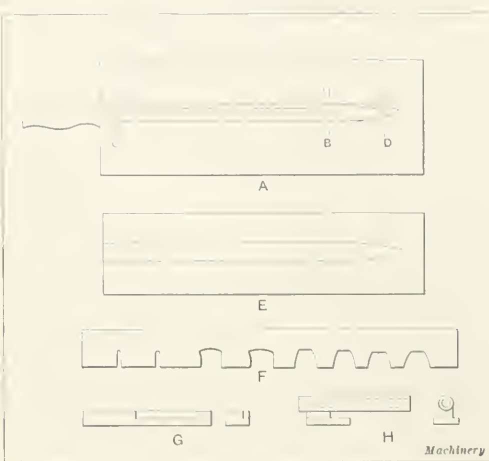


Fig. 2. Gages used in inspecting Lee-Enfield Bayonets

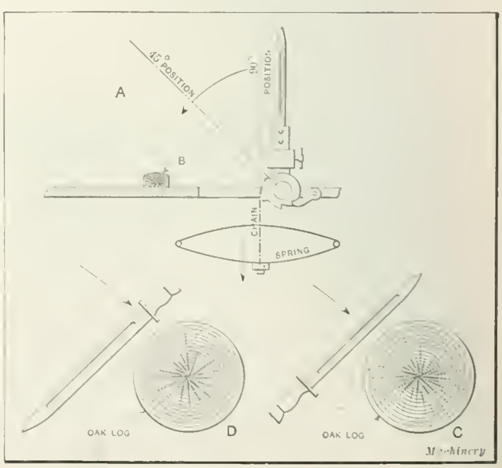


Fig. 3. (A) Whip Test Device. (C) (D) Final Acceptance Test

Description of Tests and Gages

The gages shown in Fig. 2 are representative of those used in the inspection of the bayonet. *A* shows a receiver gage for length of blade and length of groove. The maximum and minimum length of blade permissible are indicated by lines at *D*, while the limits on the grooves are indicated at *B* and *C*. *E* is another receiver gage for testing the width of the bayonet. There are two of these gages, one of maximum width which receives the blade freely, and one of minimum width which will not accept blades. The actual width of the blade is tested with a "feeler" 0.010 inch in thickness. The type of gage shown at *F* is for the purpose of determining the cross-section and general outline of the groove, guard, and the front side and end of the pommel.

Gage *G* is made in two sizes, one of which is for maximum size of pommel slot, and the other for minimum size. Gage *H* is a tube and plug gage for testing the alignment of pommel guards and blades by sighting through the tube. The tongued portion is slipped into the pommel slot in use. Straightness of blade is tested by sighting along the edge and back, perpendicular and parallel to both ends. This will disclose the slightest bend or twist in the blade.

Whip Test

A diagrammatic representation of the method used for testing the front and back edges of the bayonet blade is shown in Fig. 3 at *A*. In this test an oak block is used on which the blade strikes as indicated at *B*. The bayonet blade is held in a socket mounted on a shaft having at one end a ratchet and pawl provided with a suitable quick release. An elliptic spring is placed below the fixture and is connected by means of a chain to the collar on which the ratchet teeth are cut. As the ratchet is thrown out of engagement, the pull of the spring causes the holder and the bayonet to describe an arc of 90 degrees, the motion being arrested by the oak block against which the blade strikes. Two tests are made in this fixture, one with the bayonet held at 45 degrees and the other at 90 degrees, the 90-degree test being made against the oak block shown, while the 45-degree test is made on the iron plate with the oak block removed. The pull of the spring is from 17 to 19 pounds for the 90-degree test and from 9 to 12 pounds for the 45-degree test.

Broken blades are rejected after coming from this test and bent blades are returned for straightening and rehardening. The blades which have successfully passed the test are next taken to the compression test.

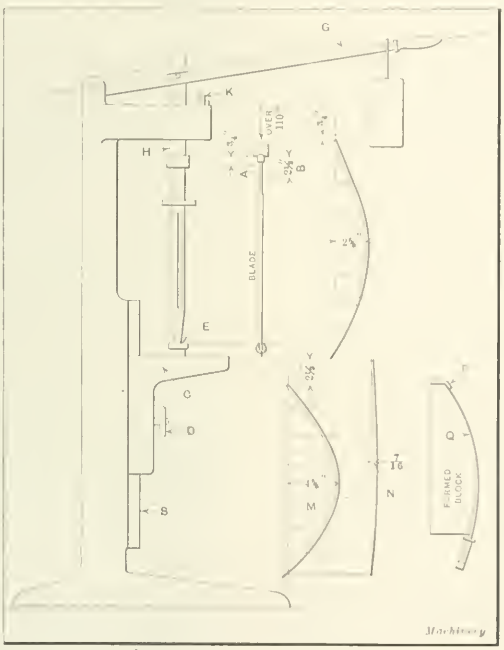


Fig. 4. Compression and Bending Tests

Compression Test

In making the test for compression of the bayonet blade, a special type of machine is used as indicated in Fig. 4. This machine consists of a standard, much like that of a small vertical drilling machine, carrying a vertical slide *B* on which an adjustable table *C* can be locked in any desired position by means of the locking screw shown at *D*. The spindle *H* is mounted so that it can be controlled by the lever *G*, and an adjustable stop *K* is provided to limit the vertical movement. In using this fixture, the bayonet is placed with its point in the cup shaped bushing *E*, while the spindle is brought down upon the pommel by the hand-lever. Sufficient pressure is exerted on the lever to compress the blade ¾ inch. After this it is examined for "set," returned to the testing machine, bent the other way, examined again for set, and if not bent is gaged for size.

The blade must raise 110 pounds from the compressed point and straighten itself under this load. This is a normal compression test, but in addition to this, one blade in every two hundred is given a 2½-inch compression test as indicated at *M* in Fig. 4. When the blade is given this extra test, it must recover with a final set of not over 7/16 inch as shown at *N* or it will be rejected. If the bayonet passes this test satisfactorily, the entire lot is passed by the inspector. If unsatisfactory, another bayonet may be tried, and if this also does not pass inspection, the lot is returned for retreatment. The blade which is given the test is destroyed. The various diagrams shown in Fig. 4 represent the approximate curvature taken by the blade under the tests mentioned. The machine is covered with a stout wooden case during the testing, to protect the operator from flying fragments in case of breakage. This wooden case is provided with a door which is so arranged as to permit the removal of broken blades, and a small opening for inserting and removing the blades.

Bend Test

This is a hand test over a formed block which is curved to the same form as the curve obtained in testing under the machine. In this test the point of the blade is held under a suitably formed clamp *P* at the end of the block, and the blade is bent by holding the handle in the hand and pressing it around the form as indicated at *Q*. This is done after the wooden grips have been attached and does not require any great strength on the part of the operator. A wire screen is provided on this fixture to protect the operator in case of breakage. The object of this test is to throw a strain on the handle, which is softened during the brazing, and the slightest set is sufficient to cause a rejection of the blade.

Final Acceptance Tests

Before the blade is finally accepted, another test is made as indicated at *D* and *C* in Fig. 3. At this time the bayonet is completely finished. The blade is held by the operator and the handle is sharply struck against an oak log about 18 inches in diameter. Then the handle is grasped and the blade struck against the log. The front, back and sides of the blade are struck on the log during the test. The brazing of the guard is also tested as it is struck against the log.

Hardening Troubles

The testing of a military bayonet is extraordinarily severe. If the blade is made of minimum thickness, it fails to lift the weight of 110 pounds on the ¾-inch compression test, even though it does not set at this time. If the blade has not been sufficiently drawn in tempering, it snaps like glass under the test, while if it is drawn too much it sets. If, again, the forging heat is too high, the blade is ruined, and if the flame is sharp or oxodizing, the result is the same. As the shape of the bayonet and its section vary considerably, the blade tends to draw during the cooling, so that it bends both edgewise and sidewise.

The temperature at which a bayonet should be drawn is the same as that used for such wood cutting tools as axes, and is called an "axe blue." The high-carbon steel used in the bayonet is exceedingly sensitive to slight changes in hardening temperatures, and the tempering must be done very carefully in order to produce the desired results. The straightening must be done before the blades have become cold. In tempering, the use of a lead-tin mixture is likely to check the blade so that it will break under the test. The bayonet blade may be tempered by drawing it over an open flame, but this method requires long training and great skill.

The testing of a bayonet brings up a number of points in connection with the manufacture not ordinarily met with in other lines of mechanical work. The methods used in determining the physical characteristics of the steel after it has been put through the various processes of manufacture are of interest and illustrate clearly the problems with which the manufacturer has been confronted in making military equipment that conforms to government requirements.

* * *

REPAIRING A WATCH BALANCE STAFF

BY GUY H. GARDNER*

In passing a jeweler's establishment, all of us have seen through the window the watchmaker seated at his pygmy lathe, and have noted some points in which his work resembles ours. Many machinists, however, have carried their investigations no further than a casual glance, and such men may find something of interest in a description of one piece of watch repair work. First, I wish to say that the man whose methods I am about to describe is of the older generation, and employs simpler and fewer tools than many of his younger brethren, relying on his laboriously acquired manual skill to accomplish results which others attain by improved appliances.

For example, in the job he is about to begin, he makes no use of the slide-rest, though he has one safely wrapped in chamois skin in his bench drawer and often utilizes it for certain kinds of work. Just as his slide-rest is a miniature copy of our familiar lathe carriage, minus change-gear and feed-rod connections, many of his tools and appliances manifest a similarity to ours in all but size, though others have no counterparts in our trade, so far as I am aware. Our friend is called upon to repair a watch of foreign make, which has been injured by a fall. He finds, on examination, that both pivots are broken from the balance staff.

Fig. 1 shows the staff with both pivots intact. The first lathe work consists of the removal of the balance, the other attachments of the staff being removed by other means. As may be seen, the balance is held by the riveting or "heading over" of the metal above it. This might be cut away in the lathe, but the watchmaker knows the danger of marring or springing the delicate balance, and adopts the preferable method of turning off the shoulder *A* on which the balance rests. Now, if the timepiece were of American make, he would simply insert a ready-made staff, obtained from the watch factory, which would be so nearly a perfect fit as to require, at most, only a touch of a lap at the points where exactness of size is needed, as these are sometimes a trifle large. Moreover, if but one pivot were damaged, he might "chuck" (as we should call it) a hole in the broken end of the staff and drive in a plug, the projecting part of which he would turn to the dimensions of the missing pivot.

In the present case, however, he proceeds to make a new staff. First he needs to know the approximate diameter, which he judges by inspection, and also the exact length; this last dimension must be accurately determined because, as anyone may see by looking into the back of a watch, the ends of the pivots abut against "cap jewels." To obtain this measurement he uses a tool shown in Fig. 2, in which two rods with ends like pivots, slip friction-tight in a sleeve.

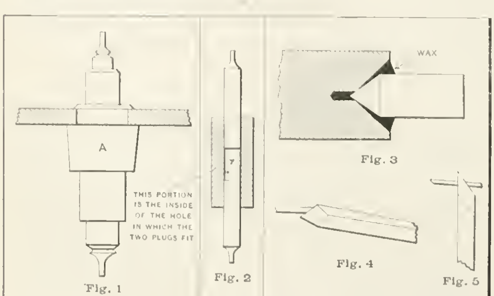
The dimension thus found looks to be about 1/4 inch, and if I may anticipate a little, the micrometer showed the over-all length of the finished staff to be 0.2395 inch. The raw material for the new staff is a bit of drill rod, which is heated in the alcohol lamp flame to a cherry red, quenched in cotton-seed oil and drawn to a light blue. This is gripped in a split chuck, cut off to length and one end is pointed like a lathe center.

Now, as this workman does not think a split chuck quite good enough for accurate work, an opinion once common among watch repairers, he uses the affair shown in Fig. 3, which he calls a "wax chuck." It consists of a piece of round brass rod in which he has bored a hole while the piece was held in the lathe. In this chuck he places the conical end of his balance staff blank; fastens it with "wax" (a compound whose basis is shellac), softening the wax by the heat of the lamp flame; and trues up the piece to center by pressing against it, as it rotates, with a bit of wood resting on the T-rest. When the wax is cool he proceeds to turn the projecting part to within about 0.001 inch of its finish dimensions, and then reverses it in the "wax chuck" and does the same to the other half.

Here we note a departure from the usual machine shop method of using the square graver, which is the only lathe tool employed on this job. In roughing out the staff he holds the tool as shown in Fig. 4, with its axis nearly parallel with that of the work, the same position being used in slightly rounding the pivot ends; but for taking the "finish chip" he adopts the position shown in Fig. 5, taking a shaving that is hardly visible without the eye-glass under which all his work is done. To form what he calls "the cone" at the base of each pivot, the graver (held as in Fig. 4) is given a rolling motion, its top being rotated toward the workman.

Now all that remains is to reduce the various "fits" to their proper dimensions by means of a lap carried in a device similar to a toolpost grinder, which is driven from the countershaft on the back of the bench. The rollers, hairspring collet and balance are put in place, and the riveting for the last-named is done by a "staking tool," which is somewhat like an arbor press except that it is perhaps 5 or 6 inches tall, and a hundred different "punches" take the place of the ram, being driven by light taps of a brass mallet. After the watch is put together, the final "operation" is a demand for $2, no charge being made for the information his customer has acquired concerning a trade closely resembling his own in some respects, yet radically different in its methods.

* Address: New London, N. H.



Figs. 1 to 5. Successive Steps in repairing a Watch Balance Staff

* * *

VANADIUM STEEL FOR AEROPLANES

One of the most recent and interesting applications of vanadium steel is in the new armored aeroplanes known as "battleplanes," built for the United States Army by the Sturtevant Aeroplane Co. This new type of flying machine possesses many novel features, but chief among them is the fact that the entire craft, wings and all, is built of vanadium steel. On the first model in which steel was used, the saving in weight as compared with the wooden construction was not great, but it was soon found that by careful refinements in details, the sections could be greatly reduced without sacrifice of strength, and in subsequent models the weight has been reduced from 25 to 30 per cent. The vanadium steel used in the framework is cold-rolled stock. The sheet steel used for the wings is also cold-rolled, and in addition vanadium steel wire is extensively used.

AN OPPORTUNITY FOR THE TOOLMAKER

BY F. B. JACOBS*

Toolmakers as a class are sometimes inclined to be dissatisfied with their environment. Just why this should be is a question; nevertheless the fact remains that a fair percentage of all who are engaged in manual labor have a secret ambition to become skilled in a higher calling. Certain shrewd business men who are keen students of human nature are well aware of this fact—hence the existence of the correspondence schools that are not at all backward in claiming to teach practically everything. If the toolmaker is possessed of a fair amount of ambition and has a yearning for something better than daily toil at manual labor, there are several avenues open to him, and the object of this article is to touch briefly on the subject of tool designing and the toolmaker's chances of succeeding in this line.

Many of the younger toolmakers of today have a vague idea that tool designing is a branch of drafting-room practice that has existed for as long a period as toolmaking, but this supposition is erroneous. Twenty-five years ago, as any gray-haired toolmaker today can testify, tool designing as practiced at present was almost unknown. In those days the toolmaker himself was the designer, planning his work as he went along. To be sure, he sometimes had a pencil sketch to guide him, but the greater part of the real designing originated in his brain, and to him alone is due the credit for many of the labor-saving ideas of the present. The patternmaker, too, often had a finger in the pie, so to speak; he was frequently given a finished part, about which he leisurely proceeded to build a pattern. This often resulted in heated arguments in cases where the finished jig did not come up to requirements—a sort of three-cornered debate between the "old man," the toolmaker and the patternmaker. Eventually the toolmaker rebuilt the jig, during which time he frequently indulged in a few far from complimentary remarks concerning patternmakers who thought they knew how to design jigs.

Origin of Tool Designing

This happy-go-lucky manner of designing jigs may have been satisfactory twenty-five years ago when present-day reproduction of machine parts was in its infancy. At that time, however, there were a very few concerns, chiefly shoe machinery manufacturers, who employed tool designers, and it was among them that our present methods of tool designing originated. The tool designing, such as it was, fell to the lot of the ordinary draftsman whose knowledge of the practical application of special tools for the rapid duplication of machine parts was almost nil. To be sure, many became proficient through dint of close application, but the manufacturer who occasionally needed a few tool designers had to go through the slow process of developing them from the material that was to be had. Practical shop men were almost unknown in the drafting-room in those days for two reasons: First, there was a deep-rooted prejudice against the man who wore overalls—he was looked upon as a common laborer who must not presume to rise above his station in life. Again, the toolmaker's wages were generally higher than the draftsman's, thus the drafting-room offered small inducement to the toolmaker.

The college-bred man was often employed in the drafting-room. When his college days were over, he waited for a few months "to consider the lucrative offers that eventually would come his way." The lucrative offers failing to materialize, he began to look for a job, to state the fact in plain English, and as the rudiments of drafting was the only practical knowledge he possessed, to the extent of turning it into bread and butter, he became a draftsman. It is not the writer's intention to discredit college-trained men—far be it from such—but at the same time we cannot help but realize that their technical training should have fitted them for something far better paying than working at the drafting board.

The old regime, however, is passing, and with it the jealously guarded veil of secrecy that surrounded knowledge of various practical subjects. One reason for this is that present advantages for education are so plentiful that it is possible for the ambitious man to obtain knowledge on a diversity of subjects at small cost. Heretofore, special education on any subject was reserved for the favored few who, through a trick of fate, happened to be born in fortunate circumstances.

Demand for Tool Designers

Without a doubt, the greatest impetus given to tool designing came through the phenomenal growth of the American built automobile. When we consider that it takes hundreds of jigs, to say nothing of other fixtures and special tools, to put a new model on the market, and that this is often accomplished in ninety days or less at a cost of approximately one hundred thousand dollars, for the ordinary type of six-cylinder car, we begin to realize the importance of tool designing. With the new order of things came the demand on a large scale for efficient men who could design tools; thus the way was opened for the toolmaker to step from a productive to a creative line of work. His knowledge of tools, in general, is a valuable asset that is never possessed by the purely theoretical man. Again, experience has taught the toolmaker just how each part of a jig or fixture should be designed with the view of lessening machine work whenever possible. The time-honored expression: "Oh, well, I guess the toolmaker can machine it somehow," is no longer tolerated. The present-day tool designer is supposed to know—he is no longer allowed to shift responsibility to another's shoulders.

When the writer speaks of a toolmaker, the all-around man is referred to—not the man who, because he has made a few reamers or jig bushings,, styles himself a toolmaker. The question naturally arises: "How is a man who has never made a working drawing to fit himself for a position as tool designer?" In the first place, the all-around toolmaker has a complete practical knowledge of special tools, that is, if he has traveled to any extent and has kept his eyes open, and it can be said to his credit that he usually has. Again, having worked to drawings for several years, he knows how to read them. As a matter of fact, the toolmaker will often spot a wrong projection or an incorrect over-all dimension that had escaped the draftsman and the checker.

How to Learn Tool Designing

To come to the direct subject: How is the toolmaker to learn mechanical drafting? There are several ways. Perhaps the most convenient method is to study the subject at home from text-books. This has the disadvantage, however, that the student has no one to point out his errors—he has to dig out everything for himself. In our large cites, evening schools teach the subject, or at least the rudiments of it, to all who care to enroll. This is a very good method, as a competent instructor is always at hand to point out mistakes. The majority of home students, however, study the subject through correspondence courses, as they are not expensive, when the knowledge gained is taken into consideration, and the instructors are competent.

There seems to be a certain amount of prejudice against correspondence schools, especially among those who are ignorant of them, but if we investigate the matter we will find that there is seldom just cause for criticism. The writer does not mean to infer that every Tom, Dick, and Harry can become proficient at drafting through correspondence teaching, for of course the human element plays the all important part. However, he does not hesitate to state most emphatically that any bright young man with a leaning toward drawing and a determination to succeed can master the principles of the subject through home study. Drafting is largely a matter of manual skill; hence it takes a long time and constant practice to become a rapid and efficient workman.

The toolmaker who wishes to become a tool designer must also master the subject of trigonometry. Now, as a matter of fact, this study is not half as formidable as its name implies; in fact, any man who is mathematically inclined should become fairly proficient in a few months' study. Briefly described, trigonometry is the science of measuring

* Address: 109 W. St. Clair St., Indianapolis, Ind.

the sides and angles of triangles and ascertaining the relations between them by certain parts which are given, namely: the tangent, cotangent, sine, cosine, secant and cosecant. A knowledge of these parts, together with the tables of trigonometric functions, such as are found in MACHINERY'S HANDBOOK, is all that is required to solve the ordinary right-angle problems that confront the tool designer. A working knowledge of square root is also quite essential. Cube root, however, is seldom used by the tool designer, as he rarely has occasion to deal with the third power of numbers. As a matter of fact, ninety per cent of the tool designers of today cannot solve problems in cube root offhand because they are rusty on the subject owing to lack of practical application. A knowledge of algebra and logarithms sometimes proves of value to the tool designer, but this is not absolutely essential. The writer's advice to the embryo tool designer is to leave these subjects strictly alone until he has mastered ordinary arithmetic and simple trigonometry; otherwise confusion is sure to result, or, to use the shop man's favorite expression, he will get completely "balled up."

How is the toolmaker to obtain employment at tool designing after he has become proficient in drawing and mathematics? Now this is where the real rub comes in. About the first question invariably asked is: "What experience have you had?" This is where the man must work out his own salvation—it is up to him and to him alone. As a matter of fact, there are only two avenues open: the toolmaker must either state that he is an experienced draftsman, or say frankly that he has had no practical drafting-room experience.

The better way is for the aspirant to stick to the truth and endeavor to convince the chief draftsman that he understands the subject of tool designing and only wants an opportunity to prove his worth. Sooner or later he will find some one who will be willing to take a sporting chance and try him out. To be sure, he will have to start at a low rate, but after he has had a year or so of that mystic "experience" he will gradually advance as he acquires practical knowledge.

There are many who claim that the shop man never makes a good tool designer, but there is no sound argument to substantiate this claim. The fact is that about fifty per cent of the tool designers of the present are practical toolmakers. Now, what man has done he can do again, thus it is up to the toolmaker to improve his spare time. He must realize that no one is coming to offer him a better position on a silver platter, so to speak; it all depends on himself. He must first fit himself for advancement and then devote all his energies to attaining success.

* * *

SHELBY STEEL TUBING FOR DIFFERENTIAL BEARINGS

Steel tubing is rapidly taking the place of solid stock that has been bored out, for various manufacturing purposes. This is especially true in the case of hollow shafts, bushings, sleeves, etc., that are made to close dimensions, as the lengths of tubing can be used as blanks to be machined to the required accuracy. The convenience of being able to obtain tubing of varying external and internal diameters and different thicknesses of walls is leading to its use for many products that were formerly made from solid stock with a great expenditure of machining time and waste of stock.

Fig. 1. Forcing Bushings into Place in Differential Gear-case

Fig. 2. Boring Tubing for Bushings

The Brown-Lipe-Chapin Co., Syracuse, N. Y., uses Shelby steel tubing for making bushings for differential gear housings. The illustrations show how the tubing is used for this purpose. As shown in Fig. 2, it is first cut to lengths long enough to make the bushings. Then these pieces are bored out to give the proper internal diameter for the force fit that must hold them to the differential gear-case. They are also turned on the outside in order to remove the scale and bring them to approximately the finished diameter before being hardened.

After the bushings have been hardened, they are forced over the hubs on the differential cases on a regular power forcing press, as shown in Fig. 1. The gear-cases with the bushings in place then go to the grinding machine and are ground on the bushing surfaces, enough metal being removed to give the required finish and diameter. It will be readily appreciated that this method of using pieces of tubing for these bushings results in lowering the manufacturing cost considerably.

C. L. L.

* * *

AVIATION AS A SPORT

Aviation as a sport has not yet attracted many in America, but after the European war it is likely to develop rapidly and become very popular. The aeroplane has been developed to a stage that few fully appreciate. Speeds of 100 miles an hour are common, and 120 to 130 miles are not exceptional. Devices for maintaining equilibrium contribute to safety, and dependable engine and wing construction has made aviation almost as safe as automobiling. Not only will aviation become a sport, but eventually the aeroplane will become a recognized means of commerce for carrying mail, express packages and high-class freight. One of the devices for making aviation more popular as a sport is the Turner aviaphone, which makes conversation possible in mid-air. This instrument consists of a helmet or cap with a telephone transmitter that is worn by each occupant of the car. Without such means it is practically impossible for the pilot and his passengers to converse while in the air owing to the noises made by the propeller and engine, but with the aviaphone, conversation is easy; this contributes to the comfort, enjoyment and safety of aviation.

THREAD MILLING IN THE LATHE

BY E. T. SPIDY*

The unusual demand for machinery for threading shrapnel and high-explosive shells which has existed for the past year and a half has made it necessary to devise special means of thread milling, and the following article describes the way in which several engine lathes were successfully adapted for this kind of work so that an output was secured equivalent to that of machines especially designed for thread milling. While the description applies to the milling of threads in shells, the same method and equipment could be used in thread milling a variety of other classes of work.

The engine lathes used were standard 18-inch machines that were in good condition and had lead-screws of a high degree of accuracy. One of the machines is shown set up in Fig. 1, and the chuck in which the work is held is shown in detail in Fig. 2. The chuck consists of a hollow body which is secured onto the lathe spindle and finished after being set up in position. The cone on the inside provides for centering one end of the shell, and tightening the nut at the front brings the shell into accurate alignment with the lathe spindle. The overhanging weight of the chuck is supported by a steadyrest of the form shown at *A* in Fig. 3; the steadyrest has a three-point bearing with brass screws to provide means of compensating for wear.

The cross-slide on the lathe carriage was removed and a special fixture *B*, Fig. 3, was substituted to carry the milling cutter. The thread milling fixture is provided with an adjustable stop for setting it to mill threads of the required depth without making measurements. The milling spindle is driven by a 2½-inch belt, at a speed of 200 revolutions per minute, power being taken from a special pulley on the countershaft, fitted with a belt shifter. One machine had this milling fixture attached to the cross-slide so that the turret and tools were retained for cutting the recess in the base of the shell preparatory to milling the thread; but experience gained with both types of equipment showed that the best results were obtained by having the machines devoted entirely to the thread milling operations.

The lead-screw and regular locking clamp on the carriage are used to transmit feed to the cutter, and a handwheel was attached to the end of the screw to facilitate taking up backlash in the clamp. Suitable pulleys were arranged on the countershaft to drive the headstock through the back-gears at a speed of 1½ revolution per minute. In cutting a thread in the base recess, the shell is placed in the chuck and the

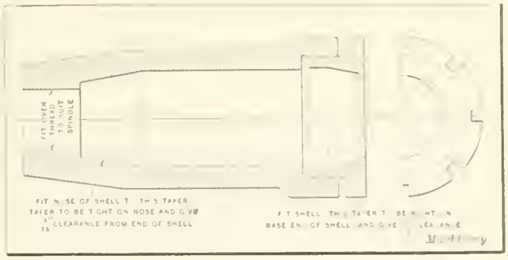


Fig. 2. Type of Chuck used for holding Shell on Machine shown in Fig. 1

screw tightened. The milling cutter is next set in motion and run into the recess by the carriage handwheel, after which the lead-screw nut is locked and the cutter drawn close to the bottom of the recess by turning the handwheel at the end of the lead-screw.

When the bottom of the recess is reached, the handwheel is reversed until the backlash has been taken up, after which the feed is started and the milling cutter fed into the work to the correct depth. The headstock and shell are now started rotating by means of a second belt shifter on the countershaft, and one complete revolution of the work finishes the milling operation. The cutter is then drawn out of the recess and the shell removed from the chuck. The entire operation does not take two minutes from the time the shell is picked up from the floor until it is put back with the thread milled. The same method is applicable in milling the thread in the nose of the shell except that the chuck must be of a slightly different shape. The cost of adapting a lathe for handling thread milling operations in this way is small, and the lathe may be easily changed back for handling the usual classes of lathe work. This may be of suggestive value to shops where thread milling machines are not available.

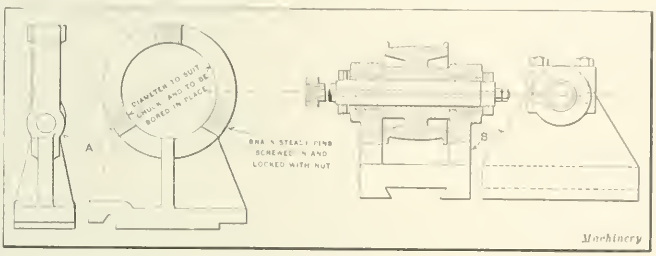


Fig. 3. Steadyrest for supporting Work; and Sectional View through Milling Fixture

* Address: 108 Walnut St., Winnipeg, Manitoba, Canada.

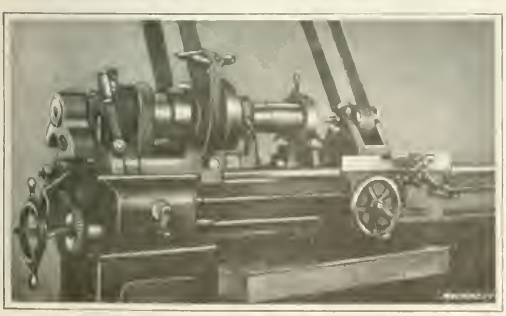


Fig. 1. Engine Lathe equipped with Special Fixture for performing Thread Milling Operation on Shells

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SCLEROSCOPE AND BRINELL HARDNESS TESTS OF CUTTING TOOLS

In a paper read before the Iron & Steel Institute, Sheffield, England, Prof. J. O. Arnold states that after a prolonged series of experiments it has been clearly determined that the Brinell and scleroscope numbers registered by hardness tests do not give any approximate measurement as to their cutting efficiency in the lathe. It was also determined that the efficiency of a lathe tool depends entirely on the thermal stability of the simple or compound hardenites in the hardened steel. A Brinell or scleroscope test is a valuable means of rapidly determining the elasticity of structural steels, but is absolutely valueless for making estimates of the varying thermal stabilities of the hardenites which mainly determine lathe efficiency in high-speed cutting tools. One peculiar condition found in making these tests was that with the various types of tools tested, the maximum efficiency was obtained at the second grinding, and when these tools were run with the point at a red heat the breakdown took place about five minutes after the point began to get red-hot.

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"ESCO" GROOVING MACHINE

The selling rights of the "Esco" grooving machine described in the June number have been turned over by the Walco Mfg. Corporation, Providence, R. I., to F. G. Street, 60 Broadway New York City.

STUDS AND NUTS FOR JIG WORK*

STANDARDS USED BY GENERAL ELECTRIC CO.

BY R. F. POHLE†

STUDS are used in jig design for locating work with holes in it. Table I shows a recommended form of stud. C-washers, Table III, are used in connection with threaded studs for clamping. When in use, the work is passed over the head of the clamping screw or nut. The C-washer is placed on the work and the screw or nut tightened. This form of clamping device is often replaced by so-called "wrench nuts" and "slip nuts."

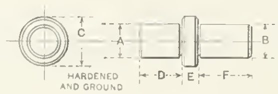
* The tables of standards given in this article embody the practice of the General Electric Co., at Lynn, Mass. These standards have been developed for the company by R. F. Pohle, who is in charge of the tool designing department.

† Address: General Electric Co., Lynn, Mass.

Nuts Used in Jig Design

A number of special nuts are used in jig design. The wrench nut, Table V, is a rapid clamping device giving excellent service. Its use for quick clamping is almost unlimited. In cases where the work is passed over a stud and usually clamped by a C-washer under an ordinary nut, it will be found much better to use the wrench nut than the C-washer. Slip nuts are made in three styles, as shown in Tables VII, IX, and XI. They are used for purposes similar to those for

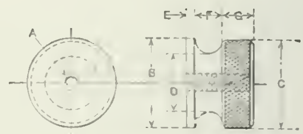
TABLE I. COLLAR STUDS



A	B	C	D	E	F
0.251	0.249	1/2	1/2	3/16	1/4 to 5/8
0.3135	0.3115	9/16	1/2	3/16	5/16 to 11/16
0.376	0.374	5/8	5/8	3/16	3/8 to 3/4
0.4385	0.4365	11/16	5/8	3/16	7/16 to 13/16
0.501	0.499	3/4	5/8	1/4	1/2 to 7/8
0.5635	0.5615	7/8	5/8	1/4	1/2 to 7/8
0.626	0.624	1	3/4	1/4	1/2 to 1 1/16
0.6885	0.6865	1 1/8	3/4	1/4	5/8 to 1 3/16
0.751	0.749	1 1/4	7/8	1/4	5/8 to 1 3/8

Machinery

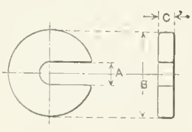
TABLE II. THUMB NUTS



A Diameter and Number of Threads per Inch	B	C	D	E	F	G
No. 10—32	5/8	5/8	3/8	1/16	3/16	1/4
No. 14—24 or 5/16—18	13/16	13/16	1/2	3/32	1/4	5/16
3/8—16 or 7/16—14	1	1 1/8	11/16	1/8	5/16	7/16
1/2—13	1 1/4	1 1/2	7/8	5/32	3/8	9/16
5/8—11 or 3/4—10	1 1/2	1 3/4	1 1/16	5/16	3/8	11/16

Machinery

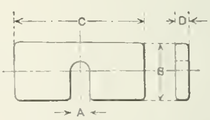
TABLE III. C-WASHERS



A	B	C
7/32	1/2 to 1 1/4	1/8
9/32	5/8 to 1 3/8	1/8
11/32	1 to 1 3/4	3/16
13/32	1 1/8 to 1 7/8	3/16
15/32	1 1/4 to 2	1/4
17/32	1 1/4 to 2 1/2	1/4

Machinery

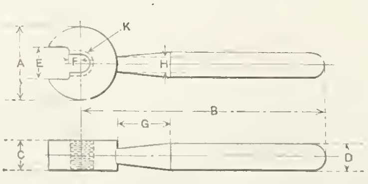
TABLE IV. STRAP WASHERS



A	B	C	D
9/32	1	2 to 3 1/4	1/4
9/32	1	3 1/2 to 4	5/16
13/32	1 1/4	2 1/2 to 4	5/16
13/32	1 1/4	4 1/4 to 5	3/8
15/32	1 1/2	3 to 4 1/2	3/8
17/32	1 1/2	5 to 6	1/2
25/32	2	4 to 5 3/4	1/2
25/32	2	6 1/2 to 8	3/4
1 1/32	3	6 to 9	3/4
1 1/32	3	10 to 12	7/8

Machinery

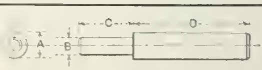
TABLE V. WRENCH NUTS



A	B	C	D	E	F	G	H	K Diameter and Number of Threads per Inch
3/4 to 7/8	2	1/4	1/4	5/16	1/4	1/4	3/16	No. 14—24
1 to 1 1/8	2	5/16	5/16	5/16	1/4	1/4	3/16	No. 14—24
3/4 to 7/8	2	1/4	1/4	3/8	1/4	1/4	3/16	5/16—18
1 to 1 1/8	2	5/16	5/16	3/8	1/4	1/4	3/16	5/16—18
1 1/8 to 1 1/4	3 1/4	3/8	3/8	7/16	3/8	3/4	1/4	3/8—16
1 1/2 to 1 3/4	3 1/4	7/16	7/16	7/16	3/8	3/4	1/4	3/8—16
1 1/2 to 2 1/4	4 1/8	1/2	1/2	9/16	1/2	7/8	5/16	1/2—13
2 to 3	5	5/8	1/2	11/16	5/8	1	3/8	5/8—11
2 1/2 to 3 1/2	5 3/4	3/4	5/8	13/16	3/4	1	1/2	3/4—10
2 1/2 to 3 1/2	6 1/4	3/4	3/4	15/16	3/4	1	1/2	7/8— 9
2 3/4 to 3 3/4	6 7/8	7/8	7/8	1 1/8	7/8	1 1/4	5/8	1— 8
3 to 3 3/4	7 1/2	1	7/8	1 1/4	7/8	1 1/2	5/8	1 1/8— 7
3 1/2 to 4	8	1 1/8	7/8	1 3/8	7/8	1 1/2	3/4	1 1/4— 7

Machinery

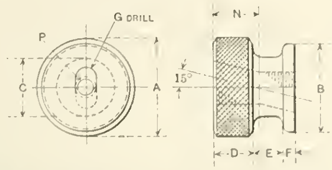
TABLE VI. SHOULDER STUDS



A	B	C	D	A	B	C	D
5/16	0.1885	1/4	3/16 to 5/16	9/16	0.4385	7/8	1 3/4 to 2 1/4
3/16	0.1885	5/16	3/8 to 1/2	9/16	0.4385	1	2 1/2 to 3
5/16	0.1885	3/8	9/16 to 11/16	9/16	0.4385	1 1/4	3 1/2 to 4
5/16	0.1885	7/16	3/4 to 7/8	5/8	0.501	7/8	3/4 to 1
3/16	0.1885	1/2	13/16 to 1 1/8	5/8	0.501	1	1 1/2 to 2
3/8	0.251	1/4	1/4	5/8	0.501	1 1/4	2 1/2 to 3 1/2
3/8	0.251	3/8	3/8 to 1/2	5/8	0.501	1 1/2	4 to 5
3/8	0.251	1/2	5/8 to 3/4	3/4	0.501	7/8	1 to 1 1/2
3/8	0.251	5/8	7/8 to 1 1/8	3/4	0.501	1	2 to 3
3/8	0.251	3/4	1 1/4 to 1 1/2	3/4	0.501	1 1/4	3 1/2 to 4 1/2
7/16	0.3135	3/8	3/8 to 1/2	3/4	0.501	1 1/2	5 to 6
7/16	0.3135	1/2	5/8 to 7/8	7/8	0.6265	1	1 1/4 to 2 1/2
7/16	0.3135	5/8	1 to 1 1/4	7/8	0.6265	1 1/4	3 1/4 to 4 3/4
7/16	0.3135	3/4	1 3/8 to 1 5/8	7/8	0.6265	1 1/2	5 1/2 to 7
7/16	0.3135	7/8	1 3/4 to 2	1	0.7515	1	2 to 4 1/4
7/16	0.3135	1	2 1/4 to 2 1/2	1	0.7515	1 3/8	5 to 5 3/4
1/2	0.376	5/8	1/2 to 3/4	1	0.7515	1 3/4	6 1/2 to 8
1/2	0.376	3/4	1 to 1 1/4	1 1/4	1.0015	1 1/4	3 to 4
1/2	0.376	7/8	1 1/2 to 2	1 1/4	1.0015	1 1/2	5 to 6
1/2	0.376	1	2 1/4 to 2 3/4	1 1/4	1.0015	1 7/8	7 to 9
1/2	0.376	1 1/4	3 to 3 1/2	1 1/2	1.1265	1 1/2	4 to 6
9/16	0.4385	5/8	1/2 to 3/4	1 1/2	1.1265	2	7 to 10
9/16	0.4385	3/4	1 to 1 1/2	....	....	....	....

Machinery

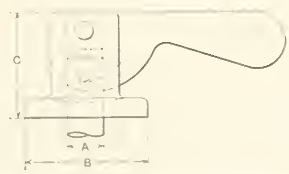
TABLE VII. KNURLED SLIP NUTS



A	B	C	D	E	F	G	N	P Diameter and Number of Threads per Inch
3/8	5/16	7/32	5/32	3/32	1/16	No. 37	5/32	No. 3—56 or 48
7/16	3/8	1/4	3/16	3/32	3/32	No. 31	3/16	No. 4—48 or 36
7/16	3/8	1/4	3/16	1/8	1/8	No. 25	7/32	No. 6—40 or 32
1/2	7/16	5/16	3/16	3/16	1/8	No. 13	1/4	No. 8—36 or 32
9/16	1/2	3/8	7/32	1/4	5/32	No. 3	5/16	No. 10—32 or 30
5/8	9/16	7/16	1/4	5/16	3/16	B	3/8	No. 12—28 or 24
7/8	3/4	5/8	5/16	3/8	3/16	9/32	7/16	No. 14—24 or 1/4—20
1 1/16	15/16	11/16	3/8	7/16	3/16	11/32	1/2	5/16—18
1 1/8	1	3/4	3/8	7/16	3/16	27/64	9/16	3/8—16
1 7/8	1 1/2	1 1/8	1/2	1/2	1/4	9/16	5/8	1/2—13

Machinery

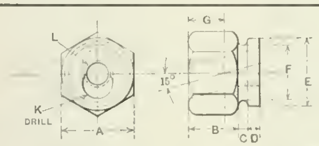
TABLE VIII. CLAMPING CAPS



A	B	C	A	B	C
3/8	1	1	7/8	3	1 9/16
3/8	1 3/8	1 1/16	1	2 1/4	1 1/2
1/2	1 1/4	1 5/16	1	2 3/4	1 9/16
1/2	1 3/4	1 5/16	1	3 1/4	1 9/16
5/8	1 1/2	1 3/8	1 1/4	2 1/2	1 15/16
5/8	2	1 3/8	1 1/4	3 1/4	1 13/16
5/8	2 1/2	1 7/16	1 1/4	4	2
3/4	2	1 9/16	1 1/2	3	1 7/8
3/4	2 1/2	1 9/16	1 1/2	4	1 7/8
7/8	2	1 1/2	1 1/2	5	2
7/8	2 1/2	1 1/2			

Machinery

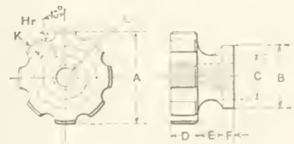
TABLE IX. HEXAGON SLIP NUTS



A	B	C	D	E	F	G	K	L Diameter and Number of Threads per Inch
3/4	9/16	1/8	3/16	11/16	9/16	7/16	5/32	No. 14—24
3/4	9/16	1/8	3/16	11/16	9/16	7/16	7/32	1/4—20
7/8	11/16	1/8	3/16	13/16	11/16	1/2	11/32	5/16—18
1	13/16	1/8	3/16	13/16	13/16	1/2	27/64	3/8—16
1 1/2	3/4	1/4	1/4	1 1/16	1 1/8	5/8	9/16	1/2—13
1 3/4	1 1/8	1/4	3/8	1 11/16	1 3/8	7/8	11/16	5/8—11
2	1 3/8	1/4	3/8	1 13/16	1 5/8	1	13/16	3/4—10
2 1/4	1 1/2	3/8	1/2	2 3/16	1 7/8	1 3/16	31/32	7/8—9
2 1/2	1 5/8	3/8	5/8	2 7/16	2	1 5/16	1 1/8	1—8

Machinery

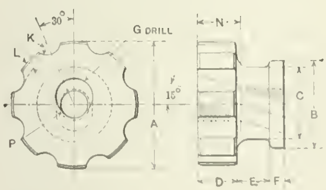
TABLE X. HAND NUTS



A	B	C	D	E	F	H	K	L Diameter and Number of Threads per Inch
1 5/8	1 1/4	13/16	9/16	9/16	1/8	1/4	1/8	1/2—13
2 1/8	1 1/2	1 1/16	11/16	1/2	3/16	3/16	3/16	5/8—11
2 1/8	1 1/2	1 1/16	11/16	1/2	3/16	3/16	3/16	3/4—10
2 1/2	1 3/4	1 1/4	3/4	11/16	3/16	3/8	1/4	7/8—9
2 3/4	2	1 1/2	13/16	11/16	1/4	3/8	1/4	1—8
2 7/8	2 1/8	1 5/8	7/8	3/4	1/4	3/8	1/4	1 1/8—7
3 1/8	2 1/4	1 3/4	1	3/4	5/16	7/16	5/16	1 1/4—7

Machinery

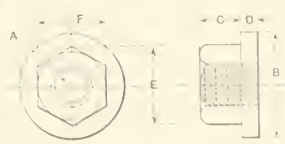
TABLE XI. FLUTED SLIP NUTS



A	B	C	D	E	F	G	K	L	N	P Diameter and Number of Threads per Inch
2	1 3/4	1 3/8	5/8	7/8	1/4	11/16	3/16	3/32	7/8	5/8—11
2 1/4	2	1 5/8	11/16	13/16	3/8	13/16	3/16	1/8	1	3/4—10
2 7/8	2 3/8	2	13/16	1 3/16	3/8	31/32	1/4	3/16	1 3/16	7/8—9
3	2 5/8	2 1/4	7/8	1 3/8	3/8	1 1/8	1/4	3/16	1 5/16	1—8

Machinery

TABLE XII. FLANGED NUTS



A Diameter and Number of Threads per Inch	B	C	D	E	F
5/16—18	13/16	3/8	1/8	11/16	13/32
3/8—16	13/16	3/8	1/8	31/64	11/16
7/16—14	1 1/16	7/16	1/8	29/32	23/32
1/2—13	1 3/16	1/2	1/8	1	7/8
5/8—11	1 7/16	5/8	1/8	1 7/32	1 1/16
3/4—10	1 11/16	3/4	3/16	1 7/16	1 1/4
7/8—9	2	7/8	3/16	1 21/32	1 7/16
1—8	2 1/4	1	1/4	1 7/8	1 5/8

Machinery

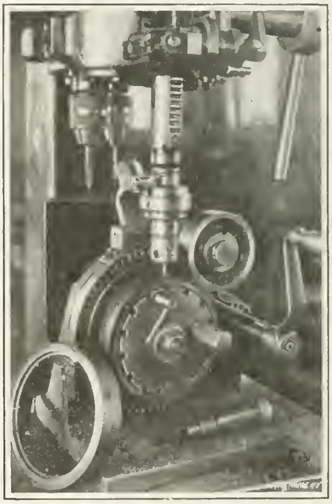
which the wrench nut is employed, but are applicable to work of smaller dimensions, or where it is not possible to obtain the required swing for the handle of the wrench nut. The clamping cap, Table VIII, is used similarly to the wrench nut and slip nut, but is only employed when the other forms cannot be used, because it is more expensive to make.

The standards for jig details that are given in this and preceding articles will, no doubt, be found valuable by designers of jigs and fixtures, because the tabulated arrangement saves the designer the trouble of deciding upon proper proportions in each case, and insures uniformity throughout the whole line of jig and fixture designs.

ATTACHING FIBER FACING TO A FRICTION RING

To mount a tough, springy strip of sheet fiber on the face of a friction ring is one of the meanest jobs that come to a machine shop. It is hard to make the fiber lie flat against the face of the ring long enough to drill and tap the holes for the attaching screws. These friction rings (one of which is shown at the left-hand side of the illustration) are about 8 inches diameter with a 1-inch face. The old method of doing the work was to clamp one end of the strip in position, drill and tap the first hole, put in the screw and then move the clamp to a second location and repeat the operation. It will be seen that this was a troublesome job, as sixteen screws are used to attach one facing, and not over three rings could be faced per day of ten hours.

At the plant of the New Britain Machine Co., New Britain, Conn., through whose courtesy the illustration is shown, the job is handled in a Turner turret drill. On the table of this machine is a simple fixture, consisting of a drum over which the friction ring fits and an indexing fixture to permit of turning the ring successively to the sixteen positions required for drilling. After the first hole has been drilled, tapped and the screw entered, the fiber strip is wound around the drum and under the roll that may be seen at the right. This keeps the fiber strip against the disk, and it is unnecessary to use clamps that obstruct the working space. By means of the crank on the pinion shaft, the pinion and the drum to which it is geared are rotated and the indexing is performed.



Attaching a Fiber Friction Ring Facing

After the drum has been indexed to bring the location of a screw-hole under the drilling spindle, a bushing plate that may be seen at the rear of the fixture is swung over into position, and with the first spindle of the four-spindle machine, the tap drill is guided through the fiber strip and the ring. The second spindle of the machine is now indexed, and this brings into line a tool that countersinks the hole for the flat-head screw; the third spindle (which is the one shown in the illustration) carries the tap for tapping, and the fourth spindle carries a center into which the screwdriver in front of the fixture is inserted for guidance, and the 8-32 screw is driven in by hand.

How well the fixture works may be judged from the fact that the production, which by the old method was only three rings per day, has been increased to twelve rings per day by the use of this fixture. C. L. L.

* * *

SHELBY TUBING FOR TEXTILE MACHINERY

The great variety of sizes and shapes in which seamless steel tubing is made today has resulted in its use in lines of manufacture where seamed tubing has formerly been employed. One of these instances is its use as bodies of tube frames for carpet looms made by the American Warp Drawing Machine Co., Boston, Mass.

Fig. 1 shows one of these tube frames assembled, and in the foreground is the length of tubing used as a basis in making this frame. In every carpet loom there are from 200 to 700 of these tube frames, the number depending upon the style and size of carpet being manufactured. The tube is rectangular in form, with one edge rounded, and measures approximately three-fourths inch wide by one inch thick. The stock is steel, 20 gage. These lengths of tube vary from 16¾ inches to 27 inches, and in each there are a large number of slots in which the steel guides are inserted, as may be seen in the illustration. The tube frame shown is 27 inches long and is provided with 190 slots.

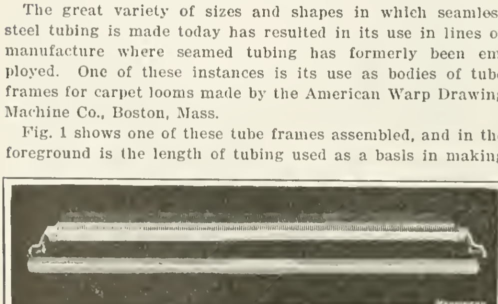


Fig. 1. Tube Frame for Carpet Loom and a Length of Tube

Fig. 2. How Tubes were seamed

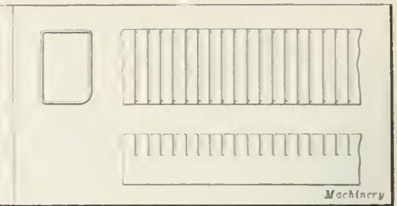


Fig. 3. Seamless Tubing, showing Slots for Inserted Guides

It was formerly the practice to use a tube bent from flat stock and electrically welded along the seam as shown in Fig. 2. This form of tube, however, was not satisfactory, as the seam would not hold in action. The slots, of course, weaken the tube, but the seam weakens it still more. Not only does a seamed tube lack the necessary strength, but it does not have the stiffness inherent in a drawn tube because of its method of manufacture.

Shelby seamless steel tubing was tried on this job with remarkable results, and Fig. 3 shows a section made in this way. In making the tube-drawing dies, one corner of the section was drawn with a larger radius than the others to conform to the design of the tube frame. Not only is the drawn tube much stiffer than the seamed tube, but under the real test of use in the loom there is no springing or twisting, and the life of the tube frame is increased several hundred per cent. C. L. L.

* * *

COST OF CONCRETE BUILDINGS

In an address before the Real Estate Exchange of Cincinnati, Ohio, W. P. Anderson, president of the Ferro Concrete Construction Co. of Cincinnati, gave some figures on the cost of reinforced concrete buildings. While it is true that many items included in the cost of such buildings will vary, Mr. Anderson took as a basis for his estimate a plain structure with no exterior decorations and included the principal items which make up the cost, such as walls, windows, floors, floor finish, stairs, toilets and plumbing fixtures. The costs of excavation, heating, lighting, and elevators vary so widely that they are omitted from the estimate.

The assumed load on the floors is 150 pounds per square foot with column spacing about 18 feet center to center and story height about 12 feet. Mr. Anderson estimated the base cost of a building 50 by 50 feet as about $1.55 per square foot of floor area; if the building is 50 by 100 feet, the cost would be reduced to $1.20; if 50 by 150, it would be $1.12; and if 50 by 200, it would be $1.07. In all these cases the building is assumed to be from four to ten stories high. A three-story building would cost somewhat more, but the difference would be slight. A two-story building would cost from 10 to 12 per cent more than these figures, and a one-story building from 12 to 20 per cent more. A decrease in the width of the building would increase the cost so that for a width of 25 feet instead of 50, the unit cost would be from 35 to 45 per cent

more and, on the other hand, if the widths are increased, the cost would be correspondingly decreased.

The effect of increasing or decreasing the floor load depends on the height of the building. Obviously, there would be practically no change in a one-story building, as the load comes directly on the ground. In a six-story building, the decrease in cost for a 75-pound load per square foot would be about twelve cents per square foot of floor space. This figure would also about equal the increase in cost if the live load were doubled. The effect on the cost of varying the column spacing is not great. When columns are spaced about 15 feet apart the cost is about six per cent greater than when spaced 25 feet apart both ways.

In giving these estimates of costs for reinforced concrete buildings, Mr. Anderson allowed two stairways and one elevator tower for a building under 150 feet in length, and two stairways and two elevator towers for greater length. Two plumbing fixtures per floor are allowed for the first 5000 square feet. No allowance was made for any interior partition work except that which is necessary around stairs, elevator shafts and toilets. The percentage of window area to wall area would have but little effect on the unit cost of the building. In calculating these estimates a steel sash window with ordinary glass was used; if wire glass were found necessary, the cost would be considerably more than for a plain wall.

* * *

WELDING HIGH-SPEED STEEL BLOCKS TO TOOL STEEL SHANKS*

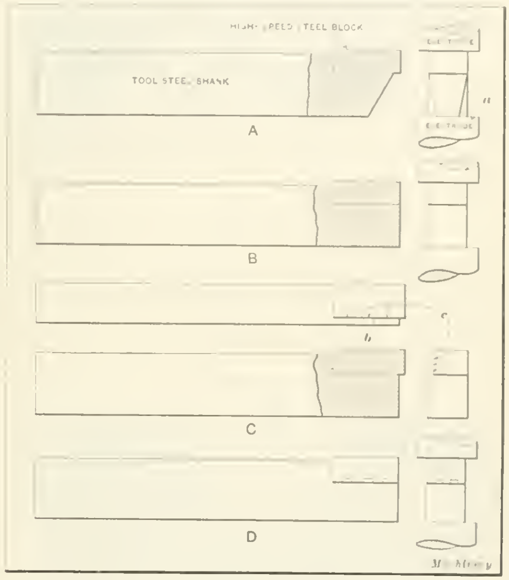
Owing to the high price of tungsten, high-speed steel has reached an almost prohibitive price, and many large manufacturers have either adopted the method of using high-speed steel bits in tool-holders or welding them to tool steel shanks. Manufacturers of electric welding machines have been called upon to supply machines for this purpose, and have been doing this work in their own shops to some extent. The work handed to them in many cases shows a lack of knowledge of the requirements which must be met if a satisfactory weld is to be made. It is essential, in resistance welding, to have the work clean and free from scale; and in making a butt-weld the cross-sectional area of the two pieces must be nearly equal.

An example which illustrates this point is shown at A in the accompanying illustration. One manufacturer sent a large batch of machine steel shanks in to have high-speed steel tips welded to them, and thinking that it was necessary to have the tool rough-formed to shape, he beveled it on the front end as shown, and provided a seat for the block. To weld a tool of this shape is practically impossible, because the smallest section is that lying next to the electrode *a*. It is practically impossible to get a welding heat between the two pieces, as the greatest point of resistance is between the electrode *a* and the smallest section of the piece. The correct way to prepare the blank is shown at *B*, where it will be seen that the cross-sectional area of the block and shank are equal.

Another condition which makes welding difficult is shown at *C*. Here the manufacturer thought he would increase the strength of the weld by leaving a rib *b* to back up the tool and resist the cutting action. With a holder or shank formed in this manner, it is a difficult matter to get the block and holder to weld at the points *c* as indicated. It also takes longer to make a weld because of the danger of burning the parts, due to unequal heating, caused by the difference in the cross-sectional area of the two pieces.

The easiest and quickest way to make a satisfactory weld is shown at *D*. Here the lower surface of the high-speed steel block is provided with a series of points or projections. These points localize the current and permit an equal temperature to be obtained. The current and time consumed in making the weld is also much less than when the block and holder are provided with plain surfaces.

Another point that has troubled many manufacturers contemplating the use of electric welding machines for this work is which type of welding machine is the most suitable; that is, a butt-welding or a spot-welding machine. Now, as far as the welding of high-speed steel bits is concerned, either a spot- or butt-welder can be used. The butt-welder, however, has the advantage over the spot-welder in that it is constructed so that a greater pressure between the electrodes can be obtained. Furthermore, it is more accessible. The machine to purchase for the work, however, depends to a great extent upon the product of the manufacturer. For instance, a manufacturer whose product consists chiefly of light work and sheet metal parts should purchase a spot-welder, whereas the manufacturer of fairly heavy machinery should purchase a butt-welding machine, because he can generally find other work for the welding machine to do, such as welding bolts, tie-rods, etc. The type of machine also depends upon the size of the tools to be welded. For welding large lathe tools, a butt-welder should



Correct and Incorrect Methods of welding High-speed Steel Blocks to Tool Steel Shanks

be used, while for welding small bits, $\frac{3}{8}$-inch square, etc., a spot-welder can be employed to advantage.

One of the difficulties encountered in welding high-speed steel tips to tools is that of getting the correct relation between pressure, current and time. The current and time are more easily ascertained than the pressure required, and it takes considerable experience to know when the two materials should be brought together. Another point that many manufacturers overlook is that the physical properties of high-speed steel and tool steel are so different that severe strains are set up unless the pieces are heat-treated before they have a chance to cool down from the electric welding heat. The electric welding in this case, therefore, should be done near a furnace where heat-treatment can be accomplished, so that the greatest efficiency can be obtained from the tool. If it is not heat-treated directly after welding, the high-speed steel bit will develop severe surface cracks and its structure will be greatly weakened. It has been found by experiment that tool steel shanks, although more costly, give better results than those made from low-carbon steel D. T. H.

* * *

In August, 1908, the Ford Motor Co. of Detroit, Mich., turned out its first model T type of touring car, and until January, 1916, had turned out exactly 1,000,000 model T touring cars. In the month of March alone, this company turned out 58,329 automobiles. Figuring on the total length of the Ford car as twelve feet, up to January, 1916, the company had turned out enough cars to reach from New York to Salt Lake City.

* For information on welding high-speed steel previously published in MACHINERY, see "Welding High-speed Steel Electrically," May, 1916, and other articles there referred to.

BALL BEARINGS FOR MOTOR-GENERATOR SETS

The motor-generator set of 282-ton electric locomotives now operating on the Chicago, Milwaukee & St. Paul Railway, which provides low-voltage current for the control and other

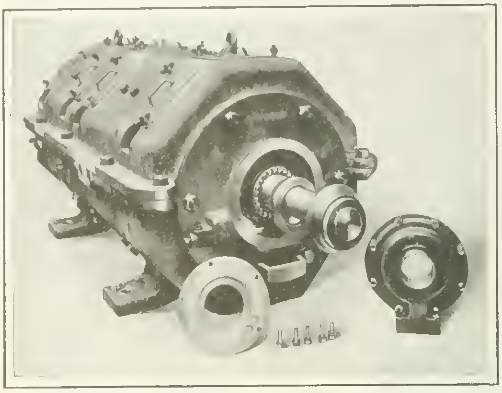


Fig. 1. Motor-generator Set with Bearing Cap removed to show Ball Bearings

auxiliaries, consists of a 3000-volt direct-current series motor, having a double winding and two commutators for operating in series at 3000 volts, a small generator for furnishing control current at 125 volts, a 120-volt generator furnishing current for regeneration and for charging storage batteries on passenger cars, and a blower of 13,000 cubic feet capacity for ventilating the main driving motors. It is also used in con-

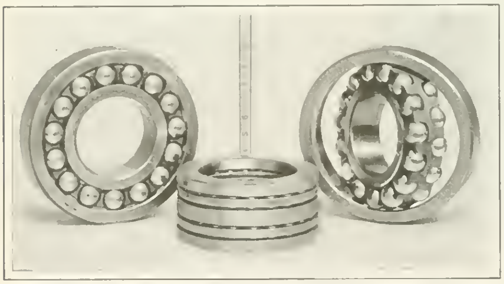


Fig. 2. Radial and Double-thrust Bearings

nection with regeneration on down grades, for lighting the locomotive interior, and for supplying the low-voltage incandescent headlight which takes current from collector rings at one end of the set.

The shaft upon which the revolving element is carried is supported by two S. K. F. radial ball bearings, as shown in Fig. 1, and is protected from shocks due to end thrust by a double-thrust ball bearing, as shown in Fig. 3. The set is

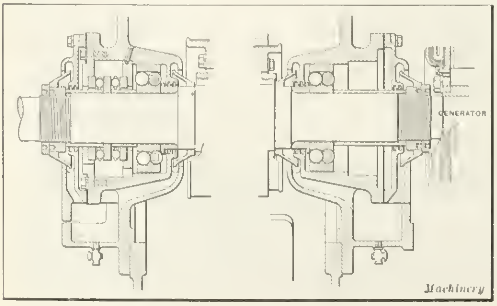


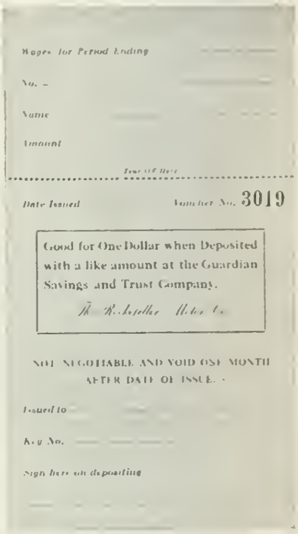
Fig. 3. Diagram showing Mounting of Motor-generator Sets

installed longitudinally in the locomotive cab and the thrust bearing takes up shocks incident to switching and train handling. This bearing has a capacity of over 5000 pounds at the normal speed of the set. The construction of the radial and thrust bearings is shown in Fig. 2; the outside diameter of the radial bearing is a little over 10 inches, the bore is 4.7 inches, and the weight, 33.5 pounds. The balls and races are made of Swedish crucible steel, and the ball retainers are of bronze.

* * *

ENCOURAGING THRIFT

The Rockefeller Motor Co., Cleveland, Ohio, builder of engine lathes and spring-making machinery, encourages its employes to make weekly deposits in the savings bank by the use of the pay envelope shown in Fig. 1. The upper part is filled in with the date, the number of the employe, his name and the amount paid. This record is solely for the information of the employe himself and may be torn off on the perforated line. The lower part is good for one dollar on deposit when another dollar is deposited, and constitutes the bank's voucher as shown in Fig. 2. Thus the thrifty employe may accumulate deposits of two dollars weekly or $104 yearly by depositing only one dollar a week. Over 90 per cent of the employes have become depositors since the scheme was adopted, which speaks well for the plan.



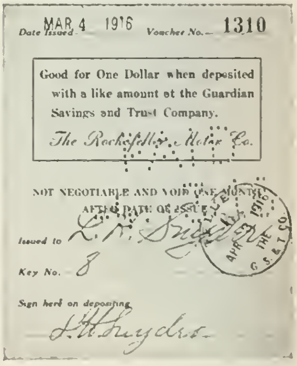
Wages for Period Ending
No.
Name
Amount
Tear off Here
Date Issued Voucher No. 3019
Good for One Dollar when Deposited with a like amount at the Guardian Savings and Trust Company.
The Rockefeller Motor Co.
NOT NEGOTIABLE AND VOID ONE MONTH AFTER DATE OF ISSUE.
Issued to
Key No.
Sign here on depositing

Fig. 1. Pay Envelope used by the Rockefeller Motor Co. to promote the Saving Habit

* * *

MACHINE FOR PLANTING TREES

A machine that plants from ten to fifteen thousand forest tree seedlings a day is now being used at the Letchworth Park Forest and Arboretum in Wyoming County, New York. Previously the planting has been done by hand at the rate of twelve to fifteen hundred trees each day per man. The machine was designed to set out cabbage and tomato plants, but works equally well with trees. It is about the size of an ordinary mowing machine and is operated by three men and two horses. One man drives the team while the other two handle the seedlings. The machine makes a furrow in which the trees are set at any desired distance apart, and an automatic device indicates where they should be dropped. Two metal-tired wheels roll the dirt firmly down around the roots. Two attachments make it possible to place water



Date Issued MAR 4 1916 Voucher No. 1310
Good for One Dollar when deposited with a like amount at the Guardian Savings and Trust Company.
The Rockefeller Motor Co.
NOT NEGOTIABLE AND VOID ONE MONTH AFTER DATE OF ISSUE.
Issued to
Key No. 8
Sign here on depositing

Fig. 2. Lower Part of Pay Envelope which is Bank's Voucher for One Dollar

and fertilizer at the roots of each seedling. Another attachment marks the line on which the next row of trees is to be planted. This is another example of our native ability to apply machinery to the accomplishment of hand tasks.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

SHELL PRODUCTION OF U. S. MANUFACTURERS

The present capacity for making shells in the United States is approximately 300,000 per day with about seventy-five manufacturers engaged in this business. A number of concerns engaged in munition work are increasing their output, while others are taking on orders for different sizes of shells. Figuring on seventy-five manufacturers with a productive capacity of 4000 shells each per day, would give a production of 1,800,000 shells per week, and at present there are over that number doing this class of work, many of which have a production of over 4000 shells daily, so that the above estimate can be easily considered as conservative.

The most popular sizes of shells adopted by the foreign governments at war are 3-inch, 4.5-inch, 6-inch, and 9.2-inch. There are shells being made, however, in the following sizes: 1.0625-inch, 3-inch, 3.29-inch, 4.5-inch, 5.3-inch, 4.96-inch, 6-inch, 8-inch, 8.656-inch, 9.2-inch, 10-inch, and 12-inch. There are about five times as many 3-inch shells being made daily as any other size. Next in production comes the 4.5-inch, and then the 6-inch. Recently a large contract was let for 6-inch high-explosive shells.

At the present time there are between sixteen and seventeen concerns making forgings for high-explosive and shrapnel shells, with a combined production of over 300,000 shells a day, and at least six of these concerns have a capacity of over 20,000 forgings a day. For the smaller sizes of shells up to and including 6 inches, some manufacturers are using the bar stock method because of the high cost of forgings. Forgings range all the way from 8 to 12 cents a pound, and at this rate the bar stock method is cheaper; in fact, many manufacturers consider that a high-explosive shell can be made cheaper from bar stock than from forgings.

The cost and the time required for turning over from the production of shells for foreign governments to those for the United States government is a question about which there seems to be some doubt. It can be stated, however, that the only changes necessary would be in the tools and gages. As regards the exterior finishing of the shell, practically the only additional cost would be that necessary for gages, while for finishing the interior, new boring tools, reamers, taps, etc., would have to be made. These changes, however, could be made very quickly—in fact, within a month or so, so that the entire production of 300,000 shells per day could be turned over to the manufacture of U. S. munitions in this time if it were necessary.

Elizabeth, N. J. A. B. HAZZARD

GRINDING MAGNETIC CHUCKS

The problem of grinding the magnetic chucks used on the various types of grinding machines, and especially those used on the Brown & Sharpe surface grinders which are found in most up-to-date tool departments, does not at first glance present many difficulties, but nevertheless there are few men who understand the method of producing a true and accurate surface on these chucks.

Some suggestions for obtaining a surface that will be true when tested with a knife straightedge are given in the following. The selection of the proper wheel is an important point, and the writer has found the Norton Co.'s crystolon wheels, grain 36, grade J, running at 5000 feet per minute (or 2800 revolutions per minute) for the 7-inch wheels generally used on these machines, to give the best results. With the proper wheel in place, the machine is started and allowed to run for a few minutes so that the oil on the ways and in the bearings will be spread evenly, before the cut is started. Previous to this time, the wheel has been trued up with a diamond dresser. It is now lowered to the surface of the chuck, and a cut not exceeding 0.0005 inch is used for roughing off the top of the chuck. No attempt should be made to take a heavier cut than this, and for the last few cuts, in finishing the surface, not more than 0.0001 inch should be removed.

It is best to feed the chucks under the wheel by hand rather than by power, as a cut at least one-half the width of the wheel face should be taken, both for roughing and finishing, and for this reason care should be taken to true the wheel properly before the final finishing cuts are made. The wheel should cut only on the forward stroke of the machine or when the work is traveling against the rotation, and precaution should be taken to brush off the top of the chuck before the return stroke. This point is important, because as the wheel passes over the chuck on its cutting stroke, particles of the cast-iron surface are removed, as well as a part of the soft metal cores used to separate the poles of the magnet. This cast-iron dust is either thrown out into the air or settles back on the face of the chuck, while most of the softer metal is forced into the pores of the wheel. If the cast-iron dust is allowed to remain on top of the chuck, the wheel, riding over the top of it on the return stroke, will force more or less of the dust into the soft metal which has already collected in the pores of the wheel, so that in a few strokes it will become so choked up and glazed over that on the lighter cuts it will ride over the surface of the chuck and not cut continuously. The result will be that the chuck will tend to have a "wavy" surface which can be readily detected by applying a straightedge to the surface.

There are two other important points in connection with grinding magnetic chucks which may be mentioned here. First, in truing up a wheel, the top of the chuck should be covered over with paper, so as to prevent the particles of abrasive from being driven into the face of the chuck. Second, for removing particles that have been driven into the chuck, an oilstone may be passed lightly over its face, thus leaving the surface clean and smooth.

Jersey City, N. J. DONALD BAKER

TRUING OILSTONES WITH EMERY CLOTH

I have seen instructions published for truing oilstones, but in each case an important point has been omitted. It is often recommended to use emery cloth spread out on a plain surface, emery side up, and rub the stone on it until true. So far so good, but never rub the stone on the emery cloth dry. Use oil freely. When working with oil, the emery not only cuts many times faster than when working dry, but it leaves the surface of the oilstone in better shape to cut freely. The grade of emery cloth should vary with the character of the oilstone. The finer grades of cloth should be used for the fine stones, especially for finishing. The addition of grain emery of about the same grade as the cloth not only prolongs the life of the cloth but increases the rate of cutting. The loose emery is merely sprinkled on the cloth as the stone is being rubbed down. Those who have never tried this method of truing oilstones will be surprised at the rate of cutting obtained as well as the excellent cutting surface produced on the stone.

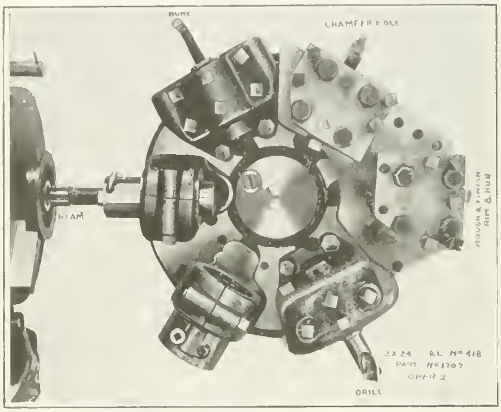
With a 1 by 2 by 6 inch carborundum stone, moderately coarse, I have cut away high-speed steel tools at one-fiftieth the rate an expert filer is supposed to use in cutting away soft steel when filing. I have reduced the length of a 3/8-inch square high-speed steel tool 0.016 inch in five minutes with

such a stone well supplied with turpentine. An expert filer is supposed to reduce a 1-inch square steel bar, 1 inch in length, in one hour.

Wilkinsburg, Pa. WILLIAM S. ROWELL

KEEPING RECORD OF MACHINE SET-UPS

In the plant of the Frost Gear & Forge Co., Jackson, Mich., a simple but satisfactory means is used for keeping an exact record of the tool set-up used on any particular job. Before the job is torn down, the camera is hung up on a skyscraper attachment and a photograph is taken of the tool set-up and work, as shown in the accompanying illustration. The operations are then indicated on the prints taken from this negative and the prints filed away. When the same job comes into the plant again, a print is handed over to the foreman,



Set-up of Tools for performing Second Operation on a Gear Blank

who gives it to the workman for setting up the machine. He can tell at a glance just where the various tools go and the types of tools used for the job, and within a short time has the tools all set up and the machine in operation. This method has been found to effect a great saving in time in setting up turret lathes in this plant. D. T. H.

MEASURING THREADED WORK

The following article describes two methods that I have found useful in measuring the diameter of threaded work. Fig. 1 shows a 1-inch micrometer with two 1/16-inch steel balls mounted in the spindle and anvil. In preparing the tool in this way I removed the anvil and spindle and lapped a cup shaped recess in each with the rounded end of a piece of hardened 1/16-inch drill rod held in the lathe tailstock while the work was rotated by the spindle. After getting approximately the required result in this way, each recess was finished by using a ball held in a split bushing mounted in the tailstock. The depth of the recesses is such that about three-quarters of the diameter of the ball is above the surface of the surrounding metal.

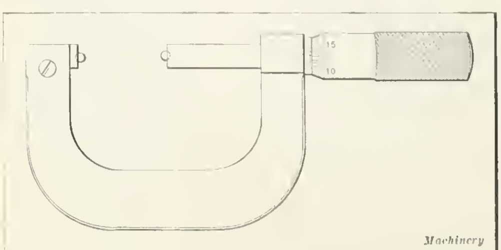


Fig. 1. Micrometer with Hardened Balls fitted in Anvil and Spindle to adapt Tool for measuring Diameter of Threaded Work

After the recesses had been formed, I magnetized the spindle and anvil by drawing them across the poles of a 5-inch horseshoe magnet. By so doing provision was made for holding the 1/16-inch balls in place in the recesses. At first thought one is likely to assume that when measuring a tap there would be a tendency for the balls to stick to the tap owing to their magnetism; but as each ball only bears against the tap at two points, while there is considerable surface in contact with the recess, the ball is held securely in place and does not give any trouble. A micrometer arranged in this way can be calibrated and used as a regular thread micrometer.

Fig. 2. Convenient Method of measuring Diameter of Threaded Work by Three-wire Method

Fig. 2 shows a convenient method of measuring threaded work by the three-wire system. For this purpose I made a block of wood 2½ by 2½ by 1 inch in size and screwed a piece of ground flat steel stock to it. I then made three steel blocks about ¼ by ¼ by ⅛ inch in size which I hardened, ground and lapped; and these blocks were subsequently magnetized by drawing them across the poles of a horseshoe magnet. Each block carries a piece of 1/16-inch drill rod, 1½ inch long, and by placing them on the plate as shown, the three wires can be moved to any position, where they will be held by the magnetized blocks. For measuring very small taps I made special blocks which had the wires mounted in the extreme corners to avoid trouble from interference. It will be evident that this device is used to measure the work by the well-known three-wire system.

Bridgeport, Conn. JAMES MCINTYRE

RUBBER JOGGING DEVICE FOR VISE JAWS

The milling operation illustrated in the accompanying half-tone consists in cutting a slot 0.504 inch wide and approximately 1⅜ inch deep into a hole which has been previously drilled and reamed. The parts in which these slots are cut

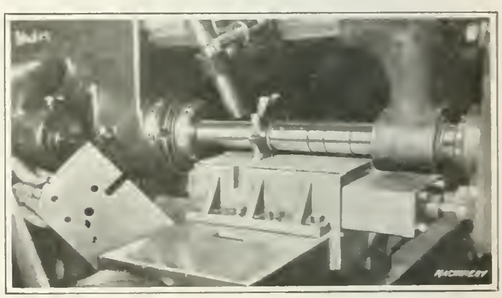


Fig. 1. Locating Plates of Irregular Length by Rubber Jogging Device

are adding machine plates. They are made of steel and are approximately 10 inches long by 5 inches wide and ⅛ inch thick. Thirty of these plates are held in the vise jaws at one time. It is essential that all the locating for this job be done from one end of the plate, as all previous operations have been located from this end. As the plates at this stage vary slightly in over-all length, some means had to be provided for jogging them up against the fixed stop *C*, Fig. 2. It was for this purpose that the W. H. Nichols Co., Waltham, Mass., designed the rubber jogging device *D*. This jogging

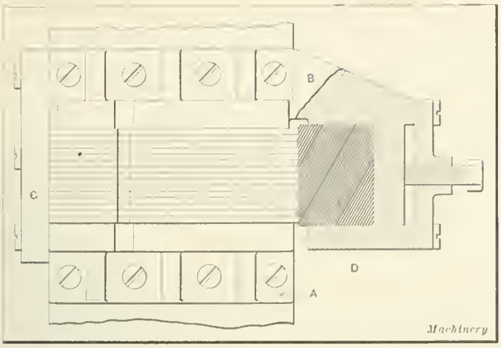


Fig. 2. Construction of Rubber Jogging Device

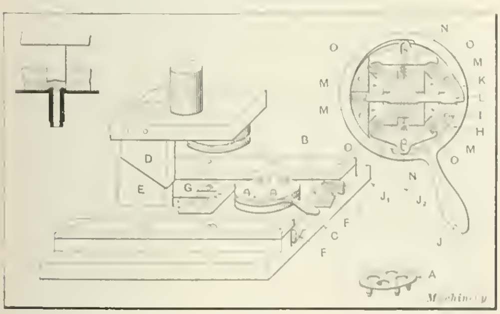
device consists of a piece of rubber approximately 4 inches wide, 3 inches long and 1½ inch thick. It slides in a slot cut in a projection from one of the vise jaws *B*, and is backed up by a small piece of steel of the same cross-section, against which the binding screw operates.

The operation of this device and its advantages are apparent. The rubber plunger when advanced by the screw is pressed against the ends of the plates and locates them accurately against stop *C*. After the parts have been milled and the vise jaws are removed to be placed in the tool crib, the rubber plunger should be well washed in gasoline to remove any oil that may cling to it. V. B.

RIVETING DIE

The accompanying illustration shows a riveting die developed for use in assembling the part shown at *A*. In designing this tool, particular attention has been paid to providing for the safety of the operator and to developing a form of mechanism which effectually prevents the work from sticking in the die after the riveting operation has been completed.

It will be seen that die-plate *B* is carried on a slide in base *C*, the motion of the die-plate on its slide being controlled by cams *D* and *E*. As the punch descends, die-plate *B* moves under it, carrying with it the work to be riveted. Then as the punch moves up, cam *E* is released, allowing springs *F* to draw the die-plate back to the starting position. By entering slot *G*, cam *D* locates the die in position under the punch ready for the performance of the riveting operation.



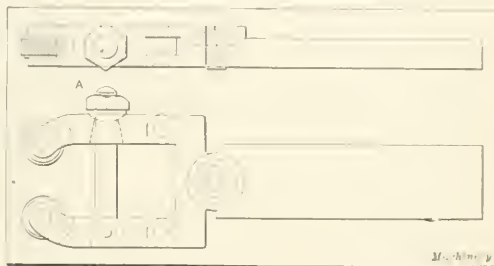
Riveting Die designed to provide for Safety of Operator and to make it Easy to remove Finished Work

At the right-hand side of the illustration is shown a detail view of the work-holding fixture. It will be seen that ring *H* is mounted on pad *I*, and by throwing handle *J* into the position J_2, cam *K* moves gage-pin *L* to bring jaws *M* into proper position. By moving handle *J* to the position indicated by line J_1, clamps *N* engage rivets *O* and hold them in place during the riveting operation. Then by moving the handle back to the position shown at *J*, the rivets are released to enable the work to be removed from the die. It will be evident from the illustration that the round plate and rivets are held in such a way that it is impossible for the work to stick in the die after the riveting operation has been completed.

Avenel, N. J. ADALBERT O. ALEXAY

KNURLING TOOL

The knurling tool here described has been found to give very satisfactory results in knurling a great variety of products. One of the difficult operations performed with this tool consisted of knurling a piece of brass tubing ⅝ inch in diameter by 3 feet long, which was driven by a spring collet in a Hendey-Norton lathe. This work was produced without blemish. The efficiency of the tool is attributable to the rocker motion which allows it to follow the work regardless of any irregularity which may be encountered. The tool is set by first letting the knurls run lightly on the work, after which the cross-slide is locked; the required depth of knurling is



Knurling Tool with Rocker Joint that allows Knurls to follow Work

then obtained by tightening bolt *A* to force the knurls into the metal. It will be evident that any desired form of knurl may be employed on this tool.

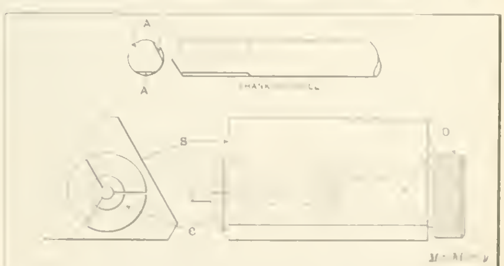
Knoxville, Tenn. J. SIDNEY EICKS

PREVENTING DRILLS FROM SLIPPING

We use a great many drills under 3/16 inch in diameter and have experienced trouble from the drills slipping in the small sized chucks that we use. In an effort to make the chucks hold more securely, operators have resorted to the use of monkey wrenches or other means of adding leverage to the usual chuck wrenches, with the result that they ruined the wrenches and often damaged the chucks. The chucks have three jaws, and to overcome difficulty from slipping we have adopted the practice of grinding three flats on the shank of the drill, as shown at *A*, just enough steel being removed so that the drill chuck jaws will hold securely on the flats.

The flats are easily ground on the shanks of the drills with the aid of a simple fixture that we designed for the purpose. It will be seen that this consists of a collet mounted in a triangular block. This block *B* is bored to receive collet *C*, which is operated by draw-spindle *D*. It is merely necessary to turn the fixture over on successive sides in order to locate the work for grinding the three flats on the shank.

Jersey City, N. J. DONALD BAKER



Shank of Drill and Fixture used for grinding Flats to prevent Drill from slipping in Chuck

INCREASING EFFICIENCY OF MACHINE TOOLS

It appears to the writer that it would be a good plan to mark feed-screws and elevating screws on machine tools in such a way that the operator would never be in doubt as to which way to turn a handwheel in order to secure movement in the required direction. It is often necessary to raise or lower a table, or to make some such change in the setting, and if the operator is not familiar with the particular machine he is running the question frequently arises, "Which way feeds in and which way feeds out?" It is true that most American machine tools are now equipped with right-hand screws, but there are still a sufficient number of exceptions to this rule to make some method of marking desirable.

The writer has seen a machine stopped during the performance of a delicate machining operation and the operator afraid to go on with his work until he had found a foreman who was able to tell him which way some screw had to be turned to feed in the desired direction without danger of spoiling the work. But foremen are not infallible, and many of them are not familiar with all the details of the machinery in their departments. Hence it would seem that marking feed-screws in such a way as to indicate the direction in which to turn all wheels and levers to move in or out would be of use to foremen as well as operators.

All guesswork would be done away with, so far as manipulation of feed-screws is concerned, by simply marking the collar on the screw with two arrows with the words "In" and "Out" beside them; the same idea could be carried through by employing arrows and other words such as "Right," "Left," "Up," and "Down." The use of such a method would relieve operators from all uncertainty regarding the way in which to use their machines, and would often be the means of preventing damage being done to the work.

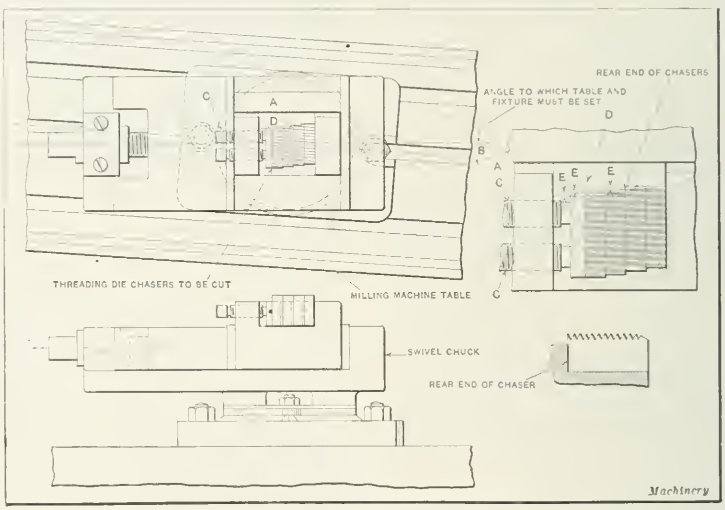
Plainfield, N. J. J. B. Murphy

MILLING THREADING DIE CHASERS

The accompanying illustration shows a milling machine fixture used for machining threading die chasers. In many shops a special chuck is made to hold the chasers in place for threading, the chuck being used on an ordinary engine lathe. This method takes more time, and satisfactory results are not likely to be obtained unless a skilled toolmaker does the work. The use of a suitable fixture on the milling machine enables the work to be done more quickly and cheaply, provided the proper tools are employed.

Referring to the illustration, it will be seen that fixture A is mounted in a swivel chuck which may be set for any required thread angle. The angle is determined by dividing the lead of the thread for which the chasers are made by the circumference of a circle with a diameter equal to the required pitch diameter of the screw; this gives the tangent of the required thread angle, from which it is easy to determine the angle B at which to set the fixture. Two set-screws C are provided for use in tightening the chasers in place ready for milling. A step block D is laid in the fixture to obtain the required distance from the rear end of the chaser to the threads. Distance E on the step block is found by dividing the lead of the thread by the number of chasers in the die, assuming that the chasers are equally spaced. It is necessary to have different step blocks for each number of threads, although one block can be used for different threads if the number per inch is the same in all cases. A single milling cutter of the same shape as the required thread is used for cutting the chasers, and the cross-feed is employed for obtaining the required distance between the teeth.

Racine, Wis. A. J. Dremel



Fixture for milling Chasers of Threading Dies

SCIENTIFIC CLOCK REPAIRING

Perhaps the writer of the article in the June number on "Scientific Clock Repairing" may be interested in the following tale from a well-known text-book on clocks—"The Modern Clock," by Ward L. Goodrich—in spite of its prolixity:

There must be in this country over 25,000 fine French clocks in expensive marble or onyx cases, which were given as wedding presents to their owners, and which have never run properly and in many instances cannot be made to run by the watchmakers to whom they were taken when they stopped. Let me give the history of one of them. It was an eight-day French marble clock which cost $25 (wholesale) in St. Louis and was given as a wedding present. Three months later it stopped and was taken to a watchmaker well known to be skillful and who had a fine run of expensive watches constantly coming to him to be repaired. He cleaned the clock, took it home and it ran three hours. It came back to him three times; during these periods he went over the movement repeatedly; every wheel was tested in a depthing tool and found to be round; all the teeth were examined separately under a glass and found to be perfect; the pinions were subjected to the same careful scrutiny; the depthings were tried with each wheel and pinion separately; the pivots were tested and found to be right; the movement was put in its case and examined there; it would run all right on the watchmaker's bench, but not in the home of its owner. It would stop every time it was moved in dusting the mantel. The owner became disgusted and took the clock to another watchmaker, a railroad time inspector, with the same result.

In this way the clock moved about for three years; whenever the owner heard of a man who was accounted more than ordinarily skillful he took him the clock and watched him "fall down" on it. Finally it came into the hands of an ex-president of the American Horological Society. He made it run three weeks. When the owner found the clock had stopped again he refused to pay for it. Three months later the watchmaker called and got the clock, kept it for three weeks, brought it back, and lo! the clock ran. It would even run considerably out of beat. When asked what he had done to the clock, he merely laughed and said "wait." A year later the clock was still going satisfactorily and he explained: "That was the first time I ever got anything I couldn't fix, and it made me ashamed. I kept thinking it over. Finally one night in bed I got to considering why a clock wouldn't run when there was nothing the matter with it. The only reason I could see was lack of power. Next morning I got the clock and put in new

mainsprings, the best I could find. The clock was cured. None of these other men who had the clock took out the springs. They came to me all gummed up, while the rest of the clock was clean, bright, and in perfect order. I cleaned the springs and returned the clock; it ran three weeks. When I took it back I put in stronger springs because I found them a little soft on testing them."

Many good watchmakers know little, I fear, about clocks, having an idea that there is but little to know. I could tell several tales more or less like that in the June number:

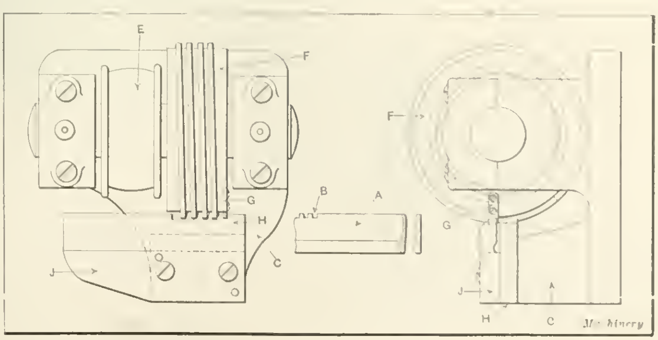
One watchmaker cleaned his "regulator" carefully, with his own skillful hands, but the kind of time it kept afterward was scandalous. Three times he took it apart, looked it over minutely, and set it up, but all in vain. As it had been a truly upright and virtuous piece of mechanism for several years, he couldn't well ship it back to the makers with a letter saying it was "N. G.," as is customary in the case of newly purchased clocks that fail to function satisfactorily. He mournfully told the sad tale to a friend who was supposed to know something of clocks. This man took off dial, hands and hour wheel, replaced them, and the mysterious trouble was ended. The maker had put counterbalances for the hands, one on the center staff, the other in the hour wheel, which Mr. Watchmaker had apparently failed to observe. At any rate, he had replaced the hands out of proper relation to their counterweights.

New London, N. H. GUY H. GARDNER

NOTCHING MACHINE

It is my purpose to describe a machine designed for cutting notches in metal molding. This machine is used in place of a punch press, and the somewhat unusual lines upon which it is designed enables the work to be done very rapidly. The metal of which the molding is made is quite soft, having a composition somewhat similar to pewter metal. Referring to the illustration, it will be seen that a portion of the molding is shown at *A*, part of the notched section being shown at *B*.

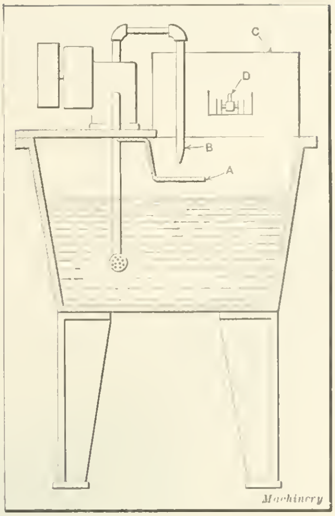
The machine consists of a cast-iron base or frame *C* on which is mounted a driving pulley *E* and drum *F*. The drum has a square thread cut on it, the lead of which corresponds to the notches which it is required to cut in the molding. The first turn of the thread is cut away from the drum and an inserted cutter *G* mounted in its place and secured by two screws. This cutter acts in conjunction with die *H* mounted at the front of the machine and cuts one slot in the molding for each revolution of the drum. A stock guide is provided at *J* to assist in feeding the material into the machine.



Machine designed for cutting Notches in Work shown at A

The stock is purchased in strips and is fed through the slot in guide *J* until it comes into contact with the thread on drum *F*. As the drum revolves, cutter *G* punches the first notch in the stock, and on the next revolution this notch is caught by the thread; then from this point the thread acts as an automatic feed and carries the stock forward at the required rate to secure a uniform pitch for the notches. This feed mechanism enables the machine to be run at high speed when it is working on soft metal.

D. B.



Tank and Pump for Use in spraying Anti-rust Solution onto Iron Castings

SPRAYING OUTFIT

We had a large number of iron castings which had to be machined all over and then dipped in an anti-rust solution to prevent rusting in service or damage while being shipped. The dipping was slow and a large amount of space was required to allow the castings to drain after they had been dipped; this method also resulted in wasting a lot of the anti-rust solution.

In looking for a more efficient method, we hit upon the plan described in the following. The equipment used consisted of a tank to hold the anti-rust solution which was made of a mixture of equal parts of kerosene and screw cutting oil. As shown, the tank cover plate extends over half the top and serves as a support for the pump. The discharge from the pump falls on plate *A* which is located directly beneath delivery pipe *B*, so that the solution rises from the plate in a mist-like spray. A tin cover *C* was provided to prevent the solution from being thrown onto the floor and wasted.

Inside the cover are six rails *D* made of 1/4-inch flat steel, and at the center there is a special chain belt with hooks placed at intervals to provide for pulling the castings through. Rails *D* extend a foot beyond the cover at each end to afford plenty of room for loading and unloading, and the openings in the cover are just large enough to allow the castings to pass through. The outer rails are made somewhat higher than those at the middle in order to keep the work traveling in the desired path. While the castings are passing through the hood they receive a light coating of the anti-rust solution which is adequate to protect them from damage.

Middletown, N. Y. D. A. HAMPSON

ROD NOTCHING DIE

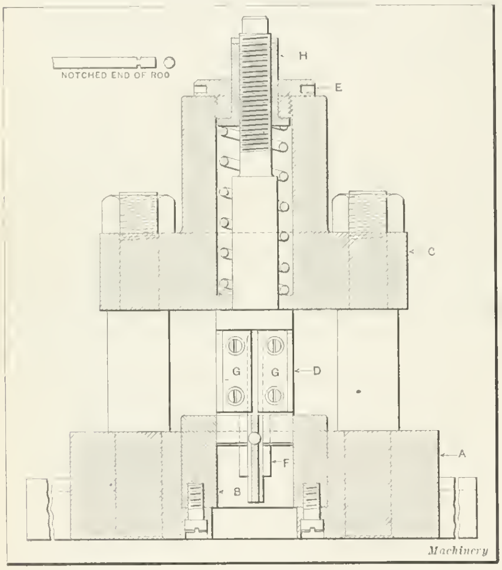
In the following is described a die which has given very satisfactory results for notching small rods. It will be seen that this tool is built on the sub-press principle; and 25,000 rods were notched with it at the rate of 1000 per hour, with the power press operated by an inexperienced workman. After finishing this run, the cutter showed no perceptible wear and there was no more tendency for the stock to tear during the latter part of the run than at the time the job was started.

Referring to the illustration, it will be seen that the tool consists of a cast-iron die shoe *A* which is planed at the top and bottom and bored to receive die retainer *B*. In addition, four holes are drilled to receive upright posts which are driven into place and riveted flush at the bottom. Punch-holder *C* is made of cast iron and bored to receive cutting plunger *D* and the pull-back spring; it is also threaded at the top of the bore to receive screw bearing *E*.

Die retainer *B* is made of mild steel and slotted to receive cutting die *F*,

the construction of which will be readily understood from the illustration. The die is held in the retainer by screws, after which the retainer is driven into the piece and also secured in place by set-screws. Owing to its shape, which makes the die quite delicate, it is made of high-grade tool steel carefully tempered and ground, and held in a way which affords ample support. The widths of the grooves correspond to those which are to be cut in the rods. A hole of slightly larger diameter than the rod is drilled in the die and extends through the cutting section of the die. A set-screw and lock-nut form an adjustable gage which engages the end of the work and locates the notches at the desired distance from the end of the rod.

Plunger *D* carries notching punches *G;* the plunger is made of mild steel and is cut away to provide seats for the different parts. The cutters are held in place by cap-screws which are so placed that when the cutting points are worn and ground up as far as possible, they can be turned end for end to provide for using the opposite points. The upward thrust of the cutters is received by the shoulders and the outward thrust by the raised portions of plunger *D*. The plunger is turned down



Sub-press Die used for cutting Notches in End of Rod

to fit bearing *H* and the shoulder acts as a stop to limit the upward stroke of the plunger. The compression spring lifts the plunger from the finished work when the operation is completed. The tensioning of this spring is regulated by bushing *H*. Threaded cap *E* serves the additional purpose of supporting the plunger bearing.

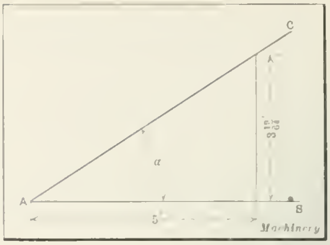
Chicago, Ill. H. FIELD MCKNIGHT

MEASURING ANGLES

In the May number of MACHINERY J. J. gives a method of measuring an angle without using a protractor, but it appears to the writer, who has occasion to measure and lay out angles daily, that there is a shorter and better method. In the illustration, let it be assumed that we wish to ascertain how many degrees and minutes the angle *BAC* or α contains. First mark off a convenient distance on the base line in some even number of inches; the longer the distance the better. In this case 5 inches was used. From this point erect a perpendicular. Next measure this line with an accurate scale. In this case it is 3 19/64 inches or 3.2968 expressed in decimals. Divide this by 5, as we are using trigonometry which necessitates working on a basis of 1. 3.2968 divided by 5 gives us 0.65936, which in a table of tangents we find to be the tangent of 33 degrees, 24 minutes, nearly.

This method is used by many draftsmen who have occasion to measure angles without the use of a protractor, and the accuracy of the results can be safely relied upon.

F. B. JACOBS
Indianapolis, Ind.



Measuring Angle by its Tangent

JAPANNING OVEN

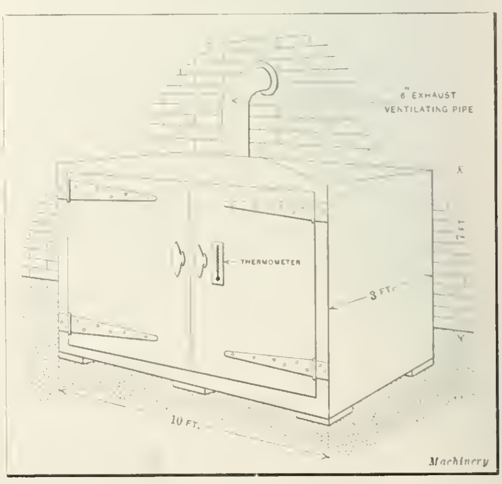
In reply to several inquiries which have been made in regard to japanning ovens, the following information is given by the writer for the benefit of those who wish to make and design their own ovens. The ovens are made on a framework of angle iron, on the outside and inside of which light sheet iron is fastened, the space between the sheets being filled with three-inch magnesia packing. For electrically heated ovens, it is best not to have any ventilation at the bottom, although theoretically this may seem to be better practice; nevertheless, experience has demonstrated the fact that ventilation may be dispensed with and satisfactory results secured.

At the top of the oven proper, an exhaust ventilating pipe, as indicated in the accompanying illustration, should be installed, and under ordinary conditions the natural draft will remove all the fumes caused by baking. The front of this oven has two large swinging doors opening to the full size of the oven, so that the work which is to be baked can be placed properly. The electric coils should be placed about three inches from the bottom of the oven and fairly well distributed over this area. On top of the coils a perforated sheet of metal should be placed to catch all work that might accidentally drop from the suspended bars above. When very heavy work is to be baked, such as cylinders, etc., provision should be made for properly supporting this plate, so that it will sustain the extra weight. Light work can be baked to better advantage by suspending it from supports suitably arranged in the oven.

Kenmore, N. Y. GEORGE B. MORRIS

* * *

If there is any one principle more than another which is influential in promoting the success of an organization, it is the following: The authority to issue an order involves the responsibility to see that it is properly executed.—*H. L. Gantt, in Industrial Leadership.*



Suggestion for a Japanning Oven

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

USE OF LEVELS IN SETTING UP WORK

H. G. E. Co.—The men in our shop use levels to set up work on the machines instead of a square or surface gage, but not one of the machines in the shop is level. Is the practice permissible?

A.—The practice certainly is not permissible if accurate work is required. Levels should never be used for setting up work on floor-plates, platens and machine tables unless the latter themselves are level. Whenever there is doubt about the machine table surface being level, a surface gage or other means of working from the table itself should be used instead of a level.

CHAMFERING THREADING DIES

W. M.—"A" claims that in backing off a threading die it is the common practice of die manufacturers to file one land ahead of the others, while "B" claims that it is not the practice and that the die should be chamfered and then filed or milled to form a cutting edge so that the teeth in each land cut equally. Which is right?

A.—The general practice of the manufacturers of dies is to chamfer each land as claimed by "B." Theoretically, it would be desirable to divide up the cut on the leading teeth in each land as suggested by "A," but if this were done, it should be done so that each of the four leading teeth in the four lands would do its proportionate part of the cutting. This would be a condition very hard to realize even in a new die chamfered by special means, and it would be quite out of the question to maintain that condition in common use.

LAYING OUT A THREAD CHASING INDICATOR

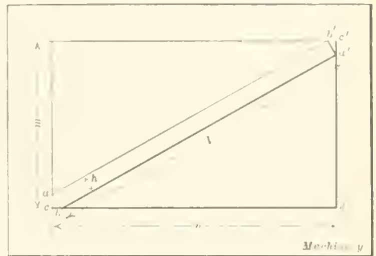
F. J. S.—In reading MACHINERY, I have noticed with much appreciation your How and Why department, and the interesting problems answered. Will you kindly answer the following question: How should one proceed to design the chasing dials for screw-cutting lathes geared even, two to one and one and one-half to one? The lead-screw has a lead of 1/4 inch or four threads to the inch. Please give number of teeth in worm-wheel, also number of graduations on dial.

A.—A thread chasing indicator on the carriage of a screw-cutting lathe is for the purpose of showing the position of the split nuts in relation to the lead-screw. The gearing of the lathe and the pitch of the lead-screw do not enter into the problem. The number of teeth in the worm-wheel is also immaterial except as it affects convenient marking of the dial. Thirty-two teeth are often used for the worm-wheel, as this number facilitates the use of the indicator when cutting multiple threads. Any number divisible by 4 is convenient for marking, but any other number may be used with equal facility when cutting single pitch threads. The use of the indicator is simply for the purpose of showing the operator when the split nut can be closed on the lead-screw without changing the position of the carriage.

CUTTING SPIRALS WITH SCROLL CHUCKS AND JAWS

T. M.—I had to cut a spiral groove 3½ threads per inch, 12 inches diameter, in a scroll ring and groove three jaws to fit for a self-centering or universal chuck. I cut the scroll ring first, then made a jig ring with three divisions planed radially for the jaws to fit in, and fastened the jaws in place with set-screws. The ring and jaws were chucked and the jaws were faced and bored, and then the spiral groove was cut across the face. A clearance of about 0.010 inch was provided. But I could not get the scroll ring to mesh with the jaws, although they were both cut on the same lathe. By slacking off the set-screws and moving one jaw inward half the pitch, the spiral ring would mesh all right. We had to rebore the jaws in order to have them center the work. I would be obliged if you would explain the cause of my trouble.

A.—Your trouble was probably due to the fact that you cut both spirals in the same direction, when you should have cut the spiral in the scroll ring clockwise and the spiral in the jaws counter-clockwise, or *vice versa*. By this, we mean that if you cut the spiral in the scroll ring with the lathe running as usual and the tool feeding from the outside to the center, the spiral in the jaws should be cut with the tool feeding from the center out, the lathe running in the usual direction. Thus, your spirals will mesh and you will have no trouble.



Laying out Diagonal Strip in Rectangle

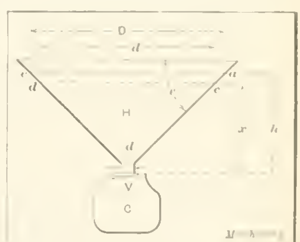
LAYING OUT DIAGONAL STRIP IN RECTANGLE

H. T. D.—What is the length of the longest strip 3 inches wide having square corners that can be laid out in a rectangle 24 by 40 inches?

A.—Referring to the diagram, triangles acb and $a'c'b'$ are equal; they are also similar to the triangle bda'. Let $ac = x$ and $bc = y$; then $\frac{x}{y} = \frac{m - y}{n - x}$; from which, $nx - x^2 = my - y^2$. Also, $x^2 + y^2 = h^2$; from which, $y = \sqrt{h^2 - x^2}$. Substituting this value of y in the preceding equation and transposing, $2x^2 - nx - h^2 = -m\sqrt{h^2 - x^2}$. Squaring both sides, transposing and collecting terms, $4x^4 - 4nx^3 + (n^2 + m^2 - 4h^2)x^2 + 2nh^2x + h^2(h^2 - m^2) = 0$. Here, $n = 40$, $m = 24$, and $h = 3$. Substituting these values and reducing, $4x^4 - 160x^3 + 2140x^2 + 720x - 5103 = 0$. Solving this equation by Horner's method, $x = 1.451955 +$, say 1.4520; $y = \sqrt{3^2 - 1.452^2} = 2.6252$. From the similar triangles acb and bda', $\frac{l}{n - x} = \frac{h}{y}$; from which, $l = \frac{(n - x)h}{y} = \frac{(40 - 1.452)3}{2.6252} = 44.052$ inches. J. J.

FLOW THROUGH VALVE OPENING

M. O. F.—In the illustration, *H* represents a hopper designed to hold water. Assuming that the valve *V* is suddenly opened, kept open for one second, and then suddenly closed, what should be the diameter d' of the opening to discharge 0.233 cubic foot into the vessel *C* when the height or head of water *h* is two feet over the valve seat?



Illustrating Size of Valve Opening for discharging 0.233 Cubic Foot of Water per Second

A.—It is impossible to answer the question as stated. If we assume the hopper to be a cone, and, for simplicity, assume further that the angle v is 45 degrees, we may proceed as follows: Let ac be the water level before the valve is opened, and let cd be the water level after the hopper has discharged 0.233 cubic foot. The volume $cacd$ is a frustum of a cone, and its cubical contents = 0.233 cubic foot. But, from mensuration,

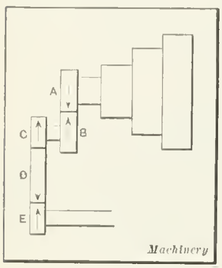
volume of frustum of cone $= \frac{\pi}{12}(D^2 + Dd + d^2)\, s$, where $s =$ perpendicular distance between the bases $= h - x$ in the diagram. Now, since $v = 45$ degrees, $D = ae = 2h = 2 \times 2 = 4$ feet, and $d = cd = D - 2s$. Substituting these values, $\frac{\pi}{12}[4^2 + 4(4 - 2s) + (4 - 2s)^2]\, s = 0.233$. Substituting 3.1416 for π, combining, reducing, and arranging terms, we obtain the cubic equation $1.0472 s^3 - 6.2832 s^2 + 12.5664 s - 0.233 = 0$, from which, by Horner's method, $s = 0.0187$ foot. Hence, $x = h - s = 2 - 0.0187 = 1.9813$ foot. It has here been assumed that the apex of the cone comes to the level of the valve seat. Now, assuming that the corners are nicely rounded,

$$d' = \sqrt{\frac{D^2}{5h^2t}\left(h^{\frac{5}{2}} - x^{\frac{5}{2}}\right)} = \sqrt{\frac{4^2}{5 \times 2^2 \times 1}\left(2^{\frac{5}{2}} - 1.9813^{\frac{5}{2}}\right)} = 0.3208$$

foot = 3.85 inches. In this formula, $t =$ the time in seconds = 1 in this case. It has been assumed that no water is flowing into the hopper while it is discharging. J. J.

CHANGE-GEARS FOR THREAD CUTTING

J. P.—On page 874 of MACHINERY'S HANDBOOK, a rule is given for calculating the change-gears for cutting screw threads; will you please explain how this rule is derived?



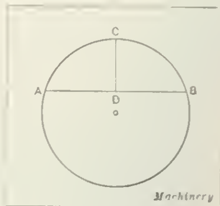
Change-gears for Thread Cutting

A.—The usual arrangement of the gears is shown in the illustration. Gear C is the change-gear on the stud and gear E is the change-gear on the lead-screw; gear A is on the spindle, B is on the stud, and D is an idler, whose function is to change the direction of rotation of the lead-screw. The arrows indicate the direction in which the gears rotate. Now if A and B have the same number of teeth, and if C and E also have an equal number of teeth, one revolution of the spindle will revolve A, B, C and E once, and the carriage will advance an amount equal to the pitch of the lead-screw. If B is n times as large as A (n is usually 2, 2½, or 3), one turn of A will produce only $\frac{1}{n}$ turn of B, and if C and E are equal, the carriage will advance only $\frac{1}{n}$ of the pitch of the lead-screw. This is equivalent to a lead-screw having n times as many threads per inch; hence the term lathe (or lead) screw constant, and this constant can evidently be determined by noting the number of threads per inch that will be cut when gears C and E are equal. Suppose that the lead-screw has six threads per inch and that $n = 2$; then the constant is $6 \times 2 = 12$, and when the spindle makes one turn, the carriage advances 1/12 inch. Now suppose that it were desired to cut a screw having seven threads per inch; evidently gear C must be larger than gear E, since the carriage must move a greater distance than when C and E are equal. The pitch of the thread to be cut is 1/7 inch, and we have the proportion $C : E = \frac{1}{7} : \frac{1}{12}$, or $\frac{C}{E} = \frac{12}{7}$. Multiplying both terms of this fraction by 4 (this does not change its value, of course), the result is $\frac{48}{28}$. Therefore, gear C should have 48 teeth and gear E 28 teeth, the same values as would be obtained by the rule. The rule is simpler, however, since it does not make use of fractions. J. J.

CYLINDRICAL TANK CALCULATION

R. L. C.—A cylindrical tank 60 feet high and 12 feet in diameter should be provided with an overflow opening at such a height in the head that the contents will overflow when the tank is two-thirds full. How can the location of this hole be found?

A.—Referring to the accompanying illustration, the problem may be stated mathematically as follows: Find a line AB so located that it divides a circle 12 feet in diameter into two parts, the area of one part being equal to two-thirds of the area of the circle, and the area of the other part being equal to one-third. This problem cannot be solved by any direct mathematical formula. It is easily solved, however, by the use of a table of "Segments of Circles," such as is given on pages 62 and 63 of MACHINERY'S HANDBOOK. Tables of this kind are, in fact, prepared for the very purpose of solving problems like this, for which no simple mathematical formula can be provided. In the present case the problem resolves itself into finding the height CD of the segment of a circle the area of which is one-third of the total area of the circle. The table referred to is based on a radius equal to 1. The area of a circle with a radius equal to 1 is 3.1416. One-third of this area equals 1.0472. By inspecting the table on page 63 of MACHINERY'S HANDBOOK, in the column "Area of Segment," it will be found that a segment having a center angle of 149 degrees and a height of 0.7328, very nearly meets the requirements. As the radius in the problem is 6 feet, the height CD in the problem would equal 6×0.7328, or 4.4 feet, very nearly.



Cylindrical Tank Calculation

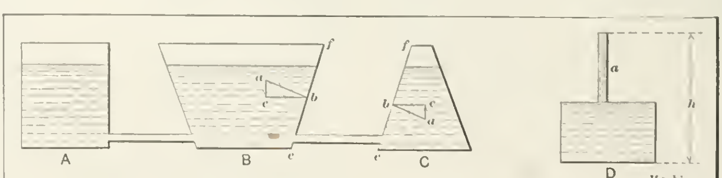
The uses of the mathematical tables given in MACHINERY'S HANDBOOK for solving many problems of this and similar kind are perhaps not as well appreciated as they should be. To a man who must do a great deal of calculating, the tables of "Powers, Roots and Reciprocals," "Circumferences and Areas of Circles," "Segments of Circles," "Lengths of Chords," etc., will save a great deal of time and facilitate the solution of problems and equations by trial and inspection to a great extent.

PASCAL'S LAW

H. M. S.—What is Pascal's law, and who was Pascal?

A.—Blaise Pascal was a great French mathematician and scientist (1623-1662). There are several theorems and principles, or laws, bearing his name, but we assume that the one to which you refer is that relating to hydrostatic pressure. In stating the law, it is assumed that the word "pressure" means specific pressure, *i. e.*, pressure per unit of area, as pounds per square inch, kilograms per square centimeter, etc. Then, if a vessel be entirely filled with a liquid, and a pressure be exerted anywhere on the mass of the liquid, it follows, according to Pascal's law, that the pressure is transmitted undiminished in all directions and acts with the same force upon all surfaces in a direction perpendicular to each element of those surfaces. This is the most important law in hydrostatics, but only a few of the conclusions derived from it can be considered here.

Referring to the illustration, A, B, and C are three vessels partly filled with water and connected by pipes, as shown; then the water stands at the same level in each vessel. To prove this, note that the pressure of the water at any point is equal to the weight of a column of water



Illustrating Pascal's Hydrostatic Law

whose area is the unit of area (say, 1 square inch) and whose height is the depth of the point below the upper surface of the water. If, therefore, the water were a little higher in one vessel than in the others, the pressure at any particular point would be a little greater than at the same level in the other vessels, and this extra pressure would cause the water to flow from that vessel to the others until the pressure was equalized. Again, if the areas of the bottoms of the three vessels are the same, regardless of their shapes, the total downward pressure on their bottoms will also be the same. In vessel *B*, the pressure acting on an element of area at *b* may be represented by *ab*, perpendicular to the element of surface *ef*. This can be resolved into the two forces *cb* and *ac* acting, respectively, on the horizontally and vertically projected areas of *b*, but not increasing the pressure on the bottom area. In vessel *C*, on the contrary, *ac* acts upward, and there being nothing but the bottom to oppose the downward reaction, the pressure on the bottom is increased, and the sum of these reaction pressures makes the total pressure on the bottom the same as in *A* and *B*. In vessel *D*, the pressure due to the water in tube *a* is transmitted equally everywhere. J. J.

CONTINUED FRACTIONS

P. O. R.—What are continued fractions and of what use are they?

A.—Consider the fraction $\frac{453}{1908}$. Dividing both numerator and denominator by the numerator, this fraction becomes $\frac{1}{4\frac{96}{453}}$.

Similarly, $\frac{96}{453}=\frac{1}{4\frac{69}{96}}$; $\frac{69}{96}=\frac{1}{1\frac{27}{69}}$; $\frac{27}{69}=\frac{1}{2\frac{15}{27}}$; $\frac{15}{27}=\frac{1}{1\frac{12}{15}}$; $\frac{12}{15}=\frac{1}{1\frac{1}{4}}$.

Consequently,

$$\frac{453}{1908}=\cfrac{1}{4+\cfrac{1}{4+\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{1+\cfrac{1}{1+\cfrac{1}{4}}}}}}}$$

This is frequently written $\frac{1}{4+}\,\frac{1}{4+}\,\frac{1}{1+}\,\frac{1}{2+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{4}$.

It will be noticed that the numerators are all 1's and the denominators are the quotients obtained by dividing the different denominators by the corresponding numerators; all such expressions are called continued fractions. A continued fraction is most conveniently evaluated in the following manner: $\frac{0}{1}, \frac{1}{4}, \frac{4}{17}, \frac{5}{21}, \frac{14}{59}, \frac{19}{80}, \frac{33}{139}, \frac{151}{636}$. Write the fraction $\frac{0}{1}$ and then the first fraction in the continued fraction; in this case, $\frac{1}{4}$. Multiply the numerator of the second fraction by the next denominator in the continued fraction and add the numerator of the preceding fraction; thus, $4 \times 1 + 0 = 4$. Do likewise with the two denominators; thus, $4 \times 4 + 1 = 17$. Write the results as the numerator and denominator of a new fraction, as shown. Multiply the numerator of the fraction last found by the next denominator in the continued fraction and add the preceding numerator to form the numerator of a new fraction; thus $1 \times 4 + 1 = 5$. Do likewise with the denominators; thus, $1 \times 17 + 4 = 21$. Proceed in this manner with the remaining denominators in the continued fraction. The last fraction is equal to the original fraction when reduced to its lowest terms. The fractions following $\frac{0}{1}$ are called convergents, and each is nearer in value to the original fraction than any that precedes it. Continued fractions are used principally to obtain approximate fractions that will be sufficiently accurate and at the same time more convenient than the original fraction or decimal. For example, suppose it were desired to calculate the change-gears for a lathe to cut screw threads in the metric system. Here 1 centimeter = 0.3937 inch = $\frac{3937}{10000}$ inch. Converting this into a continued fraction, the result is $\frac{1}{2+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{5+}\,\frac{1}{1+}\,\frac{1}{3}$. Note that the last denominator is almost, but not quite 3; it is really $\frac{1}{79}$ less than 3. Forming the convergents as before, they are $\frac{0}{1}, \frac{1}{2}, \frac{1}{3}, \frac{2}{5}, \frac{11}{28}, \frac{13}{33}, \frac{50}{127}$. The last fraction reduced to a decimal becomes 0.3937008, showing that the number of teeth in the gears should be 50 and 127, provided there is no reducing gear. It is well to note that each convergent is a fraction in its lowest terms. J. J.

CALCULATING CHANGE-GEARS FOR FRACTIONAL THREADS

Mechanic.—Please explain how to calculate the change-gears for cutting screw threads when the pitch is expressed decimally; for example, suppose the lead-screw has four threads per inch and the number of threads per inch to be cut is 14.083.

A.—We suspect that in this case the decimal 0.083 is intended to be equivalent to $\frac{1}{12}$, in which event, $\frac{4}{14\frac{1}{12}}=\frac{48}{169}$.

Hence, the gear on the lead-screw should have 169 teeth and the gear meshing with it 48 teeth. Suppose, however, that the number of threads per inch required had been 14.183. The first step is to decide the limit of accuracy. The true pitch required is $\frac{1}{14.183} = 0.07050694 +$ inch. Suppose it is decided that the nearest ten-thousandth of an inch is close enough; then the gears must be so selected that the pitch of the screw will be 0.0705 ± 0.00005 inch. In other words, it must be greater than 0.07045 and less than 0.07055. The second step is to convert the decimal into a continued fraction. Thus, $0.183 = \frac{1}{5+}\,\frac{1}{2+}\,\frac{1}{6+}$, etc. Forming the various convergents, we obtain $\frac{1}{5}, \frac{2}{11}, \frac{13}{71}$, etc. Now $\frac{1}{14\frac{2}{11}} = \frac{11}{156} = 0.0705128 2 +$ inch, which is within the limits. Therefore, $\frac{4}{14\frac{2}{11}} = \frac{44}{156} = \frac{22}{78}$; hence, the gear on the lead-screw must have either 156 or 78 teeth, and the gear meshing with it either 44 or 22 teeth. If the third convergent be used, the pitch will be $\frac{1}{14\frac{13}{71}} = 0.07050645 +$ inch, which, as will be observed, is far more accurate. The ratio of the gears in this case is $\frac{4}{14\frac{13}{71}} = \frac{284}{1007}$. Since this fraction cannot be reduced any further, and as it is impracticable to make a gear having 1007 teeth, this ratio is valueless for a simple geared lathe. It can be used, however, with a compound geared lathe, since $\frac{284}{1007} = \frac{4}{19} \times \frac{71}{53} = \frac{16}{76} \times \frac{71}{53}$. That is, gear 16 would be on the spindle and would mesh with gear 53 on the stud; gear 76 would be placed on the lead-screw; gear 71 would be on the same shaft as gear 53, and would mesh with gear 76. J. J.

INFLUENCE OF TRADE PAPERS IN FOREIGN TRADE

In a paper read at the convention of the Associated Advertising Clubs of the World in Philadelphia, June 27, C. A. Tupper, president of the Chicago Trade Press Association, said he could best point out the opportunities that lie before American trade and technical journals to help build up foreign trade, by giving specific examples of what they have already accomplished.

Some years ago he visited the principal industrial countries of the world outside of the United States and Canada, his work taking him into practically every manufacturing district of importance, with particular reference to mining, metal working, woodworking, electrical and textile plants, as well as to large construction projects and the mills or factories furnishing material for them. Docks and shipyards were also visited. In the metal working plants he found an amazingly large number of installations of American built machine tools. Upon inquiring into their origin, he learned that in the majority of cases the equipment had been bought by the German, Swiss, French or English proprietors, rather than sold to them by American manufacturers or their agencies. The distinction is important. Herein lies one of the strongest reasons for the tremendous influence which American trade and technical journals have exercised on foreign trade.

Among these metal working plants he found MACHINERY, the *Iron Age, and American Machinist* extensively circulated. Furthermore, they were eagerly and intelligently read. When a new machine tool was put upon the American market, both the editorial and advertising descriptions were closely followed by a considerable number of foreign shop owners, who studied the possible application of such a machine to their own operations with great care. In many cases such articles and advertisements subsequently led to visits to the United States by representatives of large foreign metal working interests and to considerable purchases of American tools for use abroad. In other cases correspondence developed with the American manufacturers which led directly to orders by mail.

At the present time many American machine tool manufacturers are represented abroad by active sales agencies, but the business was originally developed almost entirely through the initiative of the foreign buyer after reading descriptions of the tools in American journals.

In Germany and Austria-Hungary, before the war, there were large installations of American rock and ore crushing machinery, steam and electric shovels, and heavy construction equipment, the orders for which, Mr. Tupper says, were directly traceable to the influence of American trade journals. At the Lousavaara-Kirunavaara iron mines of Lapland and in the frozen island of Spitzbergen, which is far within the Arctic Circle, beyond Norway, extensive coal and iron ore mining and ship loading equipment had been bought from advertisements. In Spain and other countries of Southern Europe, advertisements led to contracts for complete cement mill equipments. On the historic island of Elba, there is a blast furnace plant where the blowing engines were constructed after the designs of a Philadelphia concern, as a result of a description in a trade paper, which led to a visit from the company's engineer to plants in eastern Pennsylvania. In northern Algeria there is equipment for mining and handling phosphate rock which was bought on advice taken from the pages of an American magazine.

In riding from Cologne to Berlin Mr. Tupper conversed with a German wholesale lumber dealer having large interests in the eastern provinces. This dealer read an American trade journal very carefully and purchased most of the equipment of his saw mills located in East Prussia and Silesia as the result of advertisements appearing in that paper.

In Vienna he was shown an article contributed to one of the papers in which he is now interested, and was asked whether he was the same Herr Tupper who had written it. Upon admitting that he was, an official asked him questions in considerable detail about the ore washing plant of the Oliver Iron Mining Co. at Coleraine, Minn., and negotiations were later started with American manufacturers for a plant in Transylvania, the completion of which has been delayed by the war. At Gohlis, a suburb of Leipsic, Germany, he had a similar experience with another article, which had been clipped, filed and carefully indexed. The concern that he visited there subsequently sent to him at Milwaukee a representative of the Prussian government who was interested in handling equipment for loading and unloading at wharves. This man brought out a portfolio containing clippings, both articles and advertisements, which he had gathered from American journals he had read in Germany.

But aside from the direct contact of American trade and technical journals with the foreign customer, it must be remembered that an influence of considerable importance is being exerted by the re-publication in foreign trade and technical journals of articles from American papers of the same class. An examination of copies of papers issued in Europe, Asia, South Africa, Australia and Latin America shows that reprints from American papers form a large percentage of the contents of such papers, and in many cases overshadow the original material used in them.

* * *

NEW FRENCH AEROPLANES

A new type of aeroplane has been brought out in France, which has wing planes about 75 feet wide. There are three planes arranged vertically one above the other, the total height of the triplane being about 20 feet. This triplane has a seating capacity for twelve people, but ordinarily does not carry more than six. The aeroplane is equipped with four 1½-inch rapid-fire guns, and has a speed of over 80 miles an hour. In addition to these aeroplanes, which are intended primarily for attacks on enemy positions by means of bomb dropping, a fleet of aeroplane destroyers has also been developed. These aeroplanes are, strictly speaking, battle planes, intended to attack enemy aeroplanes in the air. This type consists of a biplane, 7 feet high, with wings 21 feet wide, having a maximum speed of 100 miles an hour. These biplanes are equipped with rapid-fire guns which can be operated by the aviator himself. It is claimed that these aerial destroyers excel all aeroplanes hitherto built as regards ease of manipulation. They can rise in a helix of very small diameter, and in forty seconds are able to reach a height of 3000 feet. The steering gear is manipulated by pedals, so that the aviator has his hands perfectly free for making notes and sketches, or for the operation of the rapid-fire gun. Previous to the war France built yearly from 150 to 200 aeroplanes. At the present time it is stated that one factory alone completes five aeroplanes daily.

* * *

SPEED OF WOODWORKING MACHINERY

There is considerable difference of opinion as to the speed of woodworking machinery, and machinery of this type is often run at too low a speed for the best efficiency. There seems to have been less effort made in instructing the users of woodworking machinery as to the proper speeds to employ than in the metal working industries. Woodworking machinery requires comparatively high power, owing to the fact that it should be run at a high speed, and, while the material cut is so much softer than that cut in metal working machinery, the amount of material removed per minute is so much greater that the power for machines of approximately the same size does not differ materially. A properly driven circular saw, according to the *Railway and Locomotive Engineer*, should run at a peripheral speed of 7000 feet per minute—nearly a mile and a half. A band saw is run at about half that speed. Planing machine cutters have a speed at the edge of 6000 feet per minute, as the cutters of molding machinery trim out material at about 4000 feet per minute. Wood carving drills run at 5000 revolutions per minute. Augers 1½ inch in diameter are run at 900 revolutions per minute, and those half that size are run at 1200 revolutions per minute. Mortising machine cutters make about 300 strokes per minute.

* * *

Thin brass tubing is threaded with twenty-seven threads per inch, irrespective of diameter. The so-called ornament brass sizes have thirty-two threads per inch.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

RIVETT AUTOMATIC OSCILLATING GRINDING MACHINE

The great increase in the use of ball bearings and the accompanying demand for grinding machines has led the Rivett Lathe & Grinder Co. to bring out the oscillating grinder illustrated herewith. Its principal features are the automatic oscillation of the head, positive methods of adjustment and range of feeds necessary for good ball bearing race grinding.

The Rivett Lathe & Grinder Co., Brighton District, Boston, Mass., has brought out the automatic oscillating grinder illustrated herewith. This machine is adapted for grinding concave and convex rings, and especially for finishing ball bearing races to the highest degree of accuracy. The machine is protected by Van Norman patent, reissued March 16, 1915, No. 13,892, under which the Rivett Lathe & Grinder Co. is licensed to manufacture.

Fig. 1 shows a view of this machine from the front; Fig. 2 shows a front elevation; Fig. 3 represents a cross-section taken through the oscillating post; Fig. 4 shows the gear-box; Fig. 5 is a section through the wheel-spindle slide; and Fig. 6 shows the drive from the countershaft to the wheel-spindle and the belt adjustment. It is recommended that this machine be used for work within a limit of 3½ inches diameter, although the actual swing of the work-spindle is 7 inches with the front guard removed. The spindle will swing 5½ inches over the guard, but the best work is limited to sizes within 3½ inches diameter.

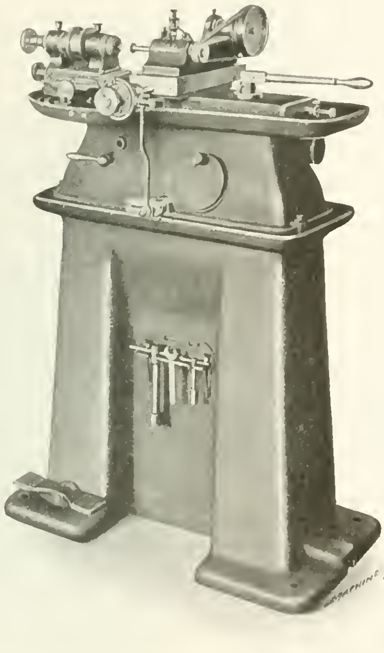


Fig. 1. Rivett Automatic Oscillating Grinding Machine

The Oscillating Mechanism

The oscillation of the work-head takes place about the post which may be seen at the left-hand side of Fig. 2. By referring to this illustration in connection with Fig. 3, which shows the oscillating post and adjacent mechanism in section, the method of oscillating the head may be seen. The oscillating head which carries the work-holding spindle is held to the top of the oscillating post by means of screws and dowels. The upper end of the post is mounted in a double taper bronze bearing which adequately supports it and keeps it free from play, while the lower end is mounted in an annular ball bearing that steadies the post with a minimum of friction. Below the lower bearing on the oscillating post is a flange that takes up end play, and above the ball bearing is a protecting flange. Located directly above this flange is the oscillating bracket that runs free on the post. This bracket oscillates constantly, and the post and its work-head are made to move in unison with it by engaging the clutch that may be seen above the bracket. This clutch is slidably mounted on the oscillating post by means of two pins that extend from the adjustable sleeve on the post down into holes in the clutch. The sleeve above the clutch is adjustable on the post; therefore, the center of oscillation may be changed at will by loosening this sleeve and changing its position. The advantage of being able to stop oscillation without stopping the entire machine is apparent, and especially valuable when adjusting or setting up the machine.

The work-spindle head is laterally adjustable on the oscillating head so as to secure movement at any desired radius from the axis of oscillation to provide for grinding any depth of groove. The work-spindle is of the regular Rivett construction, being made of tool steel and running in hardened and ground steel bearings. The thread on the spindle nose is 1⅝ inch diameter by 12 pitch, and is finish-ground on the spindle bearing. The spindle end is provided with a taper for receiving No. 4 new style standard Rivett chucks. Adequate oiling provisions are present for lubricating the bearings. The driving belt to the work-spindle and wheel-spindle countershaft is operated from an overhead countershaft which was described in the March, 1915, number of MACHINERY. A foot control at the base of the machine may be fitted to operate the countershaft, and by means of a brake that acts almost instantly the oscillation may be stopped within a limit of 10 degrees.

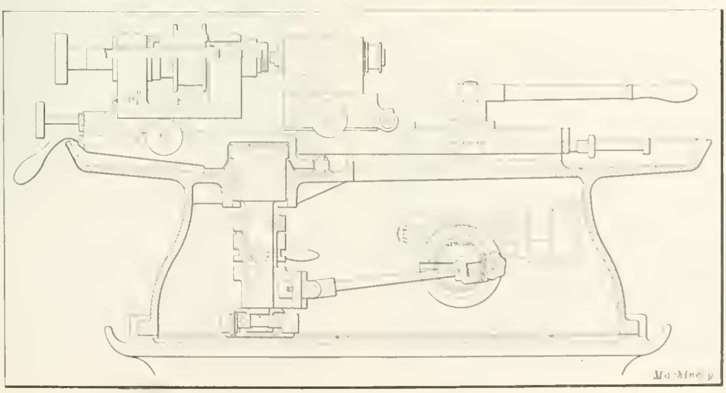


Fig. 2. Partial Front Elevation of Machine shown in Fig. 1

Method of Oscillation

Fig. 4 best illustrates the mechanism employed for oscillating the bracket on the oscillating post. The drive is received from the overhead countershaft on the three-step cone pulley *A* on the back-shaft. This back-shaft carries a worm *B* that meshes with a worm-wheel *C* on a shaft *D* at right

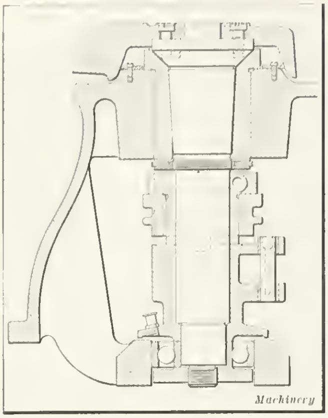


Fig. 3. Cross-section through Oscillating Post

angles to the back-shaft and enclosed in the column of the machine. This worm-shaft terminates in a crank disk *E* that is slotted and provided with a pin *F* carrying a lever *G* that connects with the oscillating bracket. At each end of this connecting-rod are universal joints, bronze-bushed. The maximum amount of oscillation that may be obtained is 120 degrees, and any amount of oscillation may be obtained by adjusting pin *F* in the slot in crank disk *E*.

Carriage and Wheel-slide Mechanism

As may be noticed from Fig. 2, the carriage of this machine has an extremely long bearing on the ways, and the wheel-slide table and wheel-slide are mounted on the carriage. By means of the hand-lever that may be seen in Figs. 1 and 2, the carriage may be moved longitudinally for a distance of 2½ inches. This movement is secured by a rack and pinion. At the rear of the carriage is an adjustable stop that can be set to bring it into position after withdrawal for gaging work, etc.

The mechanism by which the wheel-slide is automatically cross fed may best be understood by reference to Fig. 5 that shows the wheel-slide table and base of the wheel-slide in section. The long screw that traverses the wheel-slide is provided with a section *H* at the end, having a 12½-pitch, left-hand Acme thread that engages a solid nut *I*, bolted to the extreme end of the carriage. Midway of the screw is a section *J* that is threaded with a 10-pitch, left-hand Acme thread, and this section engages a nut *K* screwed to the under side of the wheel-slide table. It is obvious that every full revolution of this screw will advance or withdraw the wheel-slide an amount equal to the difference in pitch of the two threaded sections of the screw, or 0.020 inch.

The control end of this screw passes through a bushing *L* held in the extension bracket *M* of the carriage, and thence to the front of the machine. On the outer part of this screw is a double ratchet *N* having 200 divisions or teeth. The teeth on one side of the ratchet are cut left hand, and on the other side right hand, to provide for feeding in either direction. The feed pawl that gives the impulses to the ratchet, and hence to the screw, has two teeth that are spaced 1½ times the pitch of the ratchet teeth. Therefore, it is possible to turn the screw at each interval by as small an amount as 1/400 part of 0.020 or 0.00005 inch.

The automatic feed for the wheel-slide is not shown in the line engravings, but a good idea of its operation may be obtained from the halftone illustration Fig. 1, in connection with

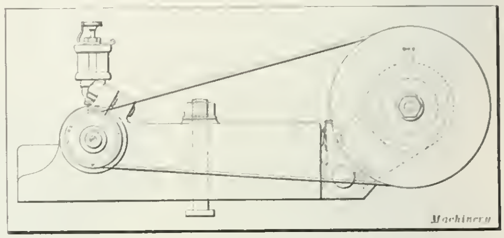


Fig. 6. Drive from Countershaft to Wheel-spindle and Method of adjusting Belt Tension

the line illustration Fig. 4. The latter view shows the method of actuating the automatic feed cams that give rise to the impulses for operating the cross-feed. On the face of the crank disk illustrated in Fig. 4, there is a double cam, the rises *O* of which operate a bellcrank lever that terminates at the outside of the machine in the slotted lever shown in Fig. 1. It is evident that the double-rise cam rocks this lever twice during each rotation of the crank disk each time an impulse is given to the feed-rod that carries motion up to the pawl meshing with the ratchet on the cross-feed screw. These two impulses operate the feed at each end of the oscillating stroke. It is possible to remove one of the cams if desired, so that the feed is operated only at one end of the oscillation. The feed-rod operating lever is slotted so that any amount of feed from 0.00005 inch up may be secured.

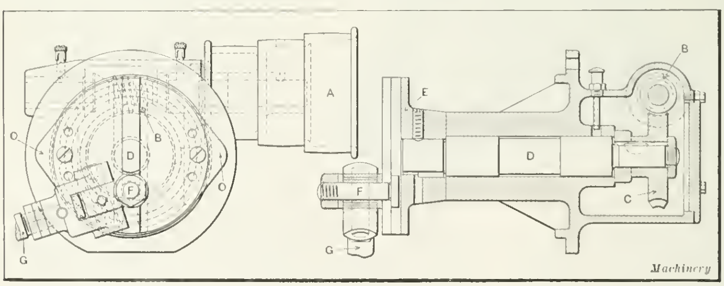


Fig. 4. Longitudinal and Cross-sectional Views of Gear-box

Wheel-spindle and Drive

Fig. 6 gives a good idea of the wheel-spindle mounting and its drive, especially when viewed in connection with Fig. 1. The wheel-spindle itself is a unit mounted on two standard ball bearings and is quickly removable from its housing by loosening the clamping nut shown in Fig. 6. The drive is through an endless canvas belt to the large pulley on the ball bearing countershaft. This ball bearing countershaft is pivoted on the wheel-slide table as shown. The belt tension is adjusted by increasing or diminishing the angle of the countershaft by means of the adjusting screw shown.

The base of this machine is provided with a generous water pan, and the machine can be fitted with water pump if desired. Doors are provided on the machine as well as the pedestal

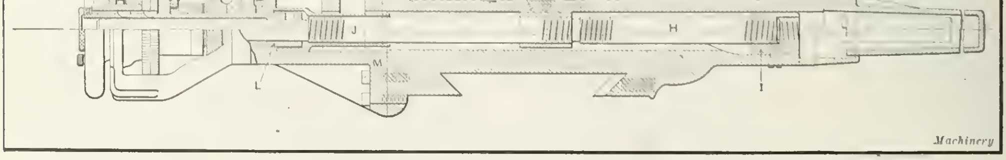


Fig. 5. Cross-sectional View through Wheel-spindle Slide

base, so as to afford ready access to the mechanism. The upper part of the grinding machine is mounted on the base casting on the three-point principle, thus obviating any twisting tendency.

Three wheel speeds are provided, those recommended being 11,600, 16,000 and 19,200. The work-head is provided with two speeds, those recommended being 300 and 590. The main shaft of the countershaft is run at a speed of 600 revolutions per minute.

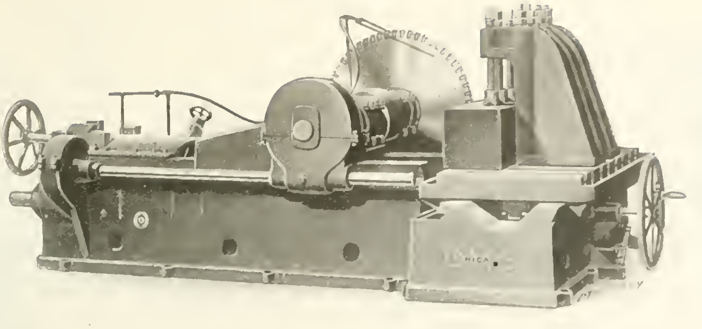


Fig. 1. Q. M. S. Cold Metal Saw for which Vulcan Engineering Sales Co. is Selling Agent

VULCAN COLD METAL SAW

Figs. 1 and 2 show rear and front views of an improved type of cold metal saw built by the Q. M. S. Co., and for which the Vulcan Engineering Sales Co., 2059 Elston Ave., Chicago, Ill., has the sales agency. The saw and gear arbors are hammered 60-point carbon open-hearth steel and scraped to accurate fits. The teeth are cut from the solid steel, and they are staggered for the purpose of reducing backlash and chatter to a minimum. The saw and gear arbors run in hard bronze bearings. A worm and wheel type of drive is employed, the worm being made of hardened steel and the wheel of a special mixture of bronze. The thrust of the worm is taken by roller bearings; and the worm-wheel is of two-piece construction, consisting of a steel center around which is shrunk a bronze rim. The worm and worm-wheel are enclosed and run in grease.

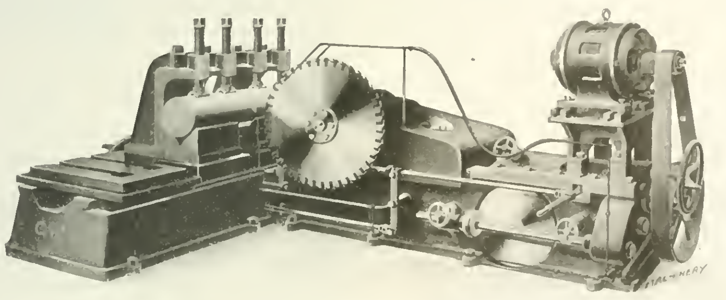


Fig. 2. Front View of Q. M. S. Cold Saw shown in Fig. 1

The carriage is of box section and is scraped to an accurate fit on the ways. It has a full length bearing, and taper gibs provide means of compensating for wear. Hand adjustment, automatic stops and quick power return are features of the design. Feed is obtained by the combination of a friction disk and gears, which give a range of feeds from 5/16 inch to 2½ inches per minute. The friction feed wheel automatically sustains the proper contact with the friction disk, thus insuring maximum power. Changes in the peripheral cutting speed of the saw may be instantaneously made, and machines are provided for running at 30 and 50 feet per minute or 40 and 60 feet per minute, according to the requirements of the work on which the saw is to be employed.

A feature of the machine is that all levers for controlling the feed, peripheral speed and return motion are concentrated in a position where they can be conveniently reached by the operator. The levers for engaging the feed and quick return are extended through the machine, so that control is obtainable from either side. All gears on the machine run in oil, and all internal bearings are lubricated by oil pipes leading to the exterior of the machine. An oil trough is cast around the work-table, and a gear-driven pump provides for delivering lubricant to the saw table. The base of the machine is a box-section casting, and the ways are carefully machined and scraped to an accurate fit. Turned shafting is used throughout the machine.

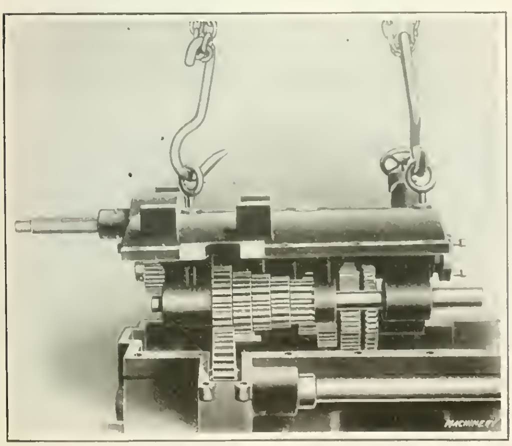


Fig. 3. How Mechanism is supported by Cover to facilitate Quick Removal

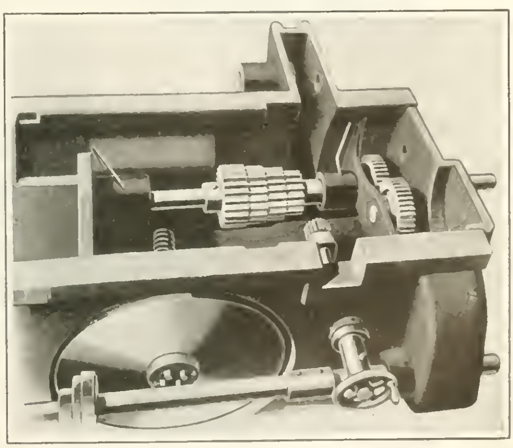


Fig. 4. View of Mechanism in Bed with Cover removed—Attention is called to Oil Pipes leading to Bearings

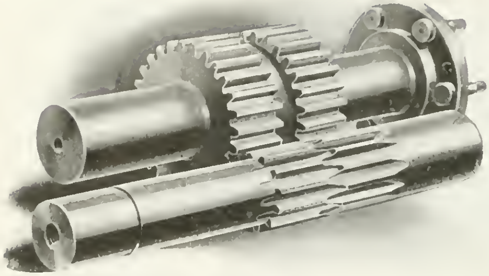


Fig. 5. Close View of Staggered Tooth Construction on Saw and Gear Arbors

The power provided is sufficient to enable the manufacturers to guarantee that the machine will drive to the limit of its cutting capacity all sizes of inserted-tooth saws that come within its range.

C & C DIRECT-CURRENT MOTORS

The C & C Electric & Mfg. Co., Garwood, N. J., has developed a line of electric motors especially adapted for those classes of service where direct-current motors of the smaller horsepowers are required for direct-connected motor drive on machine tools and other types of industrial machines. They are known as Type I-B and are of the bi-polar type with interpoles. The line includes motors up to ten horsepower capacity, and they can be furnished either shunt- or compound-wound, according

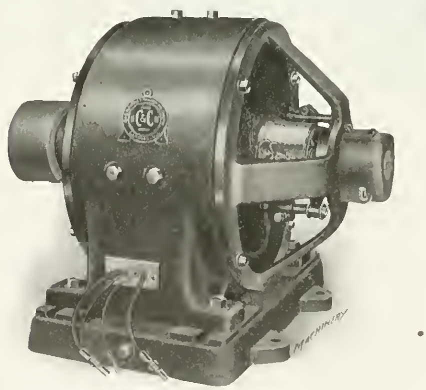


Fig. 1. Type I-B Motor with Universal Base made by C & C Electric & Mfg. Co.

to the requirements of the shop in which they are to be used. For driving machine tools and similar classes of service, the shunt-wound motors are said to be most satisfactory, as the service required is essentially one of constant speed with close speed regulation from no load to full load, and where the torque required for starting and accelerating does not greatly exceed the full load torque. The compound-wound motor is desirable for drives where the starting torque is much heavier than the full load torque, as this type of motor starts at a much heavier load than the shunt-wound motor, and any degree of compounding can be furnished to meet existing conditions. Adjustment of speed is obtained in both types of motors by either armature or field control.

Fig. 2. Armature of C & C Type I-B Electric Motor

The main frame and supporting feet are cast integral and the pole pieces are separate. The main pole pieces and pole shoes are laminated, with the interpole pieces cast separately, and the coils are form wound. The pulley side bearing bracket is provided with a wide apron to protect the windings from mechanical injury, and the bearing is supported by four arms with large openings between them, making a rigid open bracket and permitting free and ample ventilation. The commutator side bearing bracket has four arms, giving free access to the commutator and brushes. Both brackets fit in recesses in the main frame, thus insuring perfect and rigid alignment.

The armature is of standard design with a laminated core; and an air-agitating fan is placed on the pulley end of the shaft next to the armature windings, in order to provide the high degree of ventilation and cooling which is absolutely necessary in motors of compact form to guarantee satisfactory operation under severe service and a heavy overload capacity. The addition of interior commutating poles completes the constant characteristics of these motors. Under continuous operation for long periods of time, it is stated that these motors run cool and do not require any attention. The interpoles insure sparkless commutation through the full range of load without changing the brush position. These motors may be furnished in the open type or with perforated or totally enclosing covers to provide protection against dust, metal chips, dampness, etc. For use in connection with belt drive, the motors can be provided with either a universal slide-rail base or a belt tightening idler pulley for adjusting the belt tension.

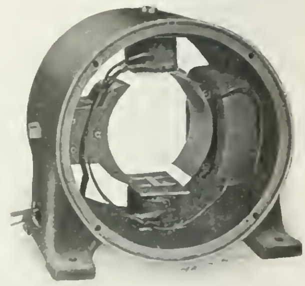


Fig. 3. Main Frame with Field and Commutating Poles of C & C Type I-B Electric Motor

"FULFLO" GRINDER PUMP

The Cincinnati Lubricant Pump Co., 126 Opera Place, Cincinnati, Ohio, has added to its line of "Fulflo" pumps a lubricant pump of the centrifugal type which is especially adapted for use in delivering water to grinding wheels. The centrifugal principle employed has been applied in such a way

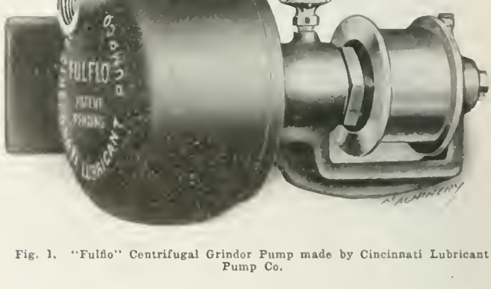


Fig. 1. "Fulflo" Centrifugal Grindor Pump made by Cincinnati Lubricant Pump Co.

that the delivery of a large volume is assured without having the water supplied under too great a pressure. The pump can be mounted above the level of the water, and owing to its positive trap arrangement, it will retain its "prime" without requiring the use of a check valve. The possibility of mounting

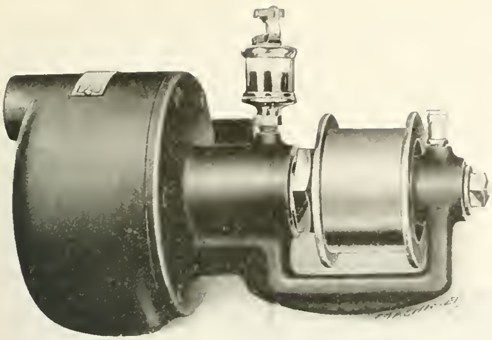


Fig. 2. "Fulflo" Grinder Pump, showing Clearer View of Driving Shaft Pulley and Bearings

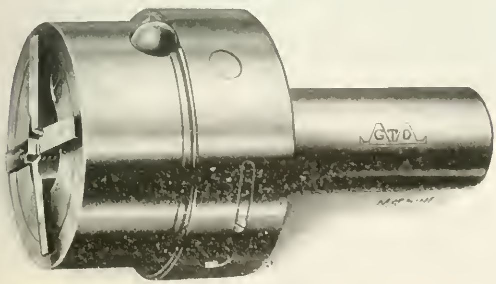
the pump above the surface of the water enables it to be placed in any convenient position on the grinder with regard to convenience, accessibility, etc.

The "Fulflo" grinder pump has no bearings in the pump proper, the impeller which is the only working part being mounted on the driving shaft. Since it has no contact with any other part, the impeller will last and retain its full efficiency almost indefinitely. As no gears or other close fitting parts govern the action of the pump, its efficiency is not affected by the presence of emery grit and dirt in the water. All passages are made of large size so that they are not likely to become clogged. The driving shaft is made of hardened and ground steel and is supported by bearings at both sides of the driving pulley. The outer bearing, which also supports the end thrust, is made of phosphor-bronze. The inner bearing is combined with the stuffing-box gland and is made of cast iron. This inner bearing is protected from emery grit and dirt by the use of a combination of metallic graphite, rubber and flax packing which is non-granular and will not cut the shaft, although it prevents the slightest particles of grit or dirt from reaching the bearing.

Large oil reservoirs provide semi-automatic lubrication for the bearings. When pulley-driven and using a suction-lift of twelve inches and a head-lift of four feet, the rates of delivery are about as follows: for 1200 revolutions per minute, five gallons per minute; for 1400 revolutions per minute, ten gallons per minute; and for 1600 revolutions per minute, fifteen gallons per minute. In order to increase the flow for a given head-lift, or to secure the same flow for a greater head-lift, it is simply necessary to increase the speed of the pump pulley proportionally.

GREENFIELD SELF-OPENING DIE

The Greenfield Tap & Die Corporation, Greenfield, Mass., has recently made several important changes in its model T Wells self-opening die. The improved tool is shown in the accompanying illustration, where it will be noticed that the openings for the chaser set-screws, which were formerly exposed, are now entirely covered by a light steel shell, thus eliminating the possibility of fine chips entering and interfering with the work. Although this steel shell affords ample protection, it can be instantly turned to expose the screws so that the chasers can be released and removed in the usual way.

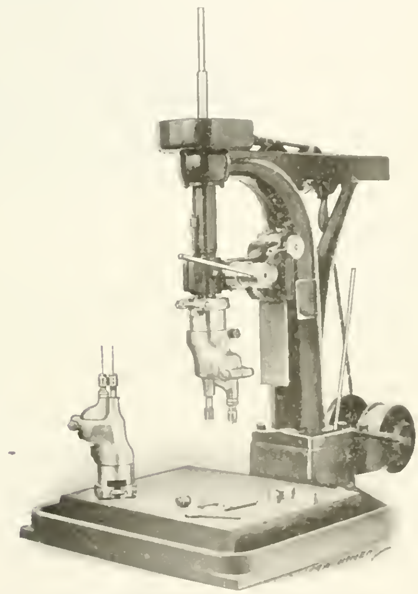


Improved Type of Wells Model T Self-opening Die made by Greenfield Tap & Die Corporation

This improved threading die is especially adapted for operations in which the die is required to revolve; and on this account the old style of projecting face trip has been discontinued, a neat and serviceable ball shaped latch at the side of the die-head now being employed to release the chasers when the cut has been taken. The well-known self-opening die principles and all essential points of construction of the previous type of model T Wells self-opening die have been retained in the present design, which also includes the improved features referred to.

SELLEW SENSITIVE DRILL HEAD

The illustration presented in connection with the following description shows a Leland-Gifford high-speed bench drill equipped with a sensitive adjustable drill head which is a recent product of the Sellew Machine Tool Co., Pawtucket, R. I. The center spindle of this head is directly connected with the main driving spindle, and the auxiliary spindle is adjustable; the minimum distance is 0.6 inch and the maximum distance 1.7 inch between centers of the spindles in the head. The chucks have a capacity for holding drills up to



Leland-Gifford High-speed Bench Drill equipped with Sellew Sensitive Drill Head

1/4 inch in diameter, and they are an integral part of the spindles. The auxiliary spindle has its own thrust bearing, and the center or main driving spindle is connected to the spindle of the drilling machine. Drill heads of this type are particularly suitable for brass work, especially in the manufacture of ammunition; and they provide for drilling two holes simultaneously, so that it is unnecessary to shift the drill jig.

Although the drill head illustrated in this connection is only provided with one auxiliary spindle, this type of head is also made in what is known as a "double" type which has auxiliary spindles on both sides of the center spindle, thus permitting of the performance of drilling operations where it is necessary to produce three holes simultaneously. These holes are located in a straight line and spaced equidistant from each other, the distance between centers being anything which comes within the range of the machine. The connecting sleeve on the drill head is clamped to the quill of the drilling machine just above the spindle ball bearing; and the head can be rotated around the center axis in order to bring the auxiliary spindle into any required position.

PIERCE PLAIN-HEAD SCREW MACHINE

The machines shown in Figs. 1 and 2 are of essentially the same design, except that the machine shown in Fig. 1 is equipped with a collet chuck, bar feed mechanism and a stock support to form the hand screw machine, while on the machine shown in Fig. 2 these features have been dispensed with to form a turret lathe. The screw machine has a capacity for handling round stock up to 1 1/16 inch in diameter, and work up to 8 inches in length can be turned. On both the screw machine and turret lathe the swing over the bed is 14⅛ inches.

The Pierce Machine Tool Co., 617 W. Jackson Blvd., Chicago, Ill., has recently placed on the market a 1- by 8-inch heavy-pattern turret screw machine with a plain head. It will be seen that the headstock is of the "bowl" type and cast integral with the bed of the machine. Ample belt clearance is provided between the "bowl" and the three-step cone pulley. The spindle is made of high-carbon hammered crucible steel; it is bored from a solid forging and accurately ground to size. The spindle is carried in phosphor-bronze bearings, which are furnished with sight-feed oilers; and the automatic chuck is forged solid on the end of the spindle, the design being such that overhang from the front spindle bearing is reduced to a minimum. The stock feed, which is positive in operation, is controlled by a conveniently located lever, the work being gripped or released at any desired point. The stock can be fed directly into the chuck while the machine is in operation. A stepped wedge automatically compensates for variations in diameter of bar stock or casting; and a guard fitted over the rear end of the spindle prevents the throwing of oil from revolving parts. The wire feed dog is fitted with a guard to afford protection from the set-screw in the revolving stock collar; and this also prevents the throwing of lubricant that may work back along the bar. The collets are hardened and ground to size; and either a plain round collet is provided or a master collet adapted for the use of hardened and ground bushings. A plain 1-inch collet is furnished unless otherwise ordered.

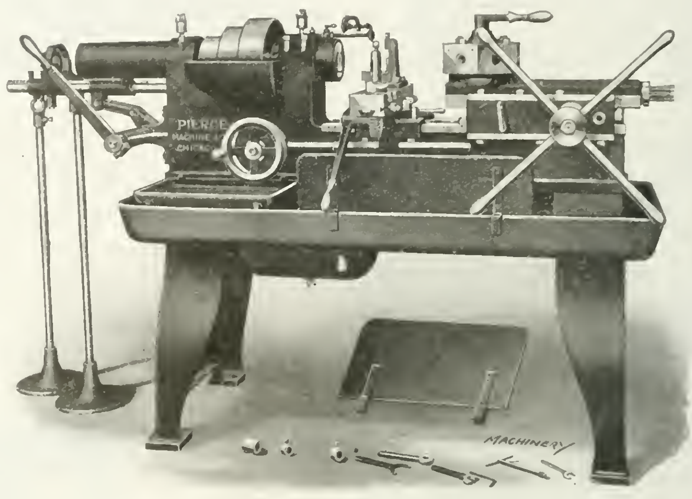


Fig. 1. Pierce 1- by 8-inch Heavy-pattern Turret Screw Machine with Plain Head

The cut-off rest is fitted with a convenient locking clamp, hand longitudinal screw feed adjustment with a micrometer dial, and means of adjusting the cut-off rest along the bed for facing, necking and similar operations. Feeding of the cut-off slide is through a rack and pinion which work in conjunction with adjustable stops. When so desired, screw cross-feed can be furnished in place of the rack and pinion feed. It will be seen that the turret is of hexagonal form, providing for the use of six tools. The holes are fitted with binder bushings unless set-screws are especially ordered. In addition, each face of the turret is provided with tapped holes for use in securing tools to the turret faces. The turret holes are counterbored to provide for receiving a boss on the back of each tool, an arrangement which permits of the accurate location of tools and the maintenance of exact alignment. The turret is automatically indexed by the backward movement of the slide, which is governed by the pilot wheel. The locking bolt is located at the front end of the slide directly beneath the cutting tool, and enters a hardened and ground taper bushing fitted into the solid turret as near the periphery as possible. Independent adjustable stops operate automatically for each position of the turret, and if desired, provision may be made for automatically releasing the power feed. A lever at the back of the saddle allows the turret to travel slightly beyond each stop when so desired, without altering the arrangement of the stops; this is a convenient feature, as it does away with trouble that would otherwise result through slight inequalities in the stock.

Positive power feed for the turret slide can be furnished as special equipment, giving four changes of feed, any of which is instantly obtainable by operating a lever located at the front of the head. The turret saddle and slide are made of ample width, and tapered gibs are fitted over the entire length of the saddle, thus providing convenient means of taking up wear. The saddle is arranged on an adjustable tapered base, by means of which perfect alignment of the turret holes with the center of the spindle can be maintained. A geared oil pump driven by a belt from the countershaft delivers an abundant flow of oil to the cutting tools, and operates when the machine is running in either direction. The oil- or chip-pan has ample capacity, and the oil-tank is cast integral with the pan, the tank being of sufficient size to hold a liberal supply of oil. It is furnished with a perforated cover which acts as a strainer and allows the oil to drain back into the tank. The countershaft is of the double friction type with ring oiling bearings. Standard equipment furnished with the machine includes an automatic chuck with one collet, a stock feed with two supports, a hand longitudinal cut-off rest with front and back tool-

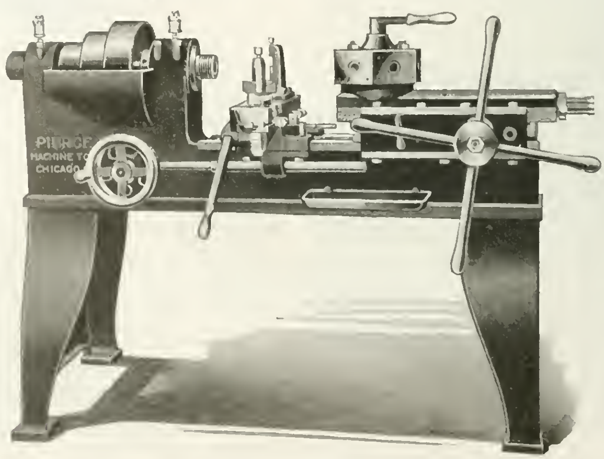


Fig. 2. Machine shown in Fig. 1, without Collet, Bar-feed and Stock Support, making 14-inch Turret Lathe

posts, a hexagon turret with binder bushings, an oil-pan and pump, a tool tray, front and back splash guards, a countershaft and the necessary wrenches for making all adjustments.

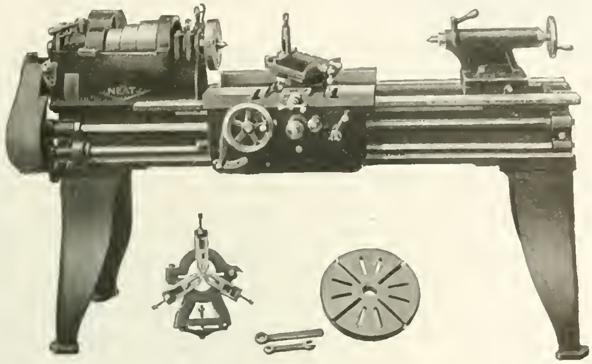
The principal dimensions of this machine are as follows: capacity of automatic chuck, for round stock up to 1 1/16 inch in diameter and for square stock up to ¾ inch; capacity for handling threaded work, up to ⅝ inch in soft steel, and up to 1 1/16 inch in brass; capacity for drilling in soft steel, up to ¾ inch in diameter; diameter of hole in automatic chuck plunger, 1 3/32 inch; diameter of hole through spindle, 1 5/16 inch; maximum length of work that can be turned, 8 inches; swing over bed, 14⅛ inches; swing over cut-off slide, 6 inches; maximum distance from end of spindle to face of turret with saddle flush, 16½ inches; diameter of holes in turret, 1 inch; size of tapped holes in face of turret, ⅜ inch; distance from center of turret holes to top of slide, 2⅜ inches; maximum cross travel of cross-slide, 6 inches; maximum longitudinal travel of cross-slide, 8½ inches; available power feeds to turret in revolutions of spindle corresponding to 1 inch of feed movement, 24, 40, 66 and 120; width of driving belt, 2½ inches; size of cut-off tool, 1 by ½ inch; extension of bar feed-rod, 3 feet, 4 inches; spindle speed for a countershaft feed of 200 revolutions per minute, 180, 285 and 480 revolutions per minute; horsepower required, 1½; floor space occupied, 2 feet, 2 inches by 5 feet; and net weight of machine without power feed for turret, 1350 pounds.

Fig. 2 shows the same machine without the collet chuck, bar feed and stock support, making a 14-inch heavy-pattern turret lathe. The design of this machine is thoroughly covered by the preceding description of various features of the hand screw machine, so that no further information is necessary to give the reader a comprehensive understanding of its various features.

"NEAT" HIGH-POWER LATHE

The National Engineering & Tool Works, 1132-1134 William St., Oak Park, Chicago, Ill., has developed what is known as the "Neat" high-power 14-inch tool-room and manufacturing lathe. As its name implies, this lathe is intended for both tool-room and general shop work, and to adapt it for heavy service all parts are liberally proportioned. The machine is driven by a three-step cone pulley and double back-gears, with a shifter lever for quickly changing the speeds. Located on the apron there is a feed-change lever; and by simply moving this lever to any one of the four positions, any of the changes of feed may be instantly obtained. The feed-rod is driven direct from the headstock by a train of gears and a safety friction is provided which will slip before damage can be done to the gears or other parts of the feed mechanism. This safety friction also provides for working the lathe to its maximum capacity without danger, as the friction will slip and prevent damage in case the tool strikes an exceptionally hard spot in the work.

The quick-change gear feature has been eliminated in designing this machine, and an unusually large number of change-gears are furnished, which makes it possible to cut a great variety of thread pitches, ranging from very coarse pitch of one thread per inch down to the finest pitches ordinarily cut on a lathe of this size. The headstock is of the "bowl" type which forms a direct support between the front and rear spindle bearings. The spindle is made of 60-point carbon crucible steel and is bored No. 3 Morse taper; it is carried in bearings lined with bronze and accurately scraped to fit the spindle. The tailstock spindle is also made of steel and is 1¾ inch in diameter. The apron, including the bearings, is cast in one piece which gives a stiff, strong construction. The design is worked out in such a way that it is impossible to throw in the half nuts when either feed is engaged. The regular equipment includes a compound rest, steadyrest, change-gears, large and small faceplates, a double friction countershaft and the necessary wrenches for making all adjustments.



"Neat" 14-inch Tool-room and Manufacturing Lathe built by National Engineering & Tool Works

The principal dimensions of the machine are as follows: swing over shears, 14⅝ inches; swing over carriage, 7 inches; maximum distance between centers for a 6-foot bed, 36 inches; maximum tailstock travel, 8 inches; diameter of hole through spindle, 1⅜ inch; capacity for thread cutting on standard lathe, 1 to 48 threads per inch; capacity for thread cutting with double compound gears, 1 to 80 threads per inch; width of driving belt, 2½ inches; ratio of back-gears, 3 to 1 and 8 to 1; size of tool used, 1¼ by ⅝ inch; and weight of machine with 6-foot bed, 1400 pounds.

LEHMANN ENGINE LATHE

In general respects the design of this machine follows standard practice. One of the most important features is the arrangement of the quick-change gear mechanism which consists of the familiar cone of gears and a sliding rocker arm with two central gears of different ratios. By dropping this rocker arm one set of changes is obtained, and by raising it the next progressive set of changes is obtained. Forty-eight changes are available for thread cutting and the same applies to the number of feed changes. The machine swings 18¼ inches over the ways and 12 inches over the carriage; work up to 5 feet in length can be held between centers, and the weight of the machine is approximately 3120 pounds.

The Lehmann Machine Co., 606-612 South Broadway, St. Louis, Mo., has recently placed on the market the 16-inch by 9-foot engine lathe illustrated and described herewith. The bed is braced by cross ribs to give ample rigidity, and the ways are chilled to insure durability and permanence of alignment. All bearings fastened to the bed are doweled in position on planed

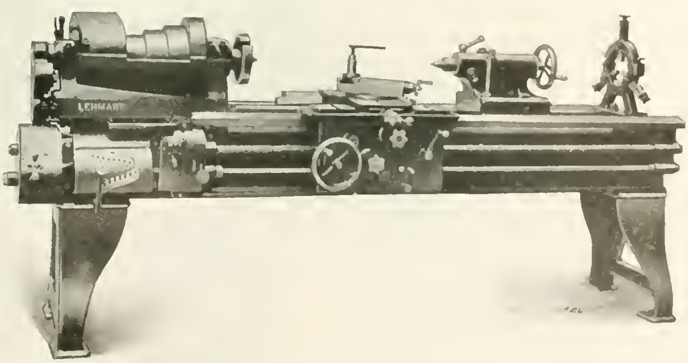


Fig. 1. Lehmann 16-inch Double Back-geared Engine Lathe

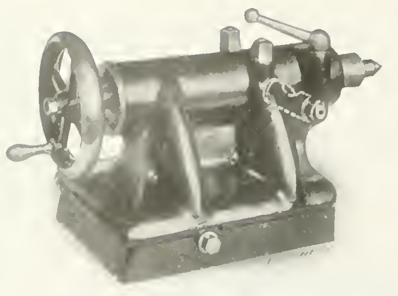


Fig. 2. Tailstock of Lehmann Lathe, showing Improved Spindle Locking Device

bosses. The vees have an included angle of 90 degrees; and the end of the bed is cut away to permit overhanging of the tailstock or placing a steadyrest at the extreme end of the bed. This also facilitates removal of the tailstock or steadyrest. It will be seen that the headstock is cast in such a way that the metal extends straight across from the front to the rear spindle bearing on a line with the spindle, thus tying the bearings together to give plenty of rigidity and serving as a guard to protect the operator from danger of being caught by the belt. The drive is through a three-step cone pulley and double back-gears which give nine changes in geometrical progression.

The spindle is made of high-carbon steel, bored from a solid forging and ground to the required outside diameter. The bearings are lined with phosphor-bronze and positively lubricated; they are securely held in place but may be readily renewed when so required. End thrust is taken by a bearing composed of alternate steel and fiber washers. The tailstock is clamped to the bed by bolts brought up to the top of the barrel. The tailstock spindle is provided with an improved locking device, which consists of a heavy plug shown in outline on the tailstock in Fig. 2, this plug being located in a bearing below the spindle. The plug is made concave to fit the spindle and rests at one end on a shoulder of large diameter, being free to move up against the spindle; the other end extends beyond the back of the tailstock casting and fits into an eyebolt which is suspended from an overhanging lug. The locking handle is located above the lug and is threaded to the eyebolt. A movement of the handle draws the plug up against the bottom of the spindle, and a slight pressure securely locks the spindle in place. The barrel is not slit.

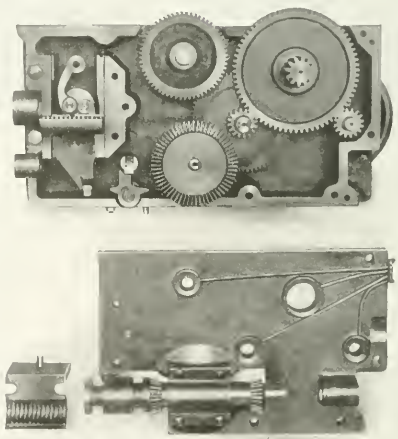


Fig. 3. Arrangement of Gearing in Apron which is of Double Plate Type

The carriage has a wide bridge which insures rigidity under heavy cuts, and is provided with an oil trough that returns the cutting lubricant inside the vees. Shear wipers are fastened to the carriage to keep the vees clean and amply provided with lubricant. The compound rest is of large diameter and heavily built. It is graduated for any angle up to 90 degrees, and is securely held in the bottom of the slide by bolts which are located at a considerable distance from the center and provide ample hold; these bolts are readily accessible at any time. The apron is tongued and grooved to the carriage and provided with a back-plate that gives a double support for all studs and a double bearing for the running shafts. The lead-screw and feed-rod have bearings in the apron to prevent sagging and undue wear on the half nuts and reverse gears. Gears and pinions, except the friction gears, are made of steel and the studs are hardened and ground. A safety device makes it impossible to engage the lead-screw and feed-rod at the same time.

The quick-change mechanism is so designed as to simplify the construction and double the range with the addition of only two gears. A cone of gears with the familiar type of sliding rocker arm is employed, but the rocker has two central gears of different ratios, each with an intermediate gear. By dropping the rocker one set of change-gears is engaged, and by raising the rocker the next progressive set of changes is obtained. This brings the device to a form where all changes commonly used are made by a movement of the rocker arm. For uncommonly fine or coarse threads and feeds, it is only necessary to throw another handle to the right or left. The lathe has a capacity for cutting forty-eight different threads from 2 to 112 per inch, with an equal number of feed changes. The gears are made of steel and the shafts of high-carbon steel, the latter being ground to size after being hardened. The whole quick-change mechanism is a single unit located within a housing that is held on the bed by dowel pins and four screws. It can be easily removed or replaced in a few minutes. The lead-screw is made of high-carbon steel and has a 4-pitch Acme thread. It is provided with a ball thrust bearing which reduces the gear strain; this is an advantage especially when cutting coarse pitch threads and worms. The feed-rod is not running when screw cutting operations are being done; and similarly, the feed-screw is not running when the feed-rod is employed. An adjustable collar on the feed-rod serves as an automatic stop for the carriage feed, and also as a safety. The steadyrest is of improved design, all adjustments and locking being accomplished by star handles. It can be reversed on the bed so that the tool may be run up close from either side.

The principal dimensions of the machine are as follows: swing over shears, 18¼ inches; swing over carriage, 12 inches; maximum capacity for work between centers, 5 feet; travel of tailstock spindle, 7½ inches; diameter of tailstock spindle, 2¼ inches; taper of centers, No. 4 Morse; size of front spindle bearing, 2⅞ by 5 inches; size of rear spindle bearing, 2 1/16 by 4 inches; diameter of hole through spindle, 1 5/16 inch; diameter of spindle nose, 2½ inches; width of driving belt, 3 inches; diameters of cone pulley steps, 6 2/3, 8 1/3 and 10 inches; ratio of first back-gears, 3.33 to 1; ratio of second back-gears, 11 to 1; countershaft speed, 200 to 245 revolutions per minute; spindle speed, 12 to 367 revolutions per minute; number of thread and feed changes, 48; size of tool used, ⅝ by 1¼ inch; size of steadyrest opening, 6 inches diameter; and weight of machine, approximately 3120 pounds.

AUTOMATIC STEEL HARDENING AND TEMPERING MACHINE

The machine which forms the subject of the following description was designed to provide for automatically and uniformly hardening and tempering steel products—especially small, thin pieces. The design provides for passing the work continuously through the machine, and large numbers of parts can be handled rapidly and economically. The operation is under electrical control by means of a device which may be

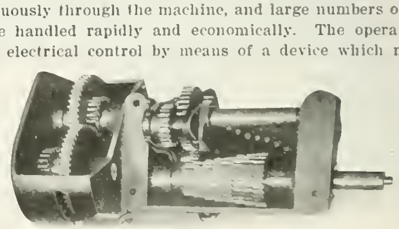
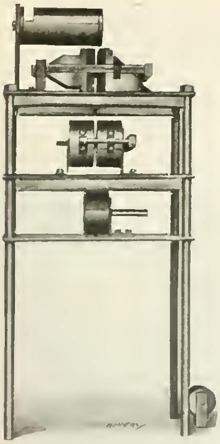


Fig. 4. Arrangement of Gearing in Quick-change Gear-box



Automatic Hardening and Tempering Machine built by American Electric Process Steel Co.

regulated to adjust the rate at which the work is passed through the machine and the duration of its retention in the various heating and cooling mediums. This electrical control is very accurate and may be adjusted to suit the size of pieces which are to be heat-treated and the composition of steel of which they are made.

If so desired, the machine may be enclosed in a muffle; and it is provided with a receptacle to contain the steel articles to be heat-treated, from which the work is automatically removed and permitted to fall between the heating blocks one piece at a time. These blocks are preferably heated by gas, and the work is compressed between them and held until properly heated, after which the blocks are opened and the heated steel product dropped down between the water-jacketed cooling blocks, by which it is caught and held until the steel has been cooled and hardened. Then the cooling blocks are opened and the hot steel product falls down into a tempering chamber in which it is retained until its temperature has been raised to the required degree, when it is released and allowed to fall into a cooling medium, which may be of any form suited to the requirements of the steel being tempered.

In this way steel products may be continuously passed through the machine until the required physical properties have been obtained. The heating and cooling blocks may be so shaped that they receive work of special form; and suitable guides may be provided to guide work of any form from the conveyor to the heating and cooling blocks. A special type of machine is designed to automatically harden or harden and temper large steel articles. The machine shown in the illustration is without electrical and gas connections. This machine possesses several advantages in hardening and tempering steel, among which the following may be mentioned: It is claimed to be impossible to overheat or burn the steel, and there is no danger of underheating the steel so that it will be left too soft.

The degree of hardness obtained is uniform throughout the work, and the method of holding prevents it from being distorted while hardening. Tempering is effected automatically and its results are sure; there is no mechanical contact between the work and parts of the machine, except the contact between the work and the heating and cooling blocks, and the plate in the tempering chamber. Consequently, there is no danger of heat being absorbed from certain parts of the work which would result in a lack of uniformity in its hardness. Efficient means are provided for accurately governing the temperatures of the heating, cooling and tempering mediums, as well as the automatic operation of the machine. This hardening and tempering equipment is a recent product of the American Electric Process Steel Co., 200 Devonshire St., Boston, Mass.

NATIONAL ELECTRIC WELDER

An instance of the way in which the field of electric welding can be extended is represented by a special spot-welding machine that was developed and built by the National Electric Welder Co., Dana Ave., Warren, Ohio, for use in the assembling department of a factory making a specialty of pressed steel forms. This welding machine is wholly automatic in its operation.

Power is delivered through a train of gears from a two-horsepower motor mounted on the base of the machine and running at 1200 revolutions per minute. The work is run through the machine in twelve-foot lengths; and spot-welds on each side are automatically made at the rate of forty per minute. A cam operates a ratchet gear, which, in turn, operates the friction rollers that carry the work through the machine. During the interval between ratchet gear movements, the welding points are brought into contact with the work by means of a second cam.

The welding points are water cooled, the temperature and flow of the water being indicated in the drip cup through which the water passes as it flows from the cooling system to the waste pipe. Despite the seeming complication of parts, the machine is exceedingly simple in operation, so much so, in fact, that it would require actual abuse to impair its efficiency. To provide against abuse, the machine is made unusually sturdy, and liberal provision has been made for carrying emergency overloads.

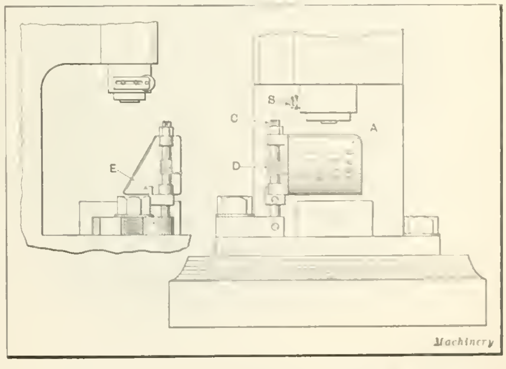
"WARNER" WORK-TABLE

The "Warner" work-table shown in the accompanying illustration is of simple construction and capable of standing up under hard conditions of service. The table is made of cast iron and supported by wrought-iron legs and babbitted joints. This type of table is a great convenience, enabling workmen to keep their tools and work in a convenient position, thus eliminating time lost in looking for misplaced tools or work. The table is particularly adapted for use in tool-rooms, machine shops and garages, and is furnished with two or more trays which are 19 by 25 inches in size. The ordinary table stands 32 inches above the floor and the total weight is 110 pounds. These tables are made both with and without castors. They were originally designed for use in a well-known manufacturing plant where they proved so economical that arrangements were made by J. L. Lucas & Son, Bridgeport, Conn., to manufacture them for the general market.

"Warner" Work-table manufactured by J. L. Lucas & Son

LEGAT PUNCH PRESS SAFEGUARD

The punch press safeguard which forms the subject of the following description was invented by R. C. Legat, and the G. E. Prentice Mfg. Co., New Britain, Conn., is now engaged



Legat Punch Press Guard made by G. E. Prentice Mfg. Co.

in its manufacture. It will be seen that this safeguard consists of a swinging plate or shield *A* which is pivoted at one side. This plate is inclined at an angle, as shown in the side view; carried on the ram of the press is a roller *B* which comes into contact with the inclined guard plate as the ram descends. While the ram is up, the operator can conveniently reach under the inclined guard plate to place work in the die; but when the ram starts to descend, roller *B* comes into contact with the inclined plate causing it to swing about pivot *C*. Should it happen that the operator neglects to remove his hand from the die when he trips the press, the forward movement of guard *A* about its pivot will result in sweeping his hand off the die so that it cannot be caught by the punch.

One end of spring *D* is secured to pivot post *C* and the other end to guard plate *A*. As a result, the spring provides for holding the guard plate back against roller *B*; and as the ram of the press rises, spring *D* returns the guard plate to the starting position. Referring to the side view of the machine equipped with this guard, it will be seen that a stop *E* is provided to limit the backward movement of the guard plate after it is released by the roller on the ram. With a power press equipped in this way, it is practically impossible for an operator to be injured; and its efficiency is attested to by the fact that the Aetna Liability Insurance Co., of Hartford, Conn., has volunteered to rebate $1.75 for every press equipped with a guard of this kind. The guard can be quickly applied to any make of press, without the necessity of changing it in any way.

TUCKER ROD CUTTER AND SHEAR

The accompanying illustrations show a No. 2 shear and rod cutter and a No. 3 shear which are recent additions to the line of machines built by W. M. & C. F. Tucker, Hartford, Conn. In designing these machines, particular attention has been paid to the development of a construction adapted for resisting all strains incident to the operation of machines of this type. All points where pressure is applied have rolling contacts in order to reduce friction to a minimum.

Cutters for the round iron rods are bushings made from cast steel, and they are carefully tempered and held in place by set-screws. Three sets of bushings accompany each machine. Bushings and blades are carried in stock and can be furnished at short notice. The shear blades have a drawing cut, and consequently there is no tendency to crowd the work out of the shear. The blades are made of tool steel and backed up with wrought iron, the design being such that they may be easily removed for sharpening. The movable blade is raised by a steel band which dispenses with the use of a spring. The No. 2 shear and rod cutter is provided with a gage for cutting rods to any desired length. Flat stock may also be cut to any length. The shears operate continuously if so desired.

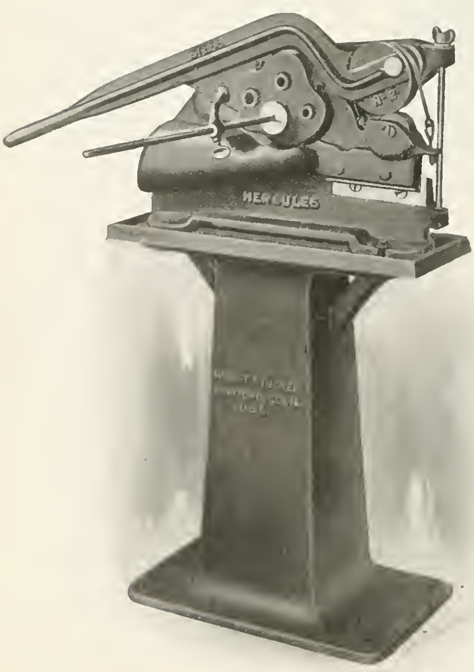


Fig. 1. W. M. & C. F. Tucker No. 2 Shear and Rod Cutter

Fig. 2. W. M. & C. F. Tucker No. 3 Shear

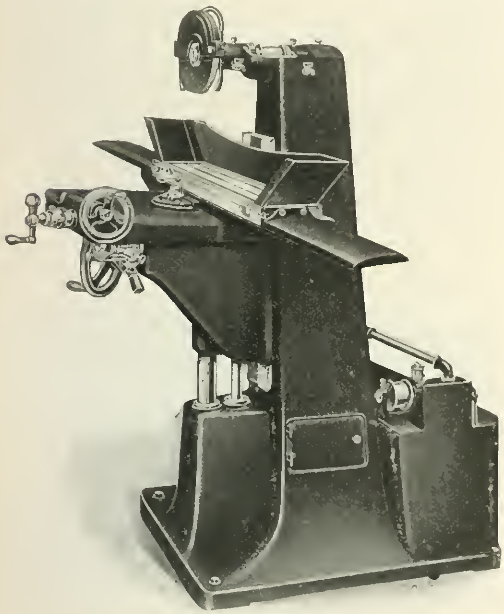
GRAYSON SURFACE GRINDER

The Grayson Tool & Mfg. Co., Indianapolis, Ind., has been engaged for years in the making of dies, tools, gages, etc., and the experience gained in handling this work has been applied in the design of a new surface grinder recently developed by this company with special reference to the requirements of tool-room work. It is generally conceded that the spindle and spindle bearings of a grinder are two of its most important members; and in the new Grayson surface grinder the spindle is made of hardened and ground high-carbon steel which is required to show a hardness of 90 on the scleroscope. In making the spindle, the method of manufacture is conducted in such a way that the threads are chased after the taper part has been hardened and ground; and this eliminates trouble due to distortion of the threads during the hardening operation. The spindle bearings are lined with phosphor-bronze and reamed to fit standard taper plug gages. After running for ten hours, the head is taken apart and the bearings are scraped to master taper plugs. Lubrication of the spindle bearings is provided by four birchwood oilers, which carry a continual supply of oil to the bearings from a reservoir located in the head.

The longitudinal reciprocating movement of the table is 20 inches and the transverse movement $6\frac{1}{4}$ inches, both of these movements being automatic; and all slides are carefully protected to avoid damage from abrasive dust. The vertical slide

on the column is chilled at the time the casting is made in order to close the grain of the metal. The knee has felt wipers which insure keeping the slides and ways clean. Power is provided by a two-step cone pulley at the end of the wheel-spindle, which drives a hardened steel worm and phosphor-bronze worm-wheel that transmit motion to a vertical shaft which is parallel to the elevating screw. This shaft drives a nest of bevel gears; and the automatic reversal is obtained by two adjustable dogs on the table that operate a hardened steel clutch. The dogs are provided with a spring cushion which makes the reversal almost silent.

The machine is equipped for performing both wet and dry grinding operations. It has been the experience of the Grayson Tool & Mfg. Co. that surface cracks are likely to develop on fine gage work, due to overheating the surface of the steel while the interior remains cool. This difficulty is overcome by grinding the work wet in order to dissipate the heat generated by the grinding operation. On the other hand, when grinding gages and other parts where it is necessary to work to very close limits, it is advisable to grind the work dry.



Surface Grinder made by Grayson Tool & Mfg. Co.

Three spindle speeds are provided to enable the operator to get approximately the same cutting speed when using a 3-inch wheel that he would properly employ when an 8-inch wheel is used on the machine. These are obtained by the use of a three-speed countershaft. There are two rates of table speed.

NEWTON DUPLEX KEYSEATING MACHINE

The Newton Machine Tool Works, Inc., Philadelphia, Pa., is now building a duplex keyseat milling machine which has a high rate of production due to the double spindle feature that eliminates the time ordinarily required for laying out the work where two keyseats are to be cut in opposite sides of a shaft. The spindles are carried in double taper bearings which are 2 11/16 inches in diameter at the large end and 1 5/16 inch through the driving section; the spindles are fitted with draw-in collets. Automatic feed is provided for the spindle heads, with safety release for use in connection with cottering operations; the maximum feed per stroke of the table is 1/16 inch. Four changes of geared speed are provided for the spindles, without requiring the removal of

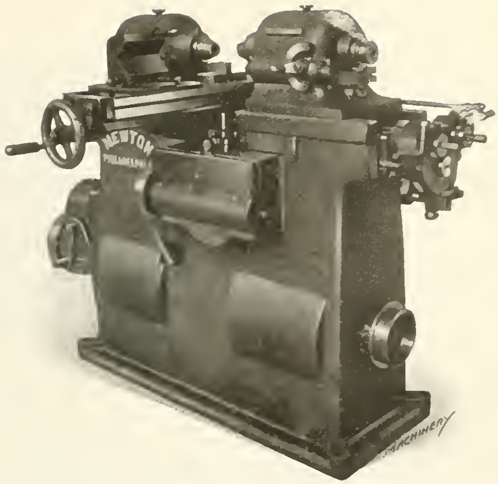


Fig. 1. Duplex Keyseating Machine built by Newton Machine Tool Works

gears; in addition, there are back-gears on each head which afford additional changes of speed, making the entire speed range from 300 to 1465 revolutions per minute, with a total of eight changes.

The single driving pulley is 10 inches in diameter by 2¼ inches face width and runs at 735 revolutions per minute. Drums 12 inches in diameter by 8 inches face width are mounted on the driving pulley shaft inside the base, and connection is made by belts to the spindles on which the back-gears are located. High spindle speeds are obtained by open belts, and the slow spindle speeds through the back-gears. The work-table is 44 inches long over all, and has a working surface 38½ by 9 inches. Three changes of feed are available, which may be either continuous for the milling of long splines or automatically reversed for performing cottering operations. The maximum diameter of shafts which can be handled in this machine is 4 inches, and the available feeds and speeds are suitable for cutting keyseats from ⅛ to ¾ inch wide.

The principal dimensions of the Newton duplex keyseating machine are as follows: maximum cross-feed for carriage,

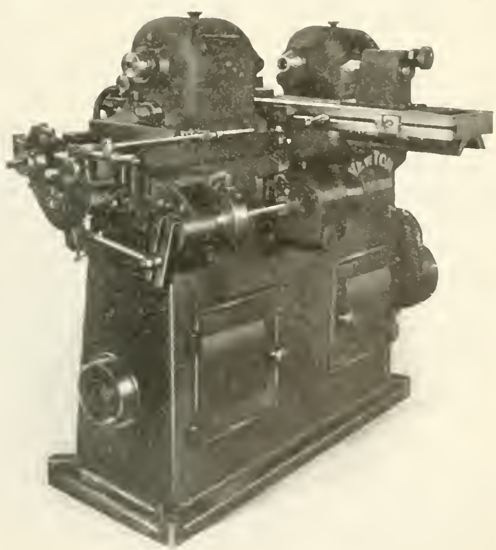
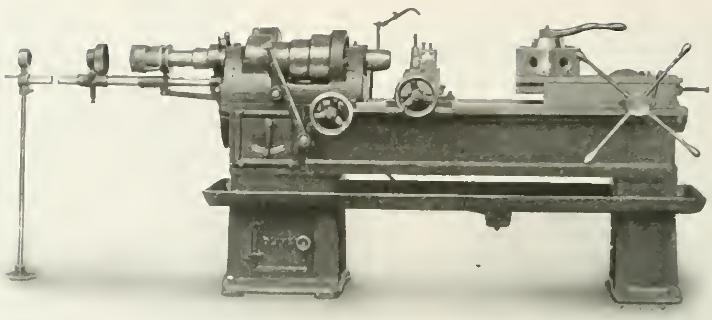


Fig. 2. Opposite Side of Newton Duplex Keyseating Machine shown in Fig. 1

24 inches; height from table to center of spindles, $3\frac{1}{2}$ inches; distance between ends of spindles, from 0 to 10 inches; size of countershaft pulley, 20 inches in diameter by $2\frac{3}{4}$ inches face width; speed of countershaft, 365 revolutions per minute; and net weight of machine, 3000 pounds. For use in connection with this machine, a fixture has been developed for the Newton slotting machine to provide for cutting both internal keys at one time, thereby insuring an accurate fit of the keys on all sides. In addition to saving time, this dispenses with the necessity of first shaping out one keyseat and then laying out the other keyseat for the operator, which was a slow job at best.


Oliver No. 47-W Screw Machine—Same Machine is equipped as Turret Lathe

OLIVER TURRET LATHE AND SCREW MACHINE

The machine shown in the accompanying illustration is made in two different types by the Oliver Machinery Co., Coldbrook and Clancy Sts., Grand Rapids, Mich. One of these is known as a No. 47-W machine and is equipped with a wire feed attachment for screw machine work. The other is known as No. 47-T and is equipped as a 16-inch turret lathe. General features of both machines are the same and the following description applies to both types.

The No. 47-W type for handling bar stock has a capacity for work up to $2\frac{1}{4}$ inches in diameter and up to 10 inches in length. The stock is handled by means of an automatic chuck and tool steel spring collet; and the necessary tool equipment may be furnished for handling the various classes of work for which this machine is adapted. Box-tools, boring and facing tools, self-opening threading die-heads, cut-off tools, drills, reamers, etc., may be supplied with the machine in addition to special tools designed for individual classes of work.

The cross-slide is equipped with a $2\frac{1}{4}$-inch forming tool-holder and a standard No. 4 tool-holder. A handwheel with micrometer dial reading to 0.001 inch controls the longitudinal feed for the cross-slide, and a similar handwheel controls the cross-feed. Multiple stops are furnished with the turret slide acting on each face of the turret.

These are heavy-duty machines, and ample power is provided to enable them to take heavy cuts at high speed. The spindle bearings are lined with babbitt and the spindle is driven by a three-step cone pulley and double back-gears. The spindle bearings are lubricated by means of felt wipers which dip into oil reservoirs in the head. The bed is of a reinforced box-section type and the supporting columns are placed at the extreme ends so that there is no overhang. The standard bed furnished on these machines is 7 feet, 2 inches long, 13 inches deep and 15 inches wide.

The hexagon turret measures 12 inches across the flat and the holes for the tools are $2\frac{1}{4}$ inches in diameter. In addition to the tool holes, there are four tapped holes on each face of the turret to provide for securing tool-holders or other special equipment in place. By forcing the turret slide back by means of the handwheel, the locking plunger is automatically released and the head revolves to the next station. The turret is geared to the spindle and may be operated by positive power feed if so desired; to change to hand feed it is merely necessary to trip the power feed lever, dropping the worm out of mesh with the worm-wheel. Gears supplied with the machine provide for obtaining four rates of feed, direct connection being made between the spindle and gear-box by means of a chain drive. A shearing pin protects the gears from damage due to overload.

The cross-slide is 6 inches wide and is adjustable for wear by means of a tapered gib. A large handwheel and coarse cross-feed screw provide for obtaining rapid and powerful cross-feed. The pan is made of pressed steel and is arranged to drain into a cast-iron pot, which is connected with a rotary pump, a copper screen preventing chips from being drawn into the oil or cutting lubricant and thus stopping the pump. The regular equipment consists of a double friction countershaft, cross-slide with toolpost and forming tool-holder, pump, piping, flexible hose, steel chip pan and wrenches.

SLEEPER & HARTLEY SPRING COILER

Sleeper & Hartley, Inc., 68 Prescott St., Worcester, Mass., has recently added to its line of universal spring coilers a No. 5 machine which has a capacity for winding springs from oil tempered stock $\frac{5}{8}$ inch square. It is believed that this is the largest cold spring coiling machine ever built; it occupies a floor space of 6 by 8 feet, and weighs approximately 16,000 pounds. The machine coils the spring and cuts it off automatically, working at a speed of about 50 feet per minute. It is adapted for making either extension or compression springs, and it is possible to feed as much as 100 feet of wire into a single spring.

The most interesting feature of the design of this machine is that the spring is not produced by being coiled around an arbor, the coiling being done by forcing the wire forward through feed rolls until it strikes a coiling point or "deflector." Provision is made for feeding a predetermined

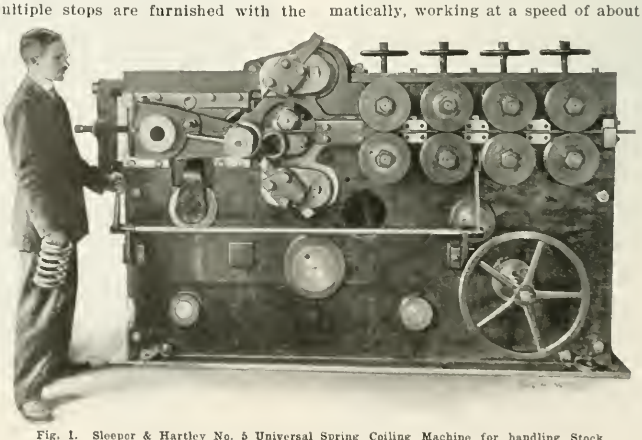


Fig. 1. Sleeper & Hartley No. 5 Universal Spring Coiling Machine for handling Stock up to $\frac{5}{8}$ Inch Square—believed to be Largest Spring Coiler ever built

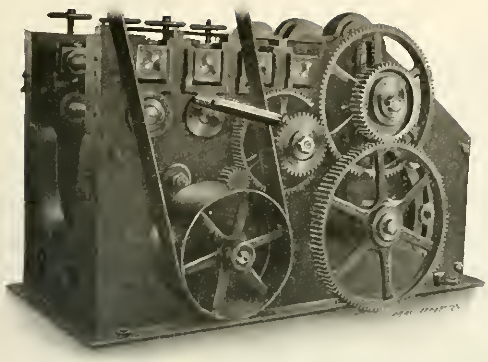


Fig. 2. Opposite Side of Sleeper & Hartley No. 5 Spring Coiler shown in Fig. 1

amount of wire into each spring. The operation is automatic, the machine coiling and cutting alternately; the coiling mechanism is stopped while the spring is being cut off, and *vice versa*. The only function of the arbor is to provide a cutting edge against which the exterior cutter may carry the wire for the purpose of shearing it off after the winding of the spring has been completed. Adjustment is provided to govern the amount of wire fed into any one spring, and also to regulate the diameter and pitch of the spring, as well as its contour. Changes in either of these features of the work may be instantly made by means of adjustments on the machine.

Variations in the rate of feed are obtained by means of change-gears, and the feed may be closely regulated by an

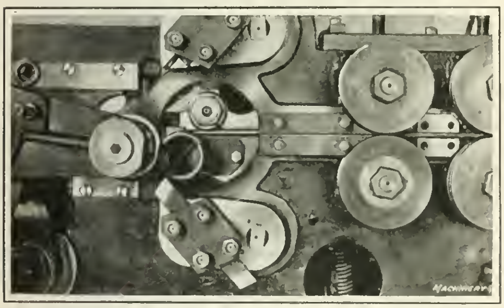


Fig. 3. Close View of Coiling Mechanism on Sleeper & Hartley No. 5 Spring Coiler

adjustable cam which controls an automatic clutch. The diameter and contour forming mechanism is also controlled by means of a cam, a single cam only being needed to produce any kind of tapered spring; and a pair of cams provides for producing every conceivable variety of barrel shaped springs. The pitch is automatically controlled, and springs may be either produced with an open spiral or the end coils may be "flatted" or "laid close" to as great an extent as desired. The machine may be changed over from one type of spring to another in from ½ to ¾ hour. It will be obvious that next to the ability to form springs of any desired contour, the greatest advantage of this machine is the ability to control the pitch and to be able to produce springs with squared ends, thereby eliminating the costly method of squaring the ends of the springs by a subsequent heating and pressing operation.

CODD CHAIN FURNACE DOOR

Anyone who has fired a furnace knows the discomfort experienced when it is necessary to open the door of the firebox to stoke the fire or shovel in more coal. But the discomfort to the fireman is not the only bad feature of this condition. Very little thought is required to show that as soon as the furnace door is opened, cold air rushes in and reduces the temperature of the fire; and this is indicated by a falling off of the indication of the pressure gage when the door of a boiler furnace is left open for any considerable length of time. Also, this reduction of temperature causes the heated furnace lining and other parts to shrink, the shrinkage being frequently followed by cracking of the brickwork. In conducting various metallurgical processes such as the heat-treatment of steel, a reduction of temperature due to heat lost through opening the furnace door is liable to result in a lack of uniformity of the product.

With the view of overcoming trouble from this source, the E. J. Codd Co., 700-708 S. Caroline St., Baltimore, Md., has developed the "Wiegand" chain screen door for furnaces, which is shown in the accompanying illustrations. It will be seen that this consists of a number of small chains which

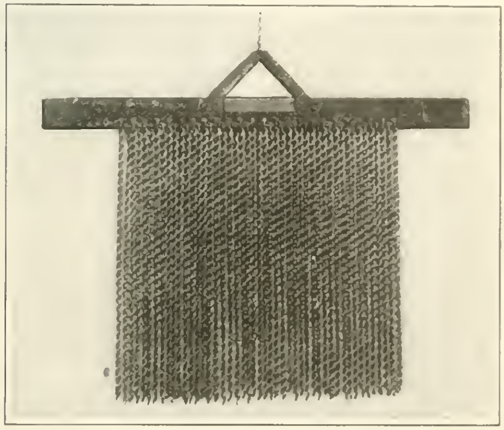


Fig. 1. "Wiegand" Chain Screen Door for Furnaces made by E. J. Codd Co.

hang loosely in front of the furnace door. These chains keep the hot air in and the cold air out of the furnace, but enable the fireman to shovel in coal or stoke the fire without personal discomfort and without lowering the temperature of the fire to a serious extent.

For the purpose of establishing the efficiency of this form of door, the following experiment was conducted. A thermometer was fixed on a standard in the fire room at a point opposite the furnace door and 10 inches in front of it. This position was selected as being one often taken by the fireman in stoking or cleaning the fire. When the ordinary fire door

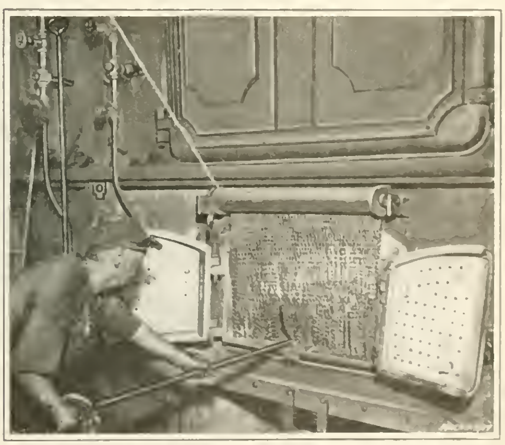


Fig. 2. Application of "Wiegand" Chain Screen Door on Boiler Furnace

was thrown open and the incandescent fire bed exposed, as is the case wherever the furnace is fired or cleaned, this thermometer rose until a temperature of 400 degrees F. was indicated. On covering the furnace door with the "Wiegand" chain screen door, the temperature at once dropped 265 degrees until a constant temperature of 135 degrees F. was indicated; and under this condition the bare hand could be held anywhere in front of the screened opening without experiencing discomfort. This indicates that a great quantity of heat lost by radiation and convection through the ordinary uncovered furnace opening may be saved by the employment of a chain door of this type. The heat intercepted by the chain composing the screen is returned to the furnace instead of being wasted, as the air which actually enters the furnace through the chain door takes up the heat that has been absorbed by the chain and carries it back into the combustion chamber. This chain door forms a flexible penetrable transparent sheet which does not interfere with inspection of the interior of the furnace. •

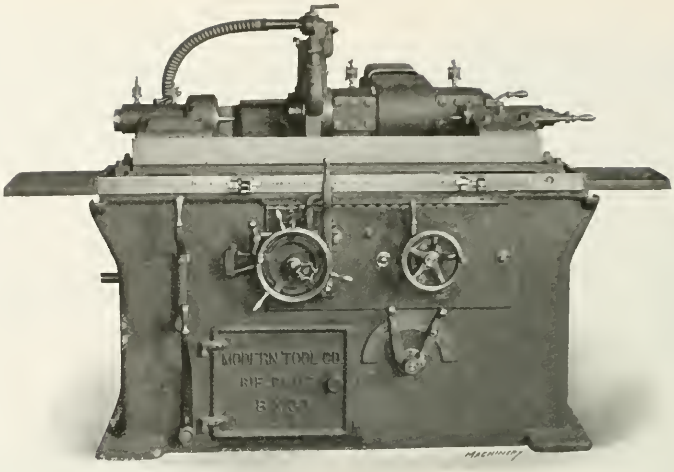


Fig. 1. Front View of Modern 8- by 30-inch Self-contained Grinder, with Heavy Type of Drive

MODERN SELF-CONTAINED GRINDING MACHINES

Noticeable features of these machines are the comparative simplicity of the mechanism, location of all control levers within easy reach of the operator, and a compact design which economizes floor space as far as possible. The machines are made in 8- by 18-inch and 8- by 30-inch sizes, but the design of both is essentially the same with the exception of the fact that a "heavy-duty" type of drive may be furnished when the larger machine is to be used for exceptionally heavy work. These are manufacturing machines, and are adapted for grinding straight or taper cylindrical work in large quantities.

The Modern Tool Co., 2nd and State Sts., Erie, Pa., has added to its line of self-contained grinding machines the 8- by 18-inch and 8- by 30-inch grinders shown in the accompanying illustrations. Fig. 1 shows a front view of the 8- by 30-inch machine, and Fig. 5 shows a front view of the 8- by 18-inch grinder. With the exception of the center distances and details of the wheel drive, the two machines are similar, and the detailed description which follows is applicable to both. Economy of floor space, ease of operation, and comparative simplicity of the mechanism are distinguishing features of these machines. All operating levers are concentrated at the front, and nothing extends above the wheel stand, all mechanism being contained within the machine.

These are essentially manufacturing grinders, and they are adapted for finishing straight or taper cylindrical work in quantities. All parts are accessible, so that they can be properly cared for without unnecessary expenditure of time, which is a factor in keeping up the rate of production. The bed is a one-piece casting, rigidly braced to insure stability.

It is of compact design and the units are so located as to be easily accessible. Vee and flat guides are used on the sliding table, swivel table and under the wheel stand, insuring perfect alignment of all parts. The base rests upon three points, preventing cross strain, preserving alignment and providing for irregularities in floor level.

These machines are provided with an exceptionally powerful drive, liberally proportioned spindles and bearings of ample size. The standard wheel-spindle is 2¼ inches in diameter; it runs in phosphor-bronze bearings 6¼ inches long, and is driven by a belt 4 inches wide. However, as there are instances where the machines will be required for exceptionally heavy service, they can be furnished with a wheel-spindle 3¼ inches in diameter, running in phosphor-bronze bearings 8¼ inches long and driven by a belt 5 inches wide, a corresponding increase having been made in the wheel stand pile. Fig. 1 shows the 8- by 30-inch machine equipped with this

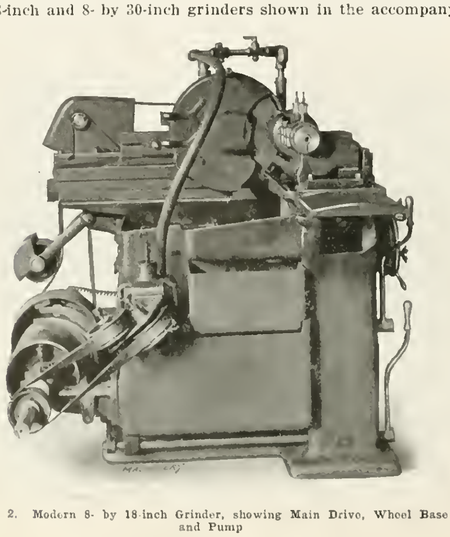


Fig. 2. Modern 8- by 18-inch Grinder, showing Main Drive, Wheel Base and Pump

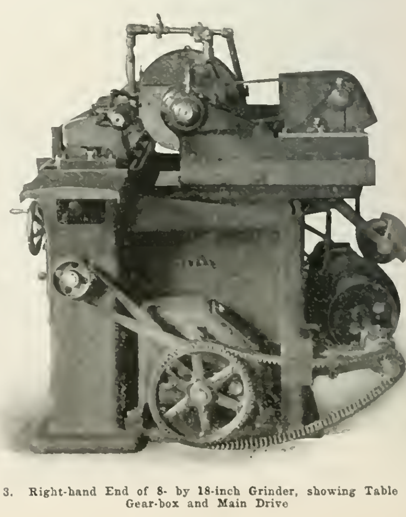


Fig. 3. Right-hand End of 8- by 18-inch Grinder, showing Table Drive, Gear-box and Main Drive

heavy drive. The bearings are in each instance provided with sight-feed oilers, which deliver the proper supply of oil to the boxes at all times.

The wheel stand pile is bolted to the bed of the machine and is of generous proportions, as may be seen by referring to Figs. 2 and 3. The wheel stand slides on vee and flat ways, and is held in place by gravity; but it is provided with a safety gib to guard against lifting under abnormal conditions. The wheel center is of large diameter, has a long bearing on the spindle, and will take any of the recognized standard grinding wheels. The wheels used on the standard machines are 16 inches in diameter and up to 3 inches face width. The wheels used on the heavy drive are 18 inches in diameter and up to 4 inches face width. The table slide is unusually heavy and powerfully ribbed to resist torsional strains. The swivel table has a generously proportioned bearing on the table slide and pivots on a large central stud. The table provides for grinding tapers and is graduated to read tapers in inches per foot.

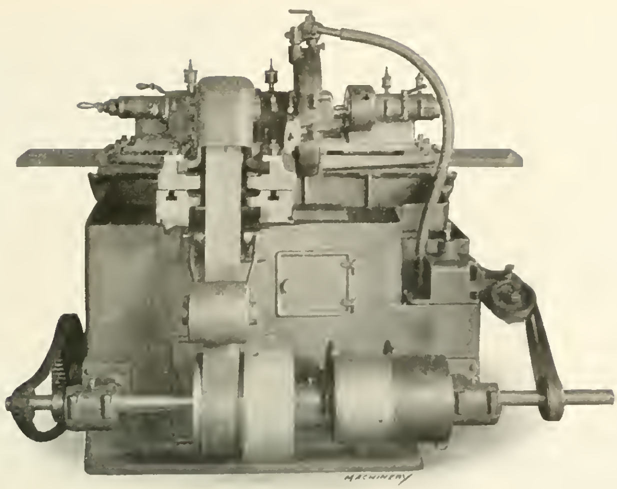


Fig. 4. Rear View of Modern 8-by 18-inch Self-contained Grinder, showing Arrangement of Main Driving Shaft

The table drive is of a very simple type, eliminating the table transmission formerly employed. It consists of a single unit contained in the bed of the machine, which is a combination of table drive and transmission. All steel spur gears are used for the reversing mechanism; and the power table traverse is controlled by a lever located immediately to the left of the table handwheel, which provides for starting or stopping the table at any point in its stroke. When the table is under power the handwheel is automatically disengaged, and when the power drive is released the handwheel is automatically engaged for traversing the table by hand. There are four table feeds, derived from a gear-box which is controlled by a lever located at the right and immediately below the table handwheel.

The automatic cross-feed is positive in its action and the design has been simplified without losing any of its important features. It can be set for a reduction of any amount from 0.0005 to 0.005 inch at either or both ends of the table reverse. This latter feature is especially advantageous when grinding against a shoulder. The feed is automatically thrown out when the work is ground to size, and a positive stop is provided for use when feeding by hand. The cross-feed handwheel is graduated to read to 0.0005 inch and is always in plain view of the operator. Adjustment of the cross-feed is made by moving a lever to give the amount of feed desired, as indicated on a graduated dial plate, and may be instantly changed to give any feed while the machine is in operation.

The headstock is of entirely new design, being driven from a shaft under the sliding table. This shaft is driven by a pulley carried in a bracket on the bed, to which power is taken from the gear-box. The shaft under the table is splined through its full length for the ball driver which is contained in the pulley mounted on the bed. The balls not only drive the shaft but also eliminate friction in the traversing movement. The headstock is driven from this shaft by a belt which runs over an idler pulley and gives a large surface of contact to the headstock pulley, thus insuring plenty of power. The belt drive gives an absolutely smooth movement to the work and eliminates any possible chance for chatter. The headstock is fitted to the swivel table by means of vee and flat ways, and is held rigidly in position by clamp bolts. The headstock spindle is hardened and ground, and runs in bronze bearings which are adjustable for wear and lubricated by means of sight-feed oilers.

A feature of the headstock design is the combination of live and dead centers. The spindle is carried in bearings in the headstock base, in which it revolves for live-center work, the faceplate being clamped to the spindle and the spindle revolving in the headstock bearings. To change for dead-center work, it is only necessary to loosen a screw which clamps the faceplate to the spindle, and tighten the clamp on the headstock which holds the spindle firmly in the headstock base. The dead-center pulley is then free to revolve upon its bearing for regular dead-center work. The tailstock is fitted to the swivel table and preserves its alignment in the same manner as the headstock. The tailstock spindle is held in any position by a spring, or it may be set positively against the work and locked in place. The work centers on the headstock and tailstock are located directly over and between the guides of the table, a form of construction which is claimed to eliminate the weight and strain necessarily present where the work centers are placed outside and overhang their bearings.

The wheel truing device is mounted on the tailstock and is adjustable to suit wheels of all diameters which come within the range of the machine, so that the wheels can be trued without removing the work from the centers.

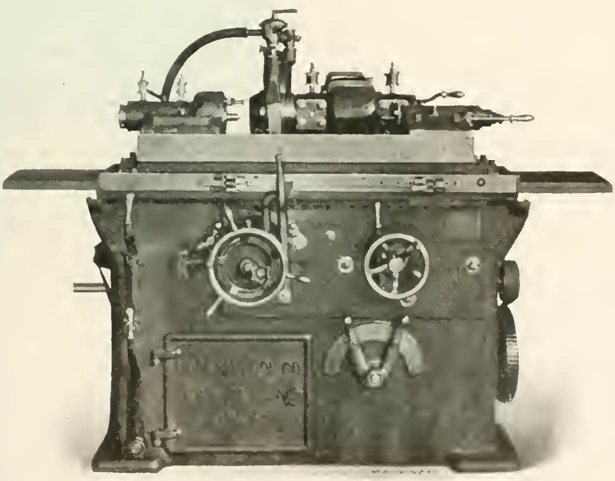


Fig. 5. Front View of Modern 8- by 18-inch Self-contained Grinder, showing Centralized Control

Steadyrests for these machines are universal in all their movements. They are equipped with positive stops for grinding duplicate parts, have a wide range and are capable of delicate adjustment. The pump is of the fan type; it revolves in a horizontal plane and is kept immersed so that it is constantly primed and no packing is required. The water tank is of ample size and provided with settling pans which are easily accessible for cleaning.

The Modern 8- by 18-inch and 8- by 30-inch self-contained grinding machines have eight work speeds from 26 to 390 revolutions per minute, and four table feeds from 22 to 104 inches per minute. The feeds and speeds are entirely independent of each other, and are suitable for the various classes of work which come within the range of these machines. All work speeds and table feeds are controlled by levers on the front of the machine, and are derived from a separate unit gear-box which, in addition to occupying a very small space, is so located as to be easily and readily inspected. The gears are made of specially treated steel and are in mesh at all times,

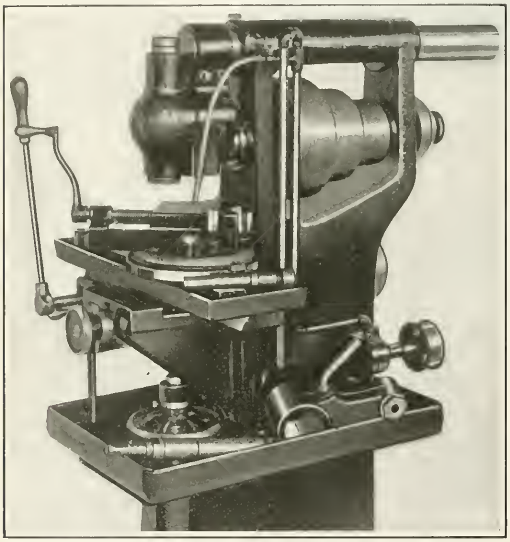


Fig. 1. Bickford Plain Milling Machine equipped with Vertical Attachment and Swivel Vise

their engagement with the shaft being effected by means of the Modern Tool Co.'s patent ball drive clutch which enables a quick and safe change to be made instantly while the machine is operating at any speed. The gear-box, while smaller in size, is the same as that used on the larger self-contained grinding machines of this company's manufacture.

These self-contained grinding machines have single constant-speed drive, which reduces the cost when equipping the machines with motors. The main drive is located at the rear of the machine and runs at constant speed, power being supplied from the lineshaft by a single belt, or by a motor connection.

BICKFORD VERTICAL MILLING ATTACHMENT AND MILLING MACHINE VISE

The Bickford Machine Co., Greenfield, Mass., is now manufacturing a vertical milling attachment which is shown in Fig. 1 set up on a machine ready for use. This attachment is of simple design and the illustration makes it so clear that only a brief description is necessary. It will be seen that the attachment is hung from the over-arm of the milling machine and that power is taken from the milling machine spindle and transmitted through bevel gearing in the head to the vertical spindle of the attachment.

Fig. 2 shows a close view of the new Bickford milling machine vise which is illustrated in position on the machine

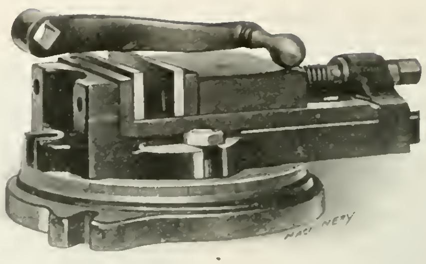


Fig. 2. Close View of Bickford Swivel Base Vise shown on Machine in Fig. 1

in Fig. 1. It will be apparent that this may be used as a swiveling vise, as shown in the illustrations, or removed from the swivel base and bolted directly to the table of the milling machine when it is desired to use a plain vise. The swivel base is convenient when milling operations are to be performed on which accurate indexing must be done between successive cuts. Two sets of lugs on the vise provide for bolting it with the jaws parallel or at right angles to the spindle, when the vise is used without the swivel base.

T. P. WALLS EMERY BAND GRINDER

In the July, 1915, number of MACHINERY, mention was made of two styles of emery band grinders built by the T. P. Walls Tool & Supply Co., 75-77 Walker St., New York City. These were bench machines intended for use in finishing parts that require a "straight grain" finish. When such a finish is required, the use of a power-driven emery band is the means of saving a great deal of labor and materially reducing manufacturing costs. These machines are made in two types, one of which is simply provided with an emery band, while the other is furnished with a disk wheel in addition to the band.

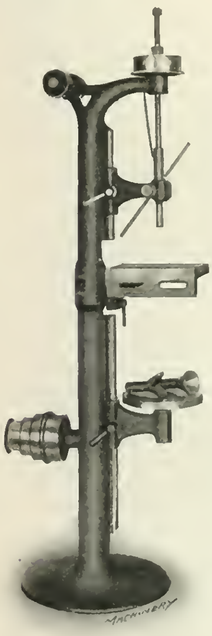
Recently the same company has introduced what are known as the "Simplex-B" and "Duplex-B" emery band grinders. As in the case of the bench machines, the "Duplex-B" is a combination emery band and disk grinder, while the "Simplex-B" machine is simply provided with the emery band. Instead of being intended for use on a bench, however, both of these machines are provided with substantial stands, making them

T. P. Walls "Simplex-B" Emery Band Grinder

self-contained units. On each machine the abrasive band is 8 inches wide by 61 inches long, and on the "Duplex-B" machine the disk wheel is 15 inches in diameter. The weight of the "Simplex-B" machine is 350 pounds and the weight of the "Duplex-B" machine is 405 pounds.

JOHNSON SENSITIVE DRILL

The Johnson Machine Tool Co., Gouverneur, N. Y., is now building a sensitive drill press suitable for performing accurate drilling operations at high speed. To relieve the spindle of belt strain, the pulley is supported on an independent bearing which takes the entire pull of the belt. Lever feed is provided, which is operated through a rack and pinion; and the quill and spindle are counterbalanced by a weight inside the column of the machine. The round table is vertically adjustable on the column, and it can be easily removed to enable a cup or crotch center to be substituted in the round table bracket. The square table has a slotted apron and can be swung around the column or tipped to any required angle. A taper pin provides for locking this table at an exact right angle to the drill spindle. The spindle is made of electrically heat-treated open-hearth steel; and it is equipped with an anti-friction thrust bearing having an adjustable collar. The regular equipment includes the square and round tables, crotch and cup centers, and a countershaft.



Sensitive Drill built by Johnson Machine Tool Co.

The principal dimensions of this drill press are as follows: capacity for drilling holes up to 9/16 inch in diameter; width of driving belt, 1¾ inch; total height with spindle up, 7 feet; height of column, 70 inches; diameter of base, 20 inches; hole in spindle bored No. 1 Morse taper; maximum distance from spindle to square table, 12 inches; maximum distance from spindle to round table, 42 inches; distance from center of spindle to column at square table, 7¾ inches; vertical adjustment of spindle head, 10 inches; vertical travel of spindle, 3 inches; vertical adjustment of round table, 26 inches; countershaft speed, 450 revolutions per minute; and net weight of machine, 325 pounds.

LANDAU TURRET HEAD DRILL

In the May, 1914, number of MACHINERY, a description was published of a small turret head drilling machine built by J. N. Landau, 239 W. 68th St., New York City. Those who read this description will recall that the turret head of the machine provides for indexing each of the tools into the working position. As each spindle is brought into the working position it is engaged by a clutch on the machine spindle to drive the tool.

The machine shown in the accompanying illustration is of essentially the same design as the preceding type of Landau multiple turret head drill with the following important exceptions: Depth stops are provided for each of the spindles in the turret head so that the depth to which the tools work may be accurately regulated; and the turret head is provided with one tapping spindle, so that it is possible to handle the work of tapping holes in which a thread is required. The forward drive of the tapping spindle is effected in the same way as that of the other spindles of the turret head; but gearing is provided on the tapping spindle, and when the hole has been tapped to the required depth, a clutch is automatically thrown to engage the reverse gearing for backing out the tap.

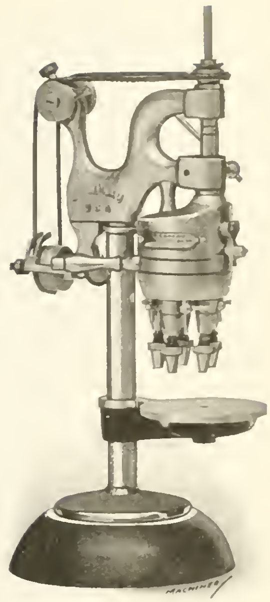


Fig. 1. Landau Turret Head Drill with Positive Depth Stops and Tapping Spindle

It will be evident that there is a great variety of instrument work and similar classes of service on which a turret head machine of this type could be used to advantage. In addition to use on the Landau machine, the turret head may be used on other types of drilling machines; and the same type of turret head may be used in the tailstock of a lathe. In all cases the method of operating the turret is the same.

Fig. 2 shows the arrangement of the gearing for backing out the tap after it has finished its work. As in the case of all other spindles in the turret head, power is transmitted from the main driving shaft to clutch A and then through gears B, C, D, and E, by which a suitable reduction of speed is obtained. Gear E is locked to the driving shaft F by engagement with locking pin G. The slowest speed for tapping is 150 revolutions per minute. After the tap has completed its work, clutch A comes into contact with an adjustable stop-bar H which is set according to the depth of hole to be tapped, with the result that the clutch on gear E is disengaged from pin G and reversing clutch I is engaged. The drive is now through gears B and C and thence through gears J, K, and L, the ratios being such that the tap is backed out at a speed of 250 revolutions per minute. Gears C and D are always in mesh with gears B and E, although gear E is only rotated when the forward driving clutch engages pin G.

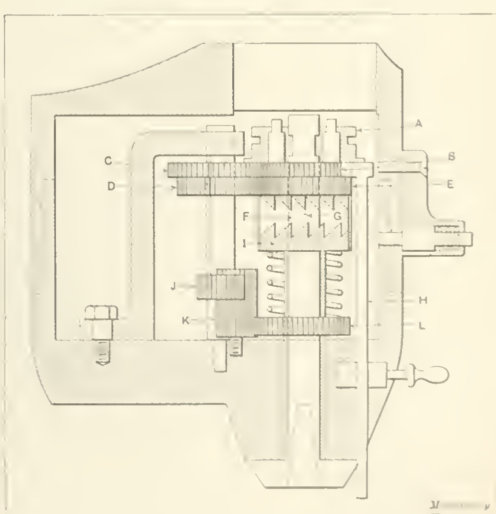


Fig. 2. Arrangement of Forward and Reverse Gearing on Tapping Spindle

OLIVER HEAVY-DUTY SCREW MACHINE

This is a heavy-duty machine that may be equipped for either screw machine or turret lathe work. The range of work for which it is adapted runs from heavy chucking operations on forgings or castings to high-speed work on brass bar stock. Both hand and power feeds are available, and the six available rates of power feed range from 0.006 to 0.052 inch per revolution for both the cross-slide and turret slide, the feeds being independent of each other. A single lever controls both feeds, and pointers running over a double dial indicate the rate of feed being employed on the cross-slide and turret slide.

The No. 27 heavy-duty screw machine or turret lathe now being built by the Oliver Machinery Co., Coldbrook and Clancy Sts., Grand Rapids, Mich., has been designed to operate under high speeds and heavy cuts. The control of all movements is concentrated at the front of the machine, making its manipulation simple and rapid. The range of work for which the machine is adapted extends from heavy chucking operations on forgings or castings to high-speed work on brass bar stock. The headstock is of the friction back-geared type, and is controlled by a lever at the left-hand side of the operating position; the head is cast integral with the bed and extended straight across on a level with the spindle bearing, thus forming an exceptionally rigid construction. The friction back-gears are entirely enclosed and the cover may be instantly removed for the purpose of inspection or making adjustment. Adjustment of the friction ring is effected by means of a simple screw mechanism which regulates the pressure on the ring. Both front and rear spindle bearings are lubricated by felt wipers which extend down into oil reservoirs of liberal capacity.

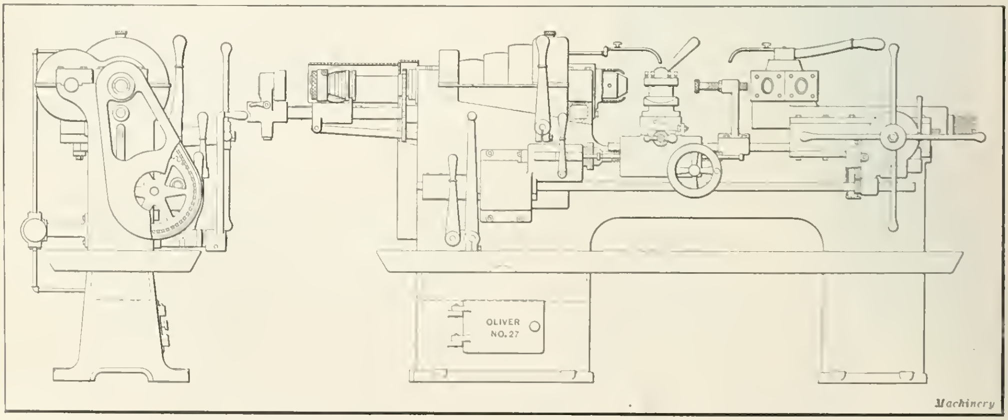
When the cross-slide is operated by power, six rates of feed are available ranging from 0.006 to 0.052 inch per revolution; and the same rates of feed are available for the turret slide, but the feeds are entirely independent of each other, any combination of the two sets of feed being quickly obtainable. The power cross-feed operates the carriage longitudinally in either direction, or it can operate the cross-slide forward or back by clamping the carriage to the bed and throwing in the cross-slide feed. Automatic knock-outs are furnished on both the cross-slide and carriage to provide for disengaging the power feed; these operate in both directions. A small lever controls the direction of feed, and micrometer dials are placed on both the longitudinal and cross-feed screws to facilitate handling accurate shoulder work or facing, these dials reading to 0.001 inch.

The cross-slide is provided with two parallel T-slots at the rear and one at right angles in the front, an arrangement which permits of the use of a great variety of tools for cross-slide work. The regular equipment consists of an open-side cut-off tool at the rear and a four-sided turret tool-holder at the front. When so desired, the power feed may be omitted and hand-operated longitudinal feed substituted in its place. The design of the cross-slide is the same in both cases, but the turret toolpost is replaced by a single tool-holder and the power gearing is omitted. The handwheel is provided with a dial reading to 0.001 inch, for accurate turning operations; and the cross-slide dial is the same as in cases where power feed is employed. Longitudinal travel is the same, no matter whether hand or power feed is used. When so desired, a lever cross-slide arrangement can be substituted in place of the screw feed mechanism.

The turret is made of cast iron and is bored and counterbored in position on the lathe to insure perfect alignment. The turret stud is 2½ inches in diameter and is drilled to allow stock up to the full capacity of the machine to pass entirely through the turret. The locking plunger is made of hardened tool steel and is accurately ground to size; it enters a hardened tool-steel bushing and slides in a hardened and ground sleeve. The turret slide may be furnished with either power or hand feed. When power feed is employed the rates available are 0.006, 0.010, 0.015, 0.025, 0.040, and 0.052 inch per revolution of the spindle. The control of these feeds is obtained by a lever located at the left of the gear-box, and a dial plate and pointer show which feed is engaged. The mechanism is of the sliding key type, enabling selection of feeds to be made while the machine is either running or at rest. The turret slide is secured in place by means of taper gibs at each side and by hold-down gibs, all of which are accurately scraped to a true bearing. Multiple stops provide for disengaging the power feed at each face of the turret, and form a positive stop by a slight forward movement of the hand-lever. The multiple stop mechanism is directly geared to the turret head and cannot get out of adjustment. The power feed mechanism consists of a steel rack and gears, working in conjunction with a drop-worm which is either released or thrown into mesh by opposite movements of the same lever that is conveniently located for the operator.

The turret slide is adjustable forward or backward on the shears of the bed, to the limit of length of the bed; and it is clamped externally by means of rectangular gibs acting outside of the shears. Adjustment for wear is provided for by means of a taper gib under the ways, which is adjusted by two screws of fine pitch. This combination of taper gibs for the slide and ways gives complete control of adjustment for any wear that may develop. In addition, the exceptionally large bearing surfaces of the slide and ways afford long life and great accuracy.

The change-gear system consists of steel and cast-iron gears running in oil; and it is of the sliding key type. Six rates of feed are provided for the turret and the same number for the cross-slide, and, as previously mentioned, these feeds are independent of each other. A single lever controls both feed changes, and the rate of feed being obtained by the turret or cross-slide is indicated by a dial and two pointers. The gear-



Oliver No. 27 Heavy-duty Screw Machine—Same Machine is equipped for Turret Lathe Work

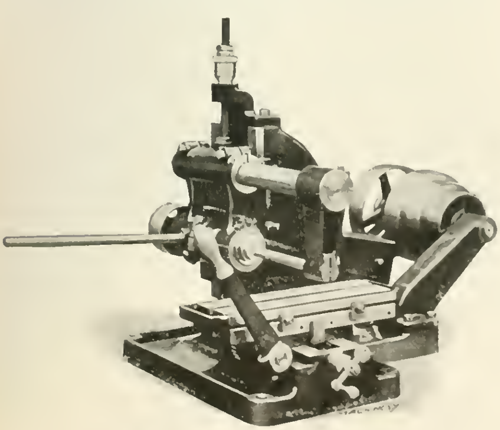
box is located underneath the headstock and is completely enclosed so that adequate protection is provided against damage from chips or dirt. All bearings are furnished with a copious supply of lubricant so that efficient operation is assured at all times. An independent and adjustable stock stop clamped to the bed forms a regular part of the equipment of the universal turret lathe. This stop allows the entire six spaces of the turret to be used for cutting tools.

The wire feed lever is of ample length to afford plenty of leverage for the feed mechanism. The pan is made of sheet steel and while it is very stiff it is also light; the pan extends entirely around the machine and is so placed that provision is made for cleaning off chips from underneath the bed. The reservoir for oil or cutting compound is contained in the leg at the head end and has a capacity for holding several gallons. A large hand-hold plate at the rear of the lathe may easily be removed for cleaning the mechanism, and to clean out the pan it is not necessary to remove the pump or piping. The pump is of the reversible type and supplies a steady flow of lubricant to each of two delivery tubes, one of which supplies lubricant to the turret tools and the other to the cross-slide tools. The pump is driven directly from the countershaft and is independent of the speed of the spindle or the rate of feed being employed.

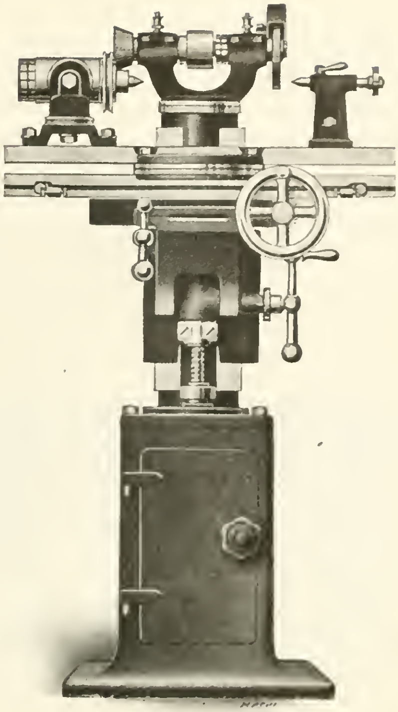
MORRIS BENCH MILLER

The Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio, is now building the No. 0 bench miller of the adjustable head type illustrated and described herewith. The machine is also furnished with a column to provide a floor type of machine. The head is moved up and down on the column by means of a lever-operated rack and segment; the lever can be placed in two positions to suit the convenience of the operator, and a micrometer depth gage is provided to facilitate the making of accurate settings. The head is counterbalanced by a weight that is made adjustable for use with different sizes of cutters and arbors, making it possible to counterbalance the head very accurately. The spindle runs in bronze bearings, the front bearing being tapered and provided with means of compensating for wear. The back shaft also runs in bronze-lined bearings and all bearings are lubricated by a capillary oiling system.

Six changes of speed are obtained through the three-step cone pulley by reversing the pulleys on the ends of the spindle and back-shaft. The table traverse is obtained by a lever-operated rack and pinion; and the saddle is fed in and out by means of a square threaded screw which has a micrometer attachment. The principal dimensions of the machine are as follows: size of table, 4 by 15 inches; maximum table feed, 6 inches; maximum vertical travel of head, 5 inches; taper of spindle, No. 7 B. & S.; countershaft speed, 360 revolutions per minute; and available spindle speeds with three-step cone pulley, 120, 180, 270, 480, 720 and 1800 revolutions per minute.



No. 0 Bench Miller built by Morris Machine Tool Co.



"Sterling" Universal Tool Grinder built by Young, Corley & Dolan, Inc.

"STERLING" UNIVERSAL TOOL GRINDER

Young, Corley & Dolan, Inc., 149 Broadway, New York City, is now building the "Sterling" universal tool grinder which is completely universal in its movements and adapted for handling all classes of light grinding. The table revolves entirely around the head so that the wheel can engage the work at any desired angle. The spindle is hardened and ground, and runs in phosphor-bronze lined bearings, guards being provided to protect the bearings from abrasive dust. The knee is supported on gibbed V-slides which form part of a cylindrical member that may be completely revolved around the center column and locked in any angular position that is desired, after which the knee may be raised or lowered to the required position. This feature will be found very useful for die grinding where great accuracy is required. The head is secured to the center column around which swings the knee-carrying frame. The base of the machine forms a cabinet which is convenient for holding accessories used in connection with the machine, and it is made sufficiently heavy so that a rigid support is provided.

Felt washers are fitted on all bearings to guard against damage from abrasive dust. The work-table swings on a turntable 10 inches in diameter which can be rigidly locked at any desired angle to provide for performing taper grinding operations. The swivel frame is bored to fit the column and has a 45-degree slide for carrying the knee. The saddle slides on the knee are provided with adjustable gibs, and adequate protection has been made against the entrance of abrasive dust. The head is secured to the top of the column and is furnished with a graduated disk to enable the frame and knee to be swiveled around the column to any angle which may be required. The spindle is made of high-carbon steel, hardened and ground, and is 1 inch in diameter; it is supported in bearings lined with phosphor-bronze. The table travel is effected by means of a rack and pinion with adjustable stops to limit the movement in either direction; the table is 30 inches long;

the capacity between centers is 16 inches and the swing 9 inches.

The headstock is fully universal, provision being made for swiveling it both vertically and horizontally. Means are provided for driving on live or dead centers according to the requirements of the work. The tailstock is provided with a removable center and a clamping device. For those classes of work where internal grinding is necessary, an internal grinding attachment is provided which fits on the main head of the machine and is driven from a pulley fitted in place of one of the grinding wheels. Power table feed, with automatic reverse, can be supplied for use on this grinder, power being taken from the countershaft. The countershaft is equipped with a drum for driving the work. The following equipment is included with the machine: countershaft, universal headstock, tailstock with center, one sleeve, one center, one universal vise, one internal grinding attachment, one metal saw chuck, one universal three-jawed chuck, one set of dogs and the necessary wrenches for making all adjustments.

NEW MACHINERY AND TOOLS NOTES

Flexible Tubing: Worcester Flexible Tubing Co., Worcester, Mass. Metallic flexible tubing for use in conveying lubricant to the cutters used on various types of machine tools.

Pneumatic Drill: Baird Pneumatic Tool Co., Topeka, Kan. A tool especially designed for drilling "telltale" holes in locomotive boiler staybolts. It is suitable for operation at 1500 revolutions per minute and weighs less than four pounds.

Keyseating Tools: National Machine Tool Co., Cincinnati, Ohio. Tools for use in cutting keyseats in which the depth is 1½ times the width. The tools are used in a drilling machine, and the cutting is done by small milling cutters which complete the operation at a single cut.

Forcing Press: Charles F. Elmes Engineering Works, Chicago, Ill. A portable horizontal hydraulic forcing press designed for the performance of various forcing operations. The stroke of the ram is 24 inches, the pressure capacity 600 tons, and the weight of the press, 10,900 pounds.

Cutting-off Machine: Southwark Foundry & Machine Co., Philadelphia, Pa. An air-operated cutting-off machine for parting shell blanks from bar stock. The machine is suitable for operation on bars from 7 to 10 inches in diameter. The tools are fed into the work by compressed air, and three tools cut simultaneously.

Work Bench: Motor Engineering Co., East 61st and Curtiss Sts., Cleveland, Ohio. A work bench provided with a vise and drawer, and constructed in such a way that by loosening the screws that secure the wooden top to the steel legs, the bench may be taken apart for shipment or transfer to another part of the factory.

Engine Lathe: Rockefeller Motor Co., Cleveland, Ohio. The design of this machine is practically standard. It is equipped with double back-gears and a three-step cone pulley which provide a wide range of spindle speeds; and a quick-change feed-box provides an ample number of feed changes. This lathe is made in three sizes.

Clutch: Porter Machine Co., Wooster, Ohio. A disk pulley-type clutch in which the wear is taken up by a lining that may be easily renewed. When the clutch is released, sufficient clearance is provided to entirely eliminate drag. The clutch has a large friction surface, and engagement is gradual, while the release is instantaneous.

Floating Punch Press: Cleveland Punch & Shear Works Co., Cleveland, Ohio. A punch press designed in such a way that the work is accurately centered, thus doing away with the necessity of reaming the punched holes. If the material to be punched is distorted, the punch floats with it, thus making adjustment of the cam ring unnecessary.

Heading Machine: Asa S. Cook Co., 603 Franklin Ave., Hartford, Conn. A heading machine equipped with a friction feed device which enables exactly the desired length of stock to be fed on every stroke of the feed arm. The machine is designed in such a way that the cut-off mechanism does not operate until all pressure has been removed from the punch.

Power Press: Consolidated Press Co., Hastings, Mich. A general-purpose power press designed for the performance of blanking and drawing operations. The frame is of a four-piece tie-rod type, and is held together by four steel rods which are shrunk into position. The frame is made in sections, tongued and grooved at the joints, and may be easily taken apart.

Universal Grinder: Simmons Machine Co., Albany, N. Y. A universal tool and cutter grinder designed to provide for handling a wide range of work. The headstock is fitted with bronze bushings, and micrometer adjustment is provided for all movements. A special countershaft is used in connection with the machine, which is of the "pull shift" type and easily operated.

Spring Forming Machine: Joseph T. Ryerson & Son, Chicago, Ill. An elliptic spring forming machine which has sufficient capacity for shaping spring leaves of all ordinary sizes. It consists of a horizontal table on which are mounted the forming dies and pressure cylinder. Adjustment is provided to set the dies for forming springs of various radii of curvature.

Soldering Press: James Donoghue, 1407 E. 111th St., Cleveland, Ohio. A power-driven machine for soldering sheets of tin plate into a continuous strip for roofing and similar purposes. The sheets have a lock turned on the edges so that they may be hooked together and fed into the machine; and as the sheets are hooked together, solder and flux are put on the seam.

Tool Grinder: Worcester Pattern & Model Co., Worcester, Mass. This grinder was particularly designed to meet the requirements of pattern shops, although it is also adapted for machine shop service where general tool grinding has to be done. When intended for use in a machine shop, the grinder is equipped with plain rests at both ends, and a buffing wheel may easily be attached.

Bar Straightening Machine: Medart Patent Pulley Co., St. Louis, Mo. An automatic machine especially designed for straightening and polishing steel shafting, although it is equally suitable for straightening iron, brass and bronze bars. The operation of the machine is continuous after the rolls have been set for a specified size of bar, and the rate of production is about 30 feet per minute.

Heavy Power Press: Consolidated Press Co., Hastings, Mich. A press especially designed for use in the production of brake drums for Ford motor cars, although it may be used for a variety of other automobile work. The machine is double geared, and the frame is tongued and grooved at every joint. The floor space occupied is 85 by 98 inches, and the weight of the press, approximately 30,000 pounds.

Rotary Punch Press: Malm Machine Co., Dayton, Ohio. A rotary punch press in which the punch and die drums are mounted on independent shafts. The punch drum is keyed to the punch driving shaft, while the die drum is mounted on an idler shaft which allows it to revolve freely. Multiple punches are mounted upon the punch drum, and these engage a similar number of dies mounted on the die drum.

Adjustable Drawing Table: G. A. Almorth, 966 Grand Ave., New Haven, Conn. A table in which the position of the drawing board can be adjusted to any angle to suit the work being done, and also to suit the stature of the draftsman who is using the table. The frame that supports the table is made of cast iron, and a cabinet furnished with three drawers and an ink bottle holder is secured to one side of the frame.

Slotter: Newton Machine Tool Works, Inc., Philadelphia, Pa. A crank-driven slotter equipped with a swiveling cutter-bar which may be adjusted to any angle up to 5 degrees on each side of the perpendicular. This adjustment makes the machine suitable for the performance of die-shaping operations. When used for tool-room work or the duplication of parts, positive stops are furnished for the cross and lateral table movements.

Balanced Hoist: Mann Corporation, Chicago, Ill. A hoist especially designed for handling shells and similar work in machine shops. The operator can attach the hook to a piece of work in the lathe or other machine, and at the same time fasten a second hook to a piece of work on the floor or truck. Then with comparatively little exertion, the finished piece is removed from the machine and the rough casting substituted in its place.

Multi-cone Clutch: Akron Gear & Engineering Co., Akron, Ohio. This clutch has three friction cones, the intermediate one of which is splined to the driving ring on the shaft; when the shifter is operated, one of the outer cones is first brought into contact with the intermediate cone, after which further movement of the shifter results in sliding these two cones into contact with the other outside cone. The clutch is then ready to transmit its full load.

Pneumatic Tapping and Drilling Machine: Baird Pneumatic Tool Co., Topeka, Kan. A machine designed for use in tapping staybolt holes and screwing the bolts into place. The machine may also be used for drilling and reaming holes, and for this service has a capacity for driving drills up to 1¼ inch in diameter. Working with an air pressure of 100 pounds per square inch, the tool runs at 175 revolutions per minute and develops 2½ horsepower.

Staybolt Cutter: Baird Pneumatic Tool Co., Topeka, Kan. A machine designed for the purpose of cutting locomotive boiler staybolts; but the use of suitable blades adapts the tool for cutting rivet heads also. It is operated with air at a working pressure of from 90 to 100 pounds per square inch, and

provides for leaving a sufficient amount of metal for the heading operation. Working on bolts from 3/4 to 1 1/8 inch in diameter, the capacity is about 1200 bolts per day.

Engine Lathe: Advance-Rumely Co., Laporte, Ind. A heavy-duty engine lathe designed to provide for taking the heaviest cuts that can be handled with high-speed steel cutting tools. The lathe swings 26 inches over the ways and 17 inches over the carriage; the capacity between centers is 48 inches; the back-gear ratio is 10.2 to 1; and the weight of the machine is 10,000 pounds. R. W. Baily, 122 S. Michigan Ave., Chicago, Ill., has the sales agency for the machine.

Bench Lathe: Walter H. Wade, 311 Atlantic Ave., Boston, Mass. This lathe was especially designed for tool-room work, but there are various other classes of precision work for which it is well suited. The bearings are made of tool steel, hardened and ground; and a quick-change gear-box is provided, which has a capacity for cutting 12 to 120 threads per inch. The machine may be driven either by a two-speed and reverse countershaft or by a friction countershaft.

Turret Lathe: Greenlee Bros. Co., Rockford, Ill. This machine swings 22 inches over the ways and 8 inches over the turret. The available speeds are from 12 to 280 revolutions per minute; and the available changes of feed are from 0.006 to 0.108 inch per revolution. The hole through the spindle is 3 1/2 inches in diameter; and the weight of the machine is 6600 pounds. In general, the design is the same as that of the smaller sizes of turret lathes of this company's manufacture.

Surface Grinding Attachment for Milling Machine: Presto Machine Works, 119 Lafayette St., New York City. An attachment which provides for converting a horizontal milling machine into a surface grinder. The attachment is clamped to the over-arm, and the driving pulley is held between two bearings which provide adequate support for the grinding wheel spindle. The work-holding fixture is mounted on the table of the machine, which provides for traversing it under the grinding wheel.

Pneumatic Trip for Punches and Shears: Baird Pneumatic Tool Co., Topeka, Kan. A device intended for use in performing punching and shearing operations on large sheets, where it is impossible for the operator to reach the regular trip. For this purpose a small air cylinder is bolted to the side of the press frame and the piston in this cylinder is connected to the trip lever on the press. One pull of the trip cord, which is within easy reach of the operator, has the same effect as the application of pressure on the treadle.

Plain Grinding Machine: Perkins Grinder Co., 706 American Trust Bldg., Cleveland, Ohio. A 10- by 36-inch plain cylindrical grinding machine equipped with automatic and hand feeds. This machine is adapted for general manufacturing work and is self-contained, every unit, including the pump and tank, being an integral part of the machine. The maximum swing is 11 inches and the maximum capacity between centers is for work up to 40 inches in length. The control is centralized, all levers and handwheels being located at the front, within easy reach of the operator.

Manufacturing Milling Machine: Pratt & Whitney Co., Hartford, Conn. A milling machine of the "Lincoln" type especially adapted for use in the manufacture of gun parts and similar products. The table recedes from the work automatically during the return stroke; and it has a working surface 6 1/2 inches wide by 18 inches long. The table and bed bearing surfaces are of equal length to give uniform wear. The maximum travel of the table is 12 inches, and in addition to a wide range of feeds, rapid power traverse is provided in each direction. The floor space occupied by the machine is 54 by 54 inches, and the weight, 3750 pounds.

* * *

BALL BEARINGS ON FREIGHT CARS

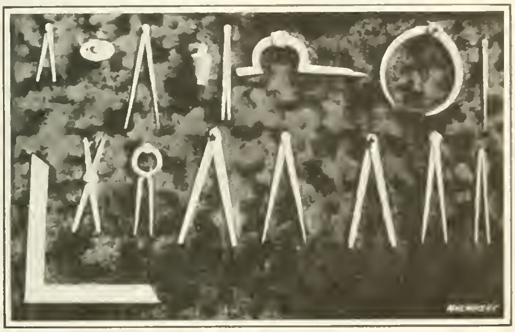
Fifty new ore cars have recently been completed for the Swedish state railways, which are all fitted with ball bearings. These cars will be used on the railway line in northern Sweden which carries the ore from the great Kiruna iron ore mines to the coast. This railway is electrically equipped, the traffic is exceedingly regular, and the conditions, in general, ideal for comparative trials of power consumption. It is proposed to run two trains, identical in equipment and loading, one composed of cars with ball bearings and one with ordinary plain bearings, and to measure the power consumption from day to day, by means of watt meters. The result of these trials will be of interest the world over for determining the value of ball bearings in railway equipment.

* * *

A match is a simple means for starting a fire, but in making the "Safe Home" match 211 operations are required from the wood in the forest to the finished product.

EARLY ROMAN TOOLS

At an exhibition held in connection with the National Retail Hardware Dealers' convention in Boston, June 14-16, the Brown & Sharpe Mfg. Co., Providence, R. I., included in its exhibits a panel of replicas of tools used by the Romans some two thousand years ago. They attracted considerable attention and will doubtless prove of interest to readers of MACHINERY. These are exact copies of certain instruments to be found in the National Museum in Naples. The originals were discovered among the ruins of the Roman city of Pompeii, just a few miles south of Naples, and represent the sort of tools used by architects and engineers, and perhaps too by the machinists of those far-off days when Pompeii and Herculaneum were overwhelmed by that gigantic earthquake in 63 A. D. The bronze instruments and works of art found in Pompeii are easily distinguished from those found in Herculaneum; those of Pompeii are oxidized and of a light bluish-green color; those of Herculaneum have a dark black-green hue, these distinctions being due to several causes, chief among which is the fact that ashes fell on Pompeii and flowing lava upon Herculaneum. In 1748 the discovery of some statues and bronze utensils by a peasant attracted the attention of the King of Naples; and excavations were then begun.



Replicas of Early Types of Roman Tools found in Excavations at Pompeii and Herculaneum

* * *

PRESSURE OF FRICTION SCREW PRESSES—A CRITICISM

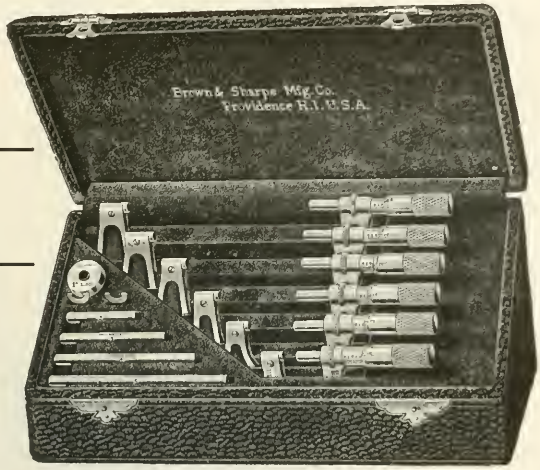
In the June number of MACHINERY, there appeared an article treating on the pressure developed by friction screw presses. While we furnished the author, at his request, some photographs of such presses as we manufacture, we do not wish to have it understood that the theory developed covers our conception of the subject. The author in no way fulfills his object "to give a clear understanding of the operation of this drive in connection with a screw-actuated ram." The author is also in error when he states that this press is almost a stranger in this country. It was, but it is quite at home now, since we have made a great many.

After lengthy deductions, and with the introduction of calculus, the author reaches this formula for the pressure exerted:

$$Q = ct$$

wherein c stands for a constant, and t for that part of the stroke that is actually doing the work. This formula says that the greater t is, the greater the pressure, and the smaller t is, the smaller the pressure. If, therefore, the empty press is tripped and the punch strikes the die without doing any work, $t = 0$, and the press should exert no pressure at all. Just the opposite is true, because in this case the press will exert its maximum pressure. A careful designer will, therefore, calculate the stresses for this extreme case. Having shown that the result of the author's deductions is wrong, it is hardly necessary to go into details, but other errors occur that challenge criticism. For instance, in figuring the speed of the flywheel, the circumferential speed is used instead of the speed of the center of gravity of the rim-section.

EDMUND W. ZEH,
Newark, N. J. Zeh & Hahnemann Co.



How About a Set of Reliable Micrometers—While Business is Good?

Why not place your order for that set of micrometer calipers you have been thinking of buying so long? The shop is busy, orders are coming in at a good rate, everybody is busy; but don't neglect your tool-room equipment. On the contrary, you should be even more careful about it now than ever. You are getting new business now that you want to keep. Better see to it that such work comes up to standard for accuracy—better provide good tools for checking it.

Brown & Sharpe Micrometer Calipers Meet Every Requirement for Tool Room or Inspection Use

So, if you are particular about quality, get in touch with the hardware dealer who carries the Brown & Sharpe line. He can furnish you with micrometer sets that are accurate and dependable and that give long service. How does a set like that shown above meet your requirements? With that in your tool room you are equipped to handle a wide range of work properly as far as checking its accuracy is concerned. We put up twelve different sets which meet a broad range of requirements. They are listed on pages 31-33, inclusive, of our No. 26 catalog. Have you a copy?

A line of our tools is also carried at our Chicago Store, 626-630 Washington Blvd., Chicago, Ill.

Providence, R. I., U. S. A.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa.; Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; The E. A. Kinsey Co. Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

FOREIGN TRADE POSSIBILITIES IN SOUTH AMERICA

At the meeting of the New York State Bankers' Association, Carlos Alfredo Tornquist, of Buenos Aires, said:

There is no reason why the United States should not be placed on a footing of equality with Europe in relation to Argentine finance and business. Nor is there any reason why the United States should not receive a share of the $250,000,000 or $300,000,000 which ordinarily goes into the coffers of European houses every year. But to obtain this trade, there must be closer personal contact between the Americans and the Argentines. The first necessity is the establishment of first-class, comfortable, and fast steamships that will make the trip between New York and Buenos Aires in twelve or fourteen days. Extended intercourse between the leaders of the respective communities—not of their secretaries and employes—also would do more to foster and augment international commerce than any number of conferences or publications. Although much of the extraordinary proportions lately reached in the trade between these two countries owes its existence to the war conditions, a great part of the advance has been the result of closer personal investigation and of the exercise of more vigorous efforts on the part of the Americans than were previously put forth.

In his report to the Department of Commerce on markets for machinery and machine tools in Argentina, J. A. Massel says:

This market at present offers good opportunities for the United States. But the exporter should realize that the South American nations are of Latin stock and that the language is chiefly Spanish. The average Latin-American, moreover, does not care for a short and dry business correspondent; he takes life more easily than the North American, and is averse to rushing matters. It is not sufficient, in Argentina, to demonstrate the superiority or advantages of an article; the salesman should, in addition, be pleasant and courteous in his conversation, and never, under any circumstances, aggressive or pushing. The principal reasons why the American so far has not had a market for his wares in that country is that very few houses have tried to adapt themselves to the business practices of Argentina. Practically all the important industries (the railroads, power plants, etc.) are in the hands of Europeans, while American capital is, in comparison, practically non-existent. Besides, Argentina finds a free and large market for its produce in Europe; while the European manufacturers have made every effort to secure this market which the Americans have neglected.

America's Share of Argentina's Foreign Trade

In 1913, which is the last year for which figures are available, Argentina imported 2300 adding and calculating machines, of which number 2088 were from the United States. Of 11,200 harrows, 2100 were bought in Germany and 8890 in the United States. Of 70,700 plows imported, 700 were from Canada, 2200 from Germany, and 66,000 from the United States. Of 10,600 reapers imported, 2000 were bought in Australia and 7300 in the United States. Of the 6300 typewriters received, 5300 were from the United States and 800 from Germany. The United States also sold 1200 of the 5100 automobiles purchased, France surpassing this country by selling 1800 cars. In nearly every other line France, Belgium, Germany, and Great Britain have surpassed this nation. Still, American goods are not disliked; the success of those lines in which an effort has been made to satisfy the people has shown that. The most successful and best-liked pipe cutting and threading tools are of American manufacture; they have almost completely displaced all others. They must cut the Whitworth thread, however.

Other Latin-American Countries

A careful study of the tariffs of the country to which the goods are sent is essential. When money is wanted for some new project, an added tax on imports is the normal thing in a number of South American states. In most of these countries, the appraiser is given all fines, or a part of all fines, that he may impose. In Argentina, he is recognized as the defendant, if the importer appeals from some ruling. In Chile and Peru, a bonus is paid to all custom-house employes instead of a share of the fines; while in Bolivia, the employes receive both a bonus and a share of the fines.

The Central Executive Council of the United States section of the International High Commission is urging the State Department to undertake the creation of gold trust funds in all the American nations similar to that maintained in this country by the Federal Reserve system. Secretary McAdoo says that such funds would greatly expedite commercial exchanges, saving unnecessary transfers of gold in the settlement of balances. The commissioners are also trying to secure the ratification of the uniform trademark, patent, copyright, and pecuniary claims treaties agreed on at Buenos Aires.

An effort is now being made to have a uniform educational system in all the Central American countries. Special attention is being paid to extending and improving rural schools and to giving practical courses in arts and trade to both men and women. It has been stated that over 4000 elementary schools have been opened in Mexico since the Carranza government was recognized by the United States.

Consul Homer Brett calls attention to the futility of trying to handle all South American business from one office, say, in Buenos Aires. A letter may be sent from Caracas, Venezuela, to New York and a reply received in twenty days, and a letter to Europe and its reply will require only thirty days; but it requires at least eighty days to send a letter to Buenos Aires and receive the reply.

In order to regulate the price of foreign exchange, the Bank of Venezuela has decided to discourage loans of every nature and to steadily decrease outstanding obligations. In its published statement of change of policy, it invites foreign capital to start banks for lending money to the people. The bank is now said to have about $1,500,000 in New York. The British Bank of South America states that there is a demand for imported goods in Brazil and Argentina, as the stocks are low, and that all goods are easily sold at high prices. The difficulty is rather in the delivery than in the selling of the goods.

D. E. J.

* * *

ANNUAL CONVENTIONS M. C. B. A. AND A. R. M. M. A.

The fiftieth annual convention of the Master Car Builders' Association and the forty-ninth annual convention of the American Railway Master Mechanics' Association, were held in Atlantic City, N. J., June 14-16 and June 19-21, respectively. Saturday and Sunday, June 17 and 18, and the evenings of the convention days, were given over to the entertainment of the two bodies and their families. The sessions of the convention were held in Convention Hall on Young's Pier, and evening entertainments took place in the ballroom on the pier. Coincident with these two conventions, the Railway Supply Manufacturers' Association held its exhibit on Young's Pier, where 76,500 square feet was given over to the exhibition of different members. Of the 436 members, 260 exhibited. Unusual interest was taken by the delegates in the latest developments in railway supplies and shop equipment, and a spirit of optimism was in evidence everywhere. The machine tool exhibit was comparatively small, and some of the exhibiting companies maintained reception booths only, because of the difficulty of securing suitable machines to exhibit.

The program of the Master Car Builders' Association convention included the following:

June 14—Reports on standards and recommended practice; train brakes and signal equipment; brake shoe and track beam equipment; car wheels.

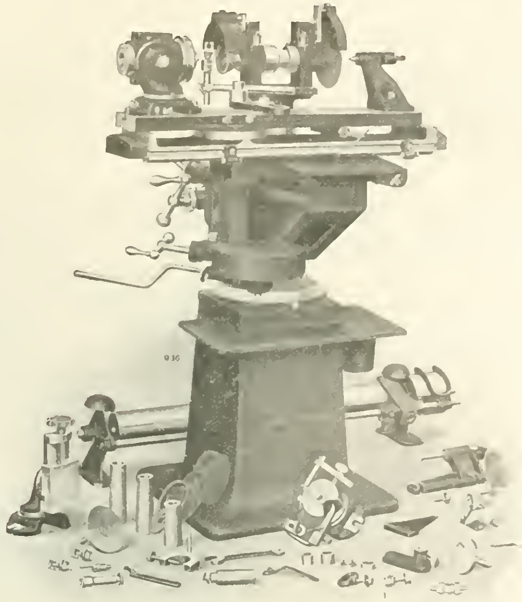
June 15—Reports on couplers; draft gear; safety appliances; loading rules; car construction; car trucks; train lighting and equipment.

June 16—Reports on tank cars; specifications and tests for materials; welding of truck sides and bolsters; election of officers.

The officers for the year were elected at this session as follows:

President, C. E. Chambers, superintendent of motive power, Central Railroad of New Jersey; first vice-president, T. W. Demarest, superintendent of motive power, Pennsylvania Lines Northwest of Pittsburg; second vice-president, James Coleman, superintendent car department, Grand Trunk Railway; third vice-president, G. W. Wildin, mechanical superintendent, New

CLEARANCE



The No. 1½ Cincinnati Universal Cutter and Tool Grinder
Patent Rights Fully Reserved

You wouldn't think of using lathe tools with the wrong clearance. On milling cutters correct clearance is even more important.

Incorrect cutter clearance will reduce the output of your milling machines as much as twenty per cent.

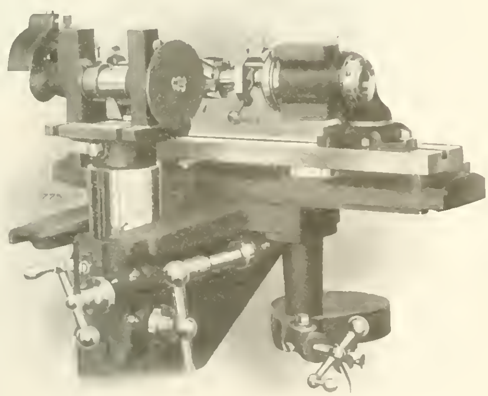
Clearance depends upon certain mathematical relations between the cutter and the grinding wheel.

To obtain these on the ordinary grinder requires several measurements and reference to diagrams, tables or charts.

The average operator doesn't understand these and after a couple of trials grinds until the clearance looks right—and your milling department suffers.

Compare the Cincinnati method. After a simple preliminary setting the swivel head is revolved the desired amount, the clearance angle being read direct from the dial—the cutters are ground with the correct clearance—and your milling department profits.

This is only one of our *exclusive features.*



Method of setting for clearance.

Catalog tells them all.

Cincinnati Milling Machine Company

CINCINNATI **OHIO, U. S. A.**

York, New Haven & Hartford Railroad; treasurer, John S. Lentz, Lehigh Valley Railroad.

The American Railway Master Mechanics' Association sessions were held June 19, 20 and 21, and the synopsis of the program follows:

June 19—Reports on mechanical stokers; revision of standards; dimensions of injector couplings; paper on "Standardization of Screw Threads," by F. O. Wells; paper on "Tests of Four Types of Passenger Car Radiators," by Prof. A. J. Wood; topical discussion on metallic packing for superheater locomotives; report on fuel economy and smoke prevention.

June 20—Reports on locomotive headlights; design, construction and maintenance of locomotive boilers; superheated locomotives; equalization of long locomotives; design, maintenance and operation of electric rolling stock; design and material for piston valve rings and bearings; cooperation with other mechanical railway organizations; paper on "Alloy Steels," by L. R. Pomeroy; topical discussion, "Instructions to Young Firemen"; number of men to each instructor; recommended status of instructors.

June 21—Discussion of reports on powdered fuel; specifications and tests for materials; modernizing existing locomotives; train resistance and tonnage rating; topical discussion, "Best Method of Introducing Oil to Cylinders of Superheater Locomotives"; election of officers.

The following officers for the year were elected:

President, William Schlafge, general mechanical superintendent, Erie Railroad; first vice-president, F. H. Clark, general superintendent of motive power, Baltimore & Ohio Railroad; second vice-president, W. J. Tollerton, general mechanical superintendent, Chicago, Rock Island & Pacific Railroad; third vice-president, C. F. Giles, superintendent of machinery, Louisville & Nashville Railroad; treasurer, Angus Sinclair.

The annual meeting of the Railway Supply Manufacturers' Association was held Saturday noon in Convention Hall. At this session the following officers were elected: President, Edmund H. Walker, Standard Coupler Co.; vice-president, Le Grand Parish, American Arch Co.; secretary-treasurer, J. D. Conway.

Two hundred sixty members of the Railway Supply Manufacturers' Association exhibited or maintained reception booths. Among these were the following who exhibited machine tools, machine shop equipment or supplies:

Atkins & Co., E. C., Inc., Indianapolis, Ind. Circular and band metal cutting saws; hacksaw blades, frames and machines.

Besly & Co., C. H., Chicago, Ill. Reception booth; photographs of Besly grinders; samples of Besly staybolt taps, and Besly abrasive circles for disk grinders.

Carborundum Co., Niagara Falls, N. Y. "Carborundum" and "Aloxite" abrasive wheels.

Chicago Pneumatic Tool Co., Chicago, Ill. Pneumatic and electric tool and speed recorder.

Clipper Belt Lacer Co., Grand Rapids, Mich. Belt lacing machine.

Davis Machine Tool Co., Inc., Rochester, N. Y. 12-inch motor-driven lathe; 16-inch quick-change gear lathe; 24-inch turret lathe; 4½-inch cutting-off machine; keyseater; 16-inch shaper.

Duff Mfg. Co., Pittsburg, Pa. Ball-bearing screw jacks; car jacks, etc.

Gibb Instrument Co., Pittsburg, Pa. "I-Rite" optical pyrometer.

Gilbert & Barker Mfg. Co., Springfield, Mass. Lubricating pumps and outfits.

Greene, Tweed & Co., New York City. Packing for piston rods, valves, pumps, etc.; "Favorite" reversible ratchet wrench.

Greenfield Tap & Die Corporation, Greenfield, Mass. Screw cutting tools, taps, dies, reamers, gages, automatic die-heads, etc.

Haring, Ellsworth, New York City. High-speed, alloy and carbon steels, and specialties.

Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa. Complete line of chain hoists.

Independent Pneumatic Tool Co., Chicago, Ill. Reception booth.

Ingersoll-Rand Co., New York City. Pneumatic chipping, scaling and riveting hammers; pneumatic drills; motor hoists.

Johns-Manville Co., H. W., New York City. Pipe coverings; asbestos roofing, etc.

Keller Mechanical Engraving Co., Brooklyn, N. Y. Automatic die-sinking machine.

Keller Pneumatic Tool Co., Chicago, Ill. Pneumatic tools.

Lubricating Metal Co., New York City. "Noheet" bearing metal; die-cast bearings; piston and ring packing.

Milburn Co., Alex., Baltimore, Md. Acetylene welding and cutting outfits.

National Tube Co., Pittsburg, Pa. Reception booth.

Nuttall Co., R. D., Pittsburg, Pa. Gears; flexible couplings; expansion joints.

Nutter & Barnes Co., Hinsdale, N. H. Metal cutting-off saw; saw sharpener; abrasive cutting-off machine.

Phoenix Mfg. Co., Eau Claire, Wis. "Conradson" turret; turret toolposts.

Quigley Furnace Specialties Co., Inc., New York City. Demonstration of "Hy-tempite" furnace cement.

Rich Tool Co., Chicago, Ill. Reamers, drills, and rivet sets.

Simonds Mfg. Co., Fitchburg, Mass. Hacksaw blades; metal cutting saws; files.

Warner & Swasey Co., Cleveland, Ohio. 2-A hollow hexagon turret lathe for bar work; 3-A hollow hexagon turret lathe for chucking work.

Watson-Stillman Co., New York City. Hydraulic jacks.

Wilson Welder & Metals Co., Inc., New York City. Electric welding equipment.

Yale & Towne Mfg. Co., New York City. Chain hoists; trolleys; electric hoists; locks.

PERSONALS

A. F. Orcutt has been appointed general manager of the Rivett Lathe & Grinder Co., Brighton District, Boston, Mass.

C. A. Towle has been appointed production manager of the factory of the Rivett Lathe & Grinder Co., Brighton District, Boston, Mass.

W. Wetsel, who has for some time been associated with the Baush Machine Tool Co., at Springfield, Mass., will be in charge of the company's new office, located in the Dime Bank Bldg., Detroit, Mich.

O. Bruenauer, Western sales manager of the Gurney Ball Bearing Co., located at Detroit, has removed to the home office at Jamestown, N. Y., to assume the duties of general sales and advertising manager.

H. C. Burdick, for three years assistant advertising manager of the American Multigraph Co., Cleveland, Ohio, has taken the position as advertising manager of the Glidden Varnish Co., Cleveland.

D. W. Patten, for several years with the Windsor Machine Co., Windsor, Vt. (now the National-Acme Mfg. Co.), selling the Gridley automatic lathe in Ohio, will represent the New Britain Machine Co., New Britain, Conn., in the same territory.

F. R. Blair, formerly secretary, treasurer and sales manager of the S. K. F. Ball Bearing Co., has resigned to become president of F. R. Blair & Co., Inc., with offices at 50 Church St., New York City. Mr. Blair will be engaged in developing motor efficiency devices.

Isaac H. Levin has resigned as chief engineer and chemist of the International Oxygen Co., and will from now on devote his time to chemical research as a specialist in the electrolytic field. Mr. Levin will be located temporarily at 186 Hillside Ave., Newark, N. J.

Henry M. Shaw, formerly Eastern representative of the Gardner Machine Co., Beloit, Wis., has joined the Sherritt & Stoer Co., Inc., 603 Finance Bldg., Philadelphia, Pa., and will represent the company in the sale of machine tools, railway and machine shop equipment, giving special attention to the Gardner Machine Co.'s products.

Alexander Luchars, publisher of MACHINERY, sailed for Liverpool on the *Kroonland* on June 29, and will be abroad several months. He expects to visit England, Holland, Switzerland, Italy, France and Germany, to study conditions in the machine tool and kindred industries, and form some opinion regarding the outlook in the machinery field after the war closes.

Walter N. Polakov, recently superintendent of power of the New York, New Haven & Hartford Railroad, and consulting engineer to the Board of Estimate and Apportionment of the city of New York, is now directing the work of David Vershbinsky, Inc., engineer and exporter, 31 Nassau St., New York City. Mr. Polakov will also act as consulting engineer for the management of power plants.

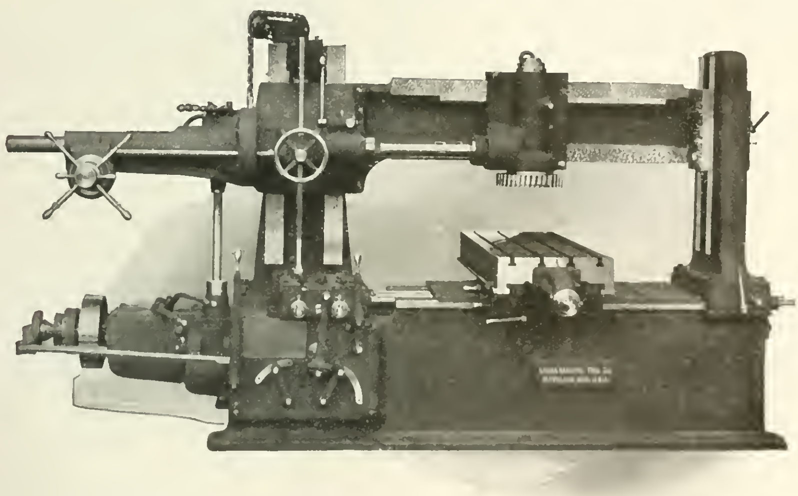
C. F. Herington, assistant engineer in the office of the mechanical engineer of the New York Central Railroad, has resigned to take a position with the Bonnot Co., Canton, Ohio, as mechanical engineer of the powdered coal department. Mr. Herington's experience with the New York Central Railroad, Pennsylvania Railroad, and Westinghouse, Church, Kerr & Co., with whom he has been associated for the past twelve years, should prove of value to him in his new position.

Dr. Robert Gans of Pankow, near Berlin, Germany, has been awarded the Elliott Cresson gold medal by the Franklin Institute for his discovery and development of "Permutit." Permutit is sodium-alumino-silicate used for softening water, having the remarkable property of exchanging its sodium for the hardening ingredients—calcium and magnesium—in water filtered through it. When the "Permutit" has been exhausted of its sodium, it may be regenerated with a solution of common salt.

DO you make DIES or MOLDS that are TOO LARGE for a regular DIE SINKING MACHINE and have to be made in sections and built up, thus increasing the cost, and decreasing the strength and life of the die? If so, the

LUCAS "PRECISION"

Boring, Drilling and Milling Machine



WITH VERTICAL MILLING ATTACHMENT

IS IT

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

F. E. Wells, formerly president of the F. E. Wells & Son Co., Greenfield, Mass., manufacturer of machinery, taps, dies, etc., has retired from business, after fifty years of active work. Mr. Wells started in the cutlery business in 1866, later engaged in the paper business and in 1873 was identified with the Wiley & Russell Mfg. Co. Later in company with his father and F. O. Wells, he started the Wells Bros. Co. In 1900 he sold his interest in the Wells Bros. Co., and with Fred W. Wells, his son, started the present business. F. O. Wells, F. H. Payne and W. M. Pratt have lately taken a controlling interest in the company.

OBITUARIES

Einar G. Lindstrom, production manager of the Putnam Machine Co., Fitchburg, Mass., was killed instantly in an automobile accident June 15. Mr. Lindstrom leaves a wife and four children.

John D. Hughes, superintendent of the Putnam Machine Co., Fitchburg, Mass., was killed in an automobile accident June 15. Mr. Hughes was forty-two years of age, and is survived by his wife.

COMING EVENTS

July 27. Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

August 15.—Annual meeting of the International Railroad Master Blacksmiths Association, Chicago, Ill. A. L. Woodworth, secretary and treasurer, C. H. & D. Ry., Lima, Ohio.

September 5-8.—Annual convention of the Traveling Engineers' Association at Chicago, Ill. W. O. Thompson, secretary, New York Central Car Shops, E. Buffalo, N. Y.

September 11-16. Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Delaware College, Newark, Del. Catalogue 1915-1916 with announcements for 1916-1917.

University of Vermont, Burlington, Vt. Catalogue for 1915-1916, with announcements for 1916-1917.

Louisiana State University, Baton Rouge, La. Catalogue 1915-1916, with announcements for 1916-1917.

Thomas S. Clarkson Memorial College, Potsdam, N. Y. Bulletin containing views of the various departments of the college.

Pratt Institute, Brooklyn, N. Y. Catalogue 1915-1916, containing calendar for 1915-1916 and general information regarding courses.

University of Nebraska, Lincoln, Neb. Forty-sixth annual general catalogue containing complete record for 1915-1916 and announcements for 1916-1917.

American Association of Labor Legislation, 131 E. 23rd St., New York City. Booklet entitled "Health Insurance," containing standards and tentative draft of an act submitted for criticism and discussion of those interested in compulsory insurance of workmen against sickness.

State Normal and Training School, Buffalo, N. Y. Circular of information concerning courses for training vocational teachers, 1916-1917. The vocational work is grouped under two general heads, trade group and book work group, the former qualifying for teaching the trades themselves and the latter for teaching book work, applied science, industrial geography, history, mathematics, etc., which are correlated with the hand work in the best types of vocational schools. The school is prepared to give pedagogical training for teaching most of the recognized skilled trades.

NEW BOOKS AND PAMPHLETS

An Investigation of the Laws of Plastic Flow. By Eugene C. Bingham. 43 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 278.

Strength and Stiffness of Steel Under Biaxial Loading. By Albert J. Becker. 65 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 85. Price, 35 cents.

Tests of Reinforced Concrete Flat Slab Structures. By Arthur N. Talbot and Willis A. Slater. 128 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 84. Price, 65 cents.

Constants of the Quartz-wedge Saccharimeter and the Specific Rotation of Sucrose. By Frederick Bates and Richard F. Jackson. 60 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 268.

Weights and Measures. 254 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C.

This booklet contains the proceedings of the tenth annual conference of representatives from various states held at the Bureau of Standards, Washington, D. C., May 25-28, 1915.

Industrial Accident Prevention. 54 pages, 6 by 9 inches. Published by the Department of Labor, under the direction of the Industrial Commission, Washington, D. C., as Special Bulletin 77.

This bulletin takes up accident prevention experience and reproduces a number of charts showing graphically the accident experience of various large companies. It discusses means of preventing accidents under the following heads: nature of the problem; responsibility of employer, responsibility of foremen, safety and output, mechanical guards, shop housekeeping, industrial hygiene, fatigue and safety, welfare work and safety, responsibility of employe, the mental hazard, educating the new man, need for safety education, safety advertising, discipline, organization, workmen's committees, suggestions from workmen, investigation of accidents, score-board competition, selection of men, functions of medical department, first aid, protection of eyes, miscellaneous causes of accidents.

Workshop Hints for Munition Workers. By Bernard E. Jones. 156 pages, 5 by 7¼ inches. Illustrated. Published in America by Funk & Wagnalls Co., New York City. Price, 50 cents; by mail, 58 cents.

This is an elementary work intended for the instruction of munition workers who have had no mechanical experience and are unfamiliar with mechanical terms and processes generally. The common tools and machines are illustrated and described, such as hammers, hacksaws, spanners, files, scrapers, lathes, drills, calipers, micrometers, wire gages, milling machines, gear cutters, grinding machines, etc. The operations of forging, scraping, centering, turning, boring, taper turning, drilling, milling, screw cutting and measuring are illustrated and described in the simplest terms. The work is compiled largely from articles contributed to an English publication called "Work," and the methods described pertain to British practice generally.

Mechanical Engineers' Handbook. Editor-in-Chief, Lionel S. Marks. 1836 pages, 4½ by 7 inches. Published by the McGraw-Hill Book Co., New York City. Price, $5.

This handbook is based on the well-known German engineering handbook generally referred to as "Hutte," and is intended to present in the English language an authoritative reference book covering the field of mechanical engineering in a comprehensive manner. It differs, therefore, very materially from previously published American handbooks in that it deals more thoroughly with the theoretical basis of engineering, devoting 186 pages, as it does, to the subject of mathematical tables and mathematics, and nearly 200 pages to mechanics and thermo-dynamics. The following sections of the work deal with strength of materials, materials of engineering, machine elements, power generation, hoisting and conveying, transportation, building construction and equipment, machine shop practice, pumps and compressors, electrical engineering, engineering measurements, mechanical refrigeration, and miscellaneous subjects. In the preparation of this work the editor-in-chief has been assisted by a staff of about fifty specialists, and the work gives the appearance of having been prepared with considerable care; but much of the contents indicates clearly that the editor and his collaborators had in mind mainly the technically trained mechanical engineer rather than the practically trained man when preparing this handbook, and for men of the former type it will undoubtedly prove the most comprehensive and authoritative book of its kind published in English. To obtain full benefit from the work, however, the user must possess considerable engineering training. The information given on machine tools and machine shop practice occupies about seventy pages of the work and contains many valuable tables, but the text matter is rather too abbreviated to convey much detailed information. However, in a work of this kind this may not be considered necessary, as it aims to cover briefly the whole field of mechanical engineering, and those wishing to obtain detailed information upon such subjects as machine shop practice would seek that in books specifically devoted to that subject.

NEW CATALOGUES AND CIRCULARS

Russell Mfg. Co., Greenfield, Mass. Catalogue 2 on Russell opening-die screw plates, double reversible-die screw plates, full mounted screw plates, etc.

Yeomans Bros. Co., 231 Institute Place, Chicago, Ill. Bulletin S 1000, descriptive of small electrically driven centrifugal pumps for all classes of buildings.

Davis Machine Tool Co., Inc., Rochester, N. Y. General catalogue of engine lathes, turret lathes, tool-room lathes, cutting-off machines, keyseaters, shapers, and drilling machines.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Bulletin 48905 illustrating and describing Sprague electric S-1 hoists of one-half and one ton capacities.

Perkins Grinder Co., American Trust Bldg., Cleveland, Ohio. Circular describing the Perkins 10 by 36 plain self-contained grinding machine with center control and automatic and hand feeds.

Pierce Machine Tool Co., 617 W. Jackson Blvd., Chicago, Ill. Circulars illustrating Pierce 1- by 8-inch heavy-pattern turret screw machine with plain head, and 14-inch heavy-pattern turret lathe with plain head.

Rockefeller Motor Co., 2279 Clarkwood Road, Cleveland, Ohio. Bulletin 10 of "Perfection" engine lathes made in three sizes, 16-inch swing with 6-foot bed, 18-inch swing with 8-foot bed, and 20-inch swing with 10-foot bed.

Chain Belt Co., Milwaukee, Wis. Folder 64 describing Chain-Belt traveling water screens, designed primarily to remove refuse and foreign material from water before it enters power plants, steel mills or other industrial plants.

Ready Tool Co., 654 Main St., Bridgeport, Conn. Catalogue 14, entitled "The Vital Factor in Cutting," illustrating "Red-E" lathe tools, threading tools, cutting-off tools, side tools, boring tool-holders, milling machine dogs, lathe dogs, etc.

Schuchardt & Schutte, 90 West St., New York City. Circular of the S. & S. tachoscope, a precision revolution counter combined with anti-magnetic stop watch. The instrument may be used for speeds up to 30,000 revolutions per minute.

Lansing Stamping & Tool Co., Lansing, Mich. Bulletin 2 of the "Capital" internal grinder, having a capacity of from 3/16 inch to 2 by 2 inches. The wheel-spindle is mounted in S. K. F. ball bearings, and is capable of being run at 30,000 revolutions per minute.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Revised discount sheet applying to prices quoted in Cutler-Hammer catalogue, which has the effect of raising the present prices approximately 10 per cent. This has been made necessary by the increase in cost of material.

J. R. Shays, Jr., 47 W. 34th St., New York City. Folder descriptive of the Lloyd flexible coupling for use in connection with direct-connected motor-driven apparatus. The circular gives a table of prices, dimensions and ratings, and will be sent upon request to those interested.

Webster & Perks Tool Co., Springfield, Ohio. Catalogue of bolt pointing, threading and special tapping machines. The threading machines are made with one, two, four and six spindles, and in a special duplex type designed to thread both ends of small studs, clips, etc., simultaneously.

New Departure Mfg. Co., Bristol, Conn. Sheets 67 FE to 70 FE and table of contents for loose-leaf catalogue, describing cylinder block boring machine head, turbine-driven forced draft blower, ball bearing roller mill for milling flour and reversing and change-speed gear head for lathe.

C. W. Hunt Co., Inc., West New Brighton, N. Y. Catalogue 15-3 illustrating and describing Hunt cut-off valves for controlling the flow of coal, ashes, coke, ore, stone, sand, gravel, cement clinker etc. Dimensions are given for the types most frequently used in power-house and storage-pocket design.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 12 discusses the possibilities of the forging machine for producing accurate work and illustrates dies used on National heavy-pattern forging machines for producing taper ring forgings within a close limit of tolerance.

E. J. Codd Co., 700-708 S. Caroline St., Baltimore, Md. Circular of the Wiegand chain screen door for furnaces, ovens and boilers, illustrating and describing a novel and simple chain screen for keeping the heat in and the cold air out when examining the interior of a furnace or supplying fuel.

Kales-Haskel Co., 413 Lafayette Blvd., Detroit, Mich. Circular illustrating special lock washers, metal cups and shells, bearing liners and shims, pipe and wire clips, etc., and containing a list of special washer dies, made in sizes from 3/64 inch inside diameter by 1/4 inch outside diameter to 13 inches inside diameter by 14½ inches outside diameter.

Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York City. Circular 502 illustrating "Jorgensen" adjustable hand screws with jaws that are adjustable to any angle and steel spindles cut with right and left threads. The provision of right and left threads permits opening and closing the jaws much more rapidly than with the old-style clamps.

Carrier Air Conditioning Co. of America, Buffalo, N. Y. Bulletin 253, entitled "Generator Cooling and Cleaning," describing the construction of the Carrier generator cooler and the benefits obtained in cooling and cleaning the air supply for ventila-

tion of turbo-generators. Special attention has been paid to the design of the spray nozzles which are of the non-clogging type.

Fawcus Machine Co., Pittsburg, Pa. Catalogue of Fawcus herringbone gears, stating the advantages of this type of gear, and describing the hobbing process and Fawcus planed gears for rolling mill connecting pinions and very large drives. Fawcus herringbone gear drives and turbine transmissions are illustrated, and tables of dimensions for standard mill drives are given, as well as other data of use in designing herringbone gears.

Strong, Kennard & Nutt Co., 507-521 Schofield Bldg., Cleveland, Ohio. Pamphlet illustrating and describing "Adjustoglas" safety goggles, for protecting the eyes of workmen against heat and flying particles. The "Adjustoglas" goggle is made with a bridge which is adjustable for width and height, and can be adjusted to any angle or any distance from the face. This insures a comfortable protector which will fit any wearer.

Cincinnati Lubricant Pump Co., 126 Opera Place, Cincinnati, Ohio. Circular describing the "Fulflo" grinder pump, a circulating pump which is centrifugal in its action, assuring a large volume of flow without too much pressure. The pump does not need to be submerged or placed below the level of the liquid, and hence can be mounted in the most desirable position on the grinder with regard to convenience of drive and accessibility.

Joseph T. Ryerson & Son, Chicago, Ill. Bulletin 20141 descriptive of the "Riley" universal elliptic spring forming machine, which will form elliptic spring leaves of any size and curvature that are used in ordinary practice, without changing dies. This machine was primarily designed for railroad spring shop use, and in addition to making springs it can also be used for straightening old plates or shaping other articles used about a railroad shop.

L. S. Starrett Co., Athol, Mass. Catalogue 21, containing 336 pages and having sixteen more pages than catalogue 20. Some of the new Starrett tools shown are quick-reading steel rules, metric steel shrink rules, three-foot blacksmiths' steel rules, metric and English blacksmiths' steel rules, metric and English folding pocket rules, drop-forged steel combination squares with metric and English graduations, improved bevel protractors with metric and English graduations, diemaker's square, pocket vernier caliper, "Yankee" one-inch micrometer caliper, vernier height gage, adjustable hacksaw frames, cutting nippers, cutting pliers and drive-pin punches. The prices of tools listed in catalogue 20 no longer hold, and users of Starrett tools should obtain catalogue 21 in order to get the revised prices.

Norton Co., Worcester, Mass. Catalogue of grinding wheels and machinery, giving price lists of straight, cup and cylinder wheels, and illustrating a great variety of shapes of these classes of wheels. There are fifty-five pages of illustrations showing shapes of grinding wheels for use in special machines. In addition, the catalogue contains information on selecting grades of wheels for various classes of work, methods of mounting grinding wheels, speeds of grinding wheels, horsepower required to drive wheels of different sizes, calculating speeds and diameters of pulleys, etc. Crystolon wheels for grinding leather, pearl, granite and marble are illustrated, with specimens of work, as well as alundum wheels for glass cutting. Price lists are also given for alundum and crystolon bricks, used principally for scouring castings, general foundry and machine shop work, dressing and smoothing granite and marble, etc. The Norton line also includes oilstones, valve grinding compounds, dressers, cylinder chucks, grinding wheel stands, protection and dust hoods and countershafts.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City. Anniversary booklet entitled "One Century in Business," describing the development and growth of the company from its inception in 1816 to the present. The business was established at 95 Fair St. (Fulton St.) by Henri Frederic Frasse, who started as a dealer in watch and clockmakers' supplies and repairer. A store was opened in conjunction with the machine shop in which was carried a complete and varied stock of jewelers' supplies and imported fine tools, consisting of files, pliers, nippers, etc. Upon the death of Henri Frasse in 1849 the business was taken over by his son, Peter A. Frasse, under whose name it is now carried on. Later the stock was increased until a complete line of machinists' tools of both foreign and American manufacture was handled, including vises, forges, blacksmiths' tools, etc. In 1900 the Shelby seamless steel tubing department was added to the business. With the outbreak of the present war, the firm was obliged to discontinue its agency of the Poldi Steel Works, and in order to take care of its customers, it began the manufacture of a complete line of electric furnace and open-hearth tool and alloy steels. The story of the growth of this business, which is so closely connected with the growth and development of the country in general, makes interesting reading, and the book, which has been carefully and artistically prepared, is a creditable souvenir of "one century in business."

TRADE NOTES

Bickford Machine Co. has moved from 12 Chapman St. to 305 Wells St., Greenfield, Mass.

Rickert-Shafer Co., formerly located at 1302 Peach St., Erie, Pa., has moved to 612 W. 12th St.

W. Robertson Machine & Foundry Co. has recently moved into its new factory at 32 Greenwood Place, Buffalo, N. Y.

Carlton Machine Tool Co., 1543 Queen City Ave., Cincinnati, Ohio, is successor to the William E. Gang Co., manufacturer of radial drills.

Abrasive Material Co., Philadelphia, Pa., manufacturer of "Abrasive" and "Boro-carbone" grinding wheels, has changed its name to Abrasive Co.

Young, Corley & Dolan, Inc., machine tool dealers, 149 Broadway, New York City, moved July 1 to more spacious quarters on the eighth floor of the U. S. Realty Bldg.

Standard Electric Tool Co., Cincinnati, Ohio, has doubled its manufacturing capacity by the addition of another floor. The business has grown steadily since its beginning.

Mann Corporation, Kankakee, Ill., recently took over the rights of manufacture and sale of the American sash trimmer formerly made by the Heald Machine Co., Worcester, Mass.

Cincinnati Lathe & Tool Co., Cincinnati, Ohio, manufacturer of the "Cincinnati" lathe, is erecting a large addition to its plant which is expected to be ready for operation early in July.

Cincinnati Lubricant Pump Co., Cincinnati, Ohio, maker of the "Fulflo" pumps for machine tool lubrication, has moved from 2270 Spring Grove Ave. to larger quarters at 126 Opera Place.

Van Dorn & Dutton Co., 2706 E. 79th St., Cleveland, Ohio, gear manufacturer, announces the removal of its Denver, Col. offices from the Ideal Bldg., to 1633 Tremont St. C. H. Davidson is the district sales manager.

Schellenbach & Hunt Tool Co., Cincinnati, Ohio, manufacturer of reamers, end-mills, boring tools and cutters, has erected a large addition to its shop which will double the capacity. The business of the company is rapidly growing.

Moltrup Steel Products Co., Beaver Falls, Pa., manufacturer of cold-drawn steel bars, machine keys and racks, finished steel plate and other steel specialties, is erecting a three-story addition to its factory which will triple the present output.

New England Annealing & Tool Co.'s factory at 74 K St., S. Boston, Mass., was destroyed by fire May 21. The company expects, by using a temporary shelter, to be able to use its annealing furnaces until its plans for rebuilding are completed.

International Oxygen Co., 115 Broadway, New York City, recently received an order from Franz Krull, Ltd., Reval, Russia, for a large oxy-hydrogen plant of the unit type generators. The gases produced by this plant are to be used for welding and piped throughout the works.

National Twist Drill & Machine Co., Detroit, Mich., is erecting a three-story concrete and brick office building 42 by 81 feet, and a four-story addition 40 by 19 feet, with L-connection to the present structure 36 by 38 feet. These additions will practically double the present floor space.

Kearney & Trecker Co., Milwaukee, Wis., has completed the addition of two sawtooth roof sections to its plant, 65 by 250 feet. One bay is equipped with a traveling crane and will be used for erection. The new addition and another recently completed add over 20,000 square feet of floor space.

Keuffel & Esser Co., Hoboken, N. J., was rendered a favorable decision by the United States Circuit Court of Appeals in its suit against the distributors of the Shepard pen. The decision upheld the validity of the Keuffel & Esser patent on the Payzant lettering pen and held the Shepard pen to be an infringement.

Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., announces that it has opened an office in the Dime Bank Bldg., Detroit, Mich. W. Wetsel, who has been associated with this company for some time, and who is familiar with all the lines manufactured by the company, including worm-gears for automobiles, will be in charge of the office.

National Scale Co., 6 Mechanic St., Chicopee Falls, Mass., has moved its New York agency from 13 Park Row to 20 Vesey St., Room 309. H. S. Trezevant is in charge. The company manufactures the "National" counting machines, "National-Chapman" elevating trucks, "National" calling system, multi-unit sectional steel shelving and metal stampings.

Lucas Machine Tool Co., Cleveland, Ohio, is building a new erecting shop, 47 by 180 feet, equipped with a 15-ton traveling crane. The present sawtooth sections of the plant open into the addition, and the crane runways of the former are extended sufficiently to permit work to be shifted from the sawtooth section floors to the erecting floor or vice versa by the cranes.

Cincinnati Screw Co., Twightwee, Ohio, has increased its capital stock to $200,000, $100,000 of which is common stock and the remainder accumulated 7 per cent preferred. The plant is growing rapidly and is being operated night and day. The company has found it necessary to expand its equipment in order to take care of the increasing volume of business, and has recently placed orders for a large number of machine tools.

Forest City Machine & Forge Co., 5110 Lakeside Ave., Cleveland, Ohio, lately erected a machine shop 100 feet wide and 226 feet long. The walls are of brick and steel sash. The cross-section is standard, one line of columns down the center supporting fifty-foot trusses and monitor trusses. The building was erected by the Samuel Austin & Son Co. of Cleveland, and was completed in fifteen working days, the work being started May 18 and being practically done June 2.

Canton Foundry & Machine Co., Canton, Ohio, maker of alligator shears, automobile turntables, industrial shop turntables, portable floor cranes and hoists and sheet metal machinery, is building a new shop for the manufacture of its portable cranes. The blacksmith department will also be located in this building. The company is contemplating further extension of its plant, comprising a new and much larger foundry and an addition to the machine shop, which will increase its capacity about 75 per cent.

Silvex Co., Bethlehem, Pa., manufacturer of the Bethlehem spark plug and shock absorbers, is building a new factory, one-story high, covering an area of 315 by 60 feet. There will be a basement under one end extending back 150 feet. It is expected that the plant will have a capacity of 10,000 spark plugs per day with sufficient space to increase the output 50 per cent without enlarging the building. The capacity for shock absorbers will also be 10,000 per year. W. S. Barstow & Co., 50 Pine St., New York City, are the designers and engineers.

L. H. Gilmer Co., Tacony, Philadelphia, Pa., manufacturer of endless belts, belting, webbing, tape, etc., has terminated the arrangement that has existed for a number of years with the R. B. Ridgley Co. of Detroit, Mich., and has opened a branch office in Detroit at 965 Woodward Ave., Hayward Bldg., in charge of W. S. Lewis, who has been assistant purchasing agent for the Cadillac Motor Car Co. for a number of years. The change has been found advisable owing to the heavy increase in the volume of business in the Detroit territory.

R. Martens & Co., Inc., New York City, have leased the new city pier at Stapleton, S. I., for a period of thirty years, at an annual rental of $42,000 for the first ten years, with increasing rental for each succeeding ten years. This pier is 1300 feet long and will accommodate four average sized cargo steamers at one time. The company is developing Russian-American trade, and in view of the great possibilities in that field for goods of American manufacture, the new pier was acquired to take care of the business. An enormous quantity of freight is already piled up on the pier.

F. E. Wells & Son Co., Greenfield, Mass., has been purchased by F. O. Wells, W. M. Pratt and F. H. Payne. The new officers of the company are F. O. Wells, president; F. H. Payne, vice-president; and Frank A. Yeaw, treasurer. These men, together with W. M. Pratt and Fred W. Wells, will constitute the board of directors. The business was established by F. E. Wells, and Mr. Wells, while retaining an interest in the company, now retires from active business. The company manufactures machinery, speed lathes, grinders, screw machines, tapping machines, as well as pipe tools, screw plates, taps, dies and similar tools.

Norma Co. of America, 1790 Broadway, New York City, manufacturer of "Norma" ball bearings, has purchased a ten-acre factory site at Elmhurst, L. I., on the outskirts of Long Island City. The property fronts on Queens Boulevard, and abuts in the rear upon the main line of the Long Island Railroad, from which a siding will be built directly into the plant. Plans are being made for the erection of a four-story building 70 by 350 feet, to be constructed of reinforced concrete. During the past five years the company has become prominently identified with the automobile industry as a maker of ball bearings, and its bearings are being extensively used in magnetos, lighting generators, etc.

Gisholt Machine Co., Madison, Wis., has recently extended its manufacturing facilities by the purchase of the Northern Electric plant in Madison, owned by the General Electric Co. The plant is of brick and steel construction, well lighted and heated and provided with a sprinkling system throughout. The equipment is modern, and all the machine tools are motor driven. The company also has works at Warren, Pa., where the Gisholt universal tool grinders and vertical boring mills are built. The Madison works will continue to build hand and automatic Gisholt turret lathes, horizontal boring and drilling machines, reamers, boring-bars, tool-holders, chucks and the special tool equipment used on Gisholt machines generally.

CLASSIFIED AND WANT ADVERTISEMENTS

Will be found on pages 292-293 of this issue and will be run in the same relative position in future.

CONTENTS
August 1916

Vol. 22
No. 12

Chicago, Milwaukee & St. Paul Electric Locomotive with Ball Bearing Motor Generator

THE INDUSTRIAL PRESS, Publishers, 140-148 Lafayette Street, New York

Business is Barter

Business is now so multifarious and complex that we forget its essentially simple function, which is barter—the exchange of commodities. This fundamental, unchanging principle is often and easily lost sight of in modern commercial business. The ancient custom of barter has worked up into a vast world-wide business, involving an incalculable number of transactions, but the purpose and effect of it all is as single and simple as was the barter of Long Island land by Wyandanch, the Indian Chief, for twenty-four English knives, coats and axes.

Some of the people who are speculating about what will happen after the war seem to forget that all business is barter. They are afraid our markets will be cluttered, that we must buy, but cannot sell. When hostilities cease, vast numbers of workers engaged in unproductive and destructive warfare must take up again the tools of industry to live and to produce the *commodities* needed to pay hereafter for the unproductive time they have spent, and the destruction they have caused. There is absolutely no other way. Most of what has been spent for the war is still owed for, and the new securities are merely *titles to commodities to be produced hereafter* by the peoples now at war. European statesmen and thinkers understand this and are instituting plans, accordingly. Russia, for example, is preparing to develop her industries to the utmost. She knows it is through the labors of her people that her debts will be paid, her wealth produced, and in no other way. So she is laying down great works for the development of her industries and great railways for the distribution of the commodities they will produce. That land alone represents a vast new market for American products. And all the others will come into the world's markets with the products peculiar to their soil, the quality and variety of which make the market and enliven the traders. They come to the market to *trade*, to *barter*, not merely to sell. With the revival of production, with exchange universal, free, untrammeled, there should be an era of extraordinary industrial development throughout the world, and great opportunities for the enterprising and wide-awake.

25" New Model.
Tapping Attachment.
Gear Connected Motor Drive.

The Largest Exclusive Builders of Upright Drilling Machines in the United States

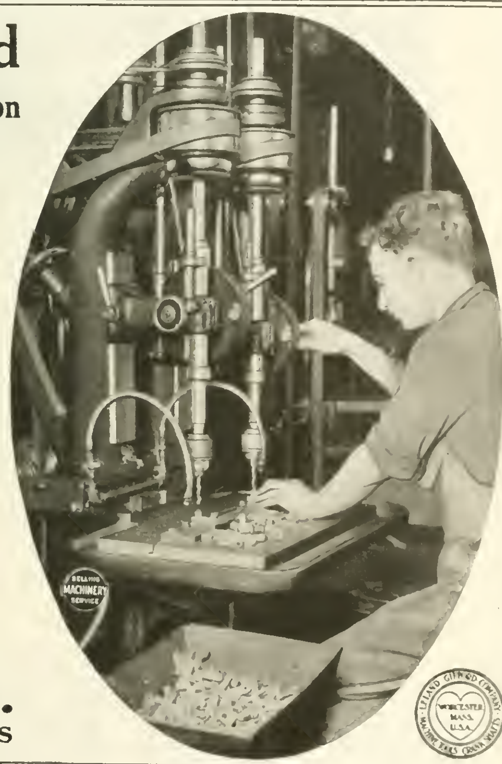
THE SNYDER Drilling Machines have great range of feed, being nearly double that on other makes. Especially adapted to boring long holes. Strong gear feed; main column and back brace with one exception is one solid piece of casting. Very accurate, rigid and powerful. Great producers.

Send for New Catalog *For Sale by Machine Tool Dealers*

J. E. SNYDER & SON, Worcester, Mass., U. S. A.

This Leland-Gifford

Trebled the Best Previous Production



The Willys-Overland Company (Toledo plant) formerly drilled these malleable iron brackets on a single spindle machine at the rate of 1300 in 9 hours.

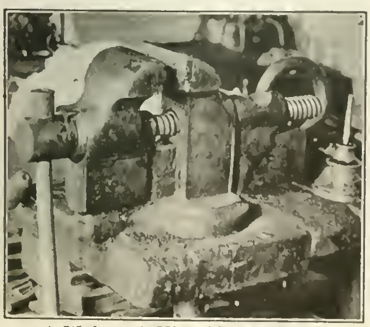
A two spindle "Leland-Gifford," fitted with Power Feed Attachment, now drills 4000 pieces in the same time and at the same labor cost.

The holes are 5-16" diameter, 3-16" deep.

Doubling the number of spindles in this particular case more than trebled production. Perhaps a "Leland Gifford" Drilling Machine could do as much for you. We'll be glad to offer suggestions if you'll send samples or blue prints.

Leland-Gifford "Sensible Sensitive" Drilling Machines can be furnished either with or without Power Feed Attachment. Many other features. Send for circulars.

Leland-Gifford Co.
WORCESTER MASSACHUSETTS



A Walworth Vise 27 Years Old

THE WALWORTH VISE

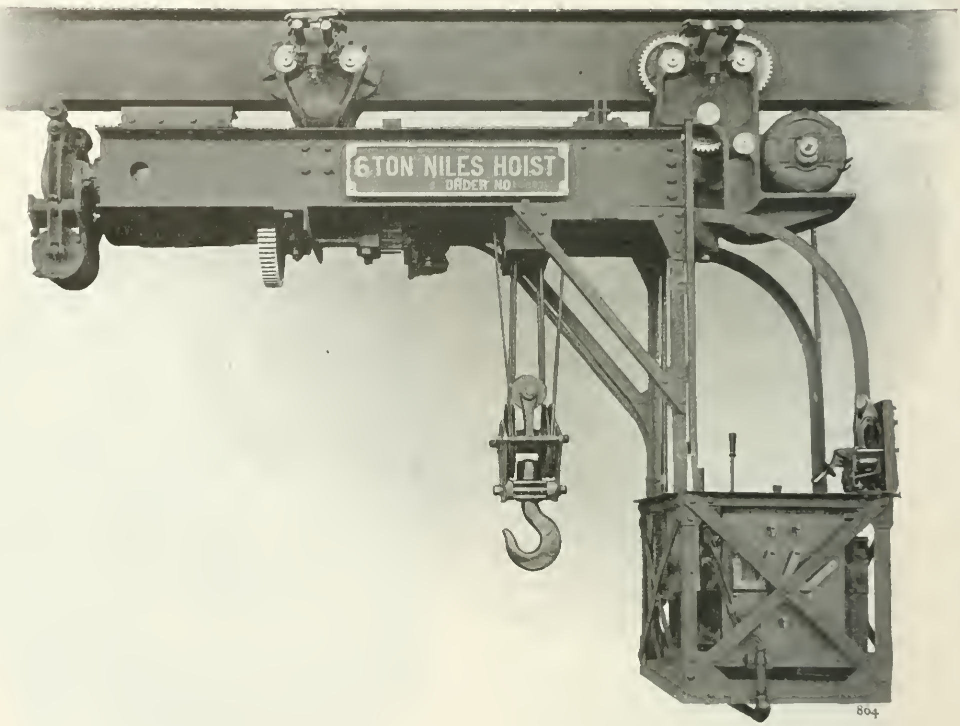
WEIGHT 73 POUNDS

Unequaled for Pipe Work
Unexcelled for Machine Work
Stays on the Job for a Generation

WALWORTH MANUFACTURING CO.
New York BOSTON, U. S. A. Chicago

Mono-Rail Trolley Hoist

Load carried from one point to any other by transfer bridge and I-beam tracks



THE single I-beam track on which the trolley runs can be arranged in an almost endless variety of ways; spur tracks can be run out at intervals over the gallery floor; a track may be curved around to run lengthwise of the gallery floor; tracks may be run off to the various buildings of an extensive plant; tracks may be run either across or lengthwise of railway sidings, for the unloading of cars. The cage for the operator is attached to the trolley so that he is always with the load.

Write for our 90-page Catalog, "Niles Electric Traveling Cranes," showing various uses to which the above trolley is being applied.

NILES-BEMENT-POND COMPANY

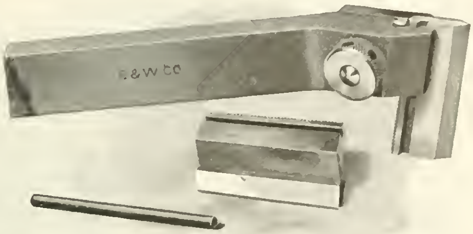
111 Broadway, New York City **25 Victoria St., London, S. W.**

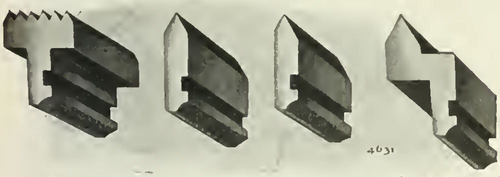
SALES OFFICES AND AGENCIES—**Boston:** 93-95 Oliver St. **Philadelphia:** 405 N. 21st St. **Pittsburgh:** Frick Bldg. **Cleveland, O.:** The Niles Tool Works Co., 730 Superior Ave. **Hamilton, O.:** The Niles Tool Works Co. **Cincinnati:** The Niles Tool Works Co., 336 W. Fourth St. **Detroit:** Kerr Machinery Bldg. **Chicago:** W. Washington Blvd. and N. Jefferson St. **St. Louis:** 516 N. Third St. **Birmingham, Ala.:** 2015 First Ave. **San Francisco:** 16 to 18 Fremont St. **For Colorado, Utah, Wyoming and New Mexico:** Hendrie & Bolthoff Manufacturing & Supply Co., Denver. **For Seattle, Wash.:** Hallidie Machinery Co. **For Canada:** The John Bertram & Sons Co., Ltd., Dundas, Montreal, Winnipeg, Vancouver. **Japan:** The F. W. Horne Co., 6 Takiyama-cho, Kyobashi-ku, Tokio. **Italy:** Ing. Ercole Vaghi, Milan. **France:** Glaenzer & Perreaud, 18 Faubourg du Temple, Paris. **Russia:** S. G. Martin & Co., Ltd., Petrograd and Moscow. **Holland:** R. S. Stokvis & Zonen, Ltd., Rotterdam. **Brazil:** Comptoir-Technique Bresilien, P. O. Box 802, Rio de Janeiro.

One Holder for Chasers and Single Point Cutters

and the change can be made in a jiffy on the

P. & W.
THREADING TOOL





A Few of its Advantages:

1. Threads can be cut very close to a shoulder.
2. Tools are sharpened by simply grinding off top of cutter.
3. Combines economy with all features essential in a threading and forming tool.
4. Cutters have 15° clearance which experience has taught gives the longest wear in various metals.

Place a trial order with our nearest store.

PRATT & WHITNEY COMPANY
HARTFORD, CONNECTICUT

OFFICES AND AGENCIES CARRYING P. & W. SMALL TOOLS IN STOCK:

NEW YORK..........326 Hudson St.
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DETROIT..........Kerr Machinery Bldg.
CHICAGO..........571 W. Washington Blvd.
ST. LOUIS..........516 North Third St.
CINCINNATI..........336 W. Fourth St.
BIRMINGHAM, ALA..........2015 First Ave.
ST. PAUL, MINN., Robinson, Cary & Sands Co.
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NILES CRANES

2 to 200 Tons Capacity
Write for Catalog

NILES-BEMENT-POND COMPANY
111 Broadway, New York City **25 Victoria St., London, S. W.**

For Full List of Offices and Agencies See Opposite Page.

The No. 4-B MILWAUKEE Vertical Miller

on Differential Housings

The Sheldon Axle & Spring Company, Wilkes-barre, Pa., installed this Milwaukee Miller over two years ago. It has given excellent service on high-grade work.

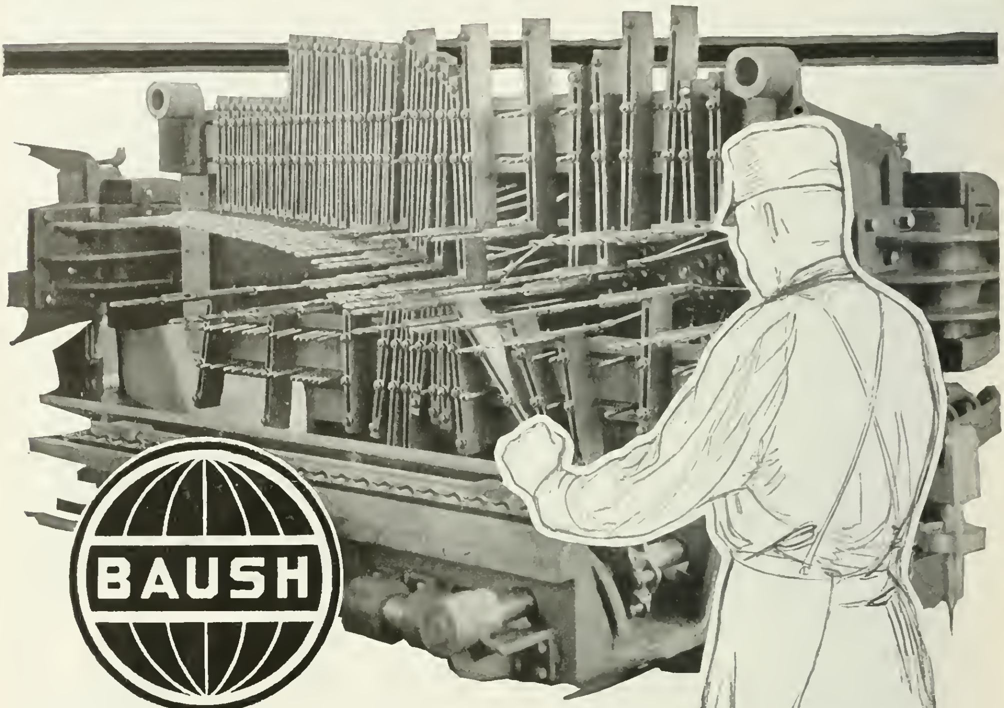
The outside dimensions of the surface to be milled on this housing are 20″ by 15″ and the amount of material to be removed varies from 1-8″ to 3-16″ in depth. The hourly production on this job is two completed housings. The distance from the center of the housing to the face being milled must be held within a limit of 0.005″. The diameter of the cutter used is 17 inches.

The rigid construction of the Milwaukee Vertical Milling Machine makes it possible to do a job of this kind without the slightest indication of chatter. If Milwaukee Millers will give satisfaction on this kind of work are they not worthy of your investigation?

KEARNEY & TRECKER COMPANY

MILWAUKEE, WISCONSIN, U. S. A.

320 SPINDLES!

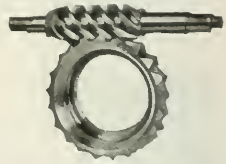


THIS piano plate drilling layout is probably one of the best illustrations that could be shown indicative of the closeness of drill centers permitted by the use of Baush patent adjustable arms.

Not only is this arm extremely compact, but it can be adjusted anywhere within a 10- x 58-in. layout. Each one of these spindles is provided with an adjustment for different length drills, which adjustment is controlled from the extreme outer end of the arm. This particular head has 80 spindles, the machine complete having 320 spindles.

As in all other of the latest type Baush multiple drills, this arm is free from lugs or projections of any kind so that the centers can be as close as the diameter of the spindle itself.

If you have any work requiring the drilling of two or more holes in quantities, you need a multiple spindle drill of some sort. Our years of specializing in the production of multiple spindle drilling machines have equipped us to solve your drilling problems for you. We will appreciate the opportunity to confer with you.

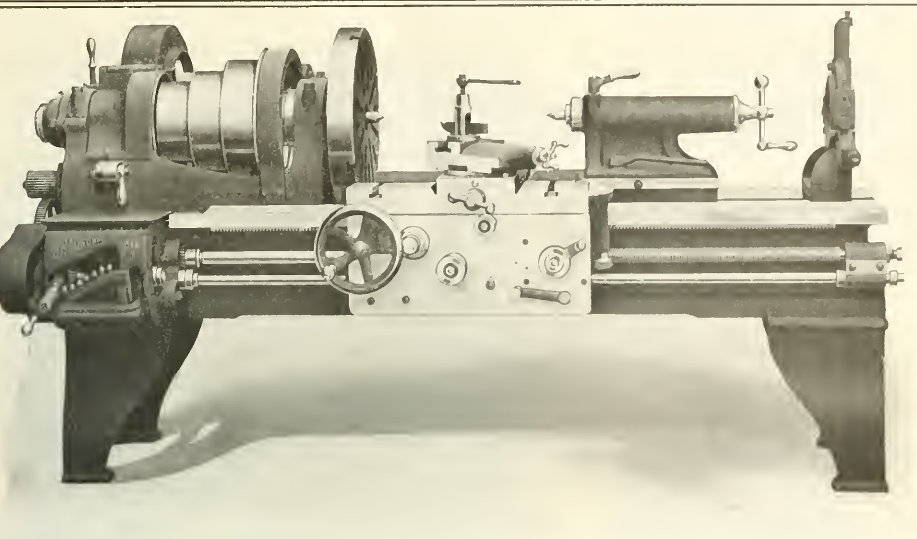


Specialists, also, in the production of worm gear units for motor cars and trucks.

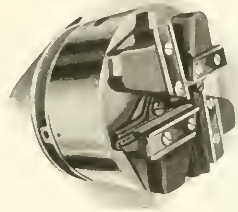
Baush Machine Tool Co., 200 Wason Avenue Springfield, Mass.

New York Office, 50 Church Street

Fenwick Freres & Co., France, Holland, Belgium, Switzerland, Italy, Spain, Portugal. Selson Engineering Co., Ltd., London.



Another Manufacturer
who uses
LANDIS DIE HEADS Exclusively



The Bridgman Bros. Company, Philadelphia, manufacture a high-grade line of steam fitters' supplies. A large battery of pipe threading and cutting machines is necessarily employed and a goodly number of these are Landis Machines, equipped, of course, with the Landis Die Head. Accurate work at the highest possible speed is the requirement at the Bridgman plant, and a check-up of results showed the Landis installation in the lead.

That was about two and one-half years ago. ***Now every pipe machine in this plant, regardless of make, is equipped with a Landis Die Head.***

One of the jobs on which the "Landis" sets a new production record is cutting off and threading 2½″ x 4″ nipples, threaded 1½″ at each end. Have you similar work?

Landis Die Heads are high output tools, made to give long service and to lower threading costs. No hobbing or retempering is required; right and left-hand threads cut with same chasers. Other advantages. *Write for the new catalogue.*

LANDIS MACHINE COMPANY, Inc.
WAYNESBORO, PENNSYLVANIA, U. S. A.

Marshall & Huschart Mchy. Co., Chicago, St. Louis and Indianapolis; Eccles & Smith, San Francisco, Cal.; Los Angeles, Cal., and Portland, Ore.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.; R. B. Whitacre & Co., St. Paul, Minn.; Hallidie Machinery Co., Seattle, Wash.; Williams & Wilson, Montreal, Canada; Alfred Herbert, Ltd., Coventry, England. Alfred H. Schutte, Berlin, Cologne, Brussels, Bilbao and Barcelona; Ernst Krause & Co., Vienna, Austria; D. Drury & Co., Johannesburg, South Africa. Benson Brothers, Sydney and Melbourne, Australia.

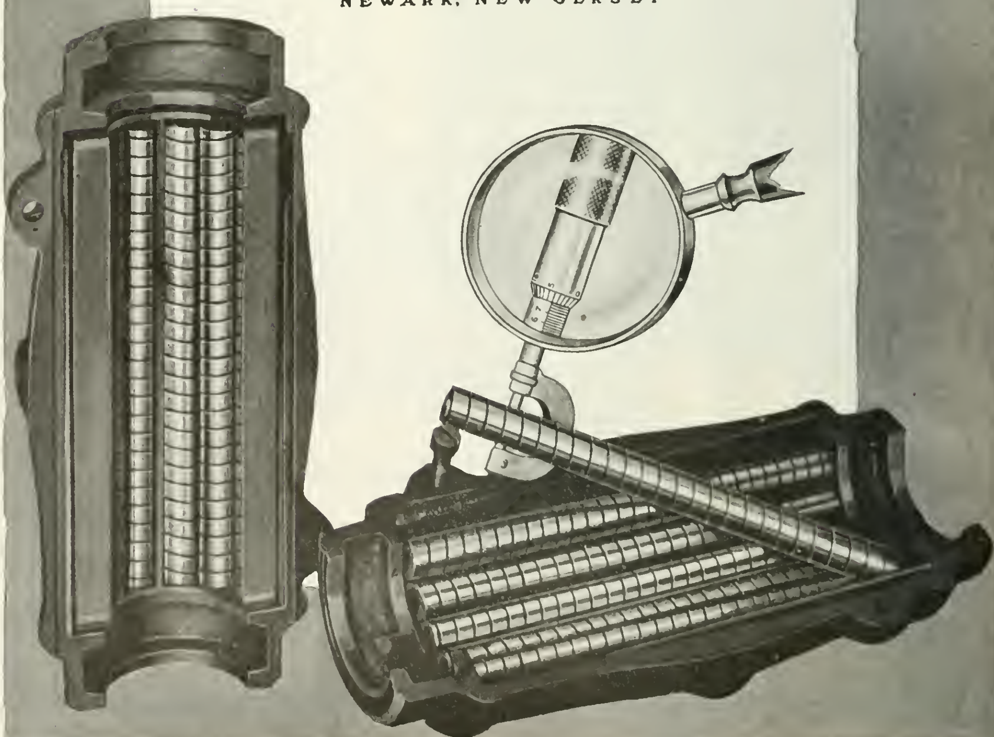
HY·FLEX·ROL

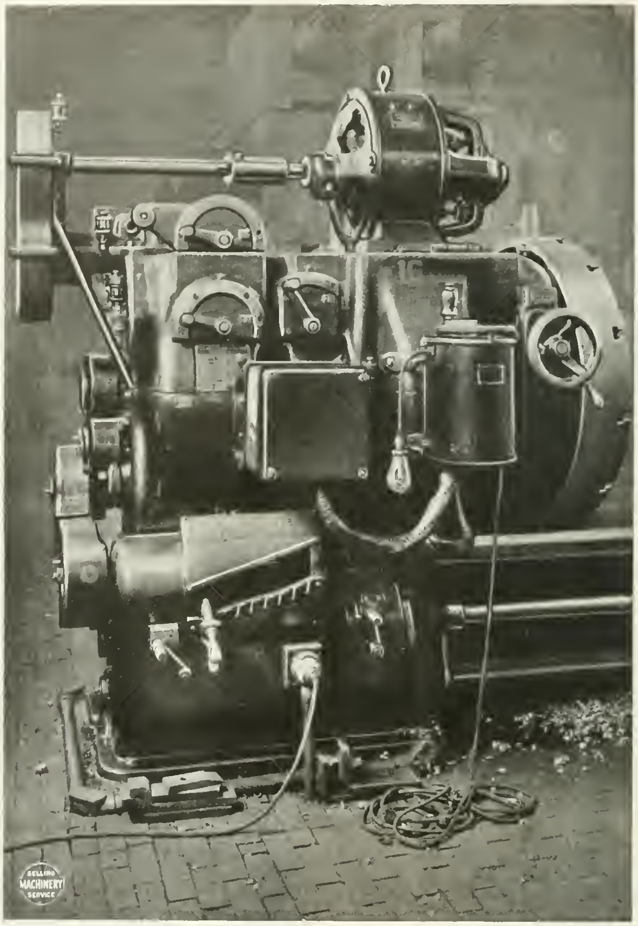
REG. U.S. PAT. OFF.

THIS Hyatt Roller Bearing has been in service 7 years in the plant of the Edison Storage Battery Company, with "no noticeable amount of wear and with no attention but a semi-annual inspection and oiling."

Bulletin 122 will be mailed on request.

HYATT ROLLER BEARING CO.
NEWARK, NEW JERSEY





Speaking of Heavy Lathes

AMER

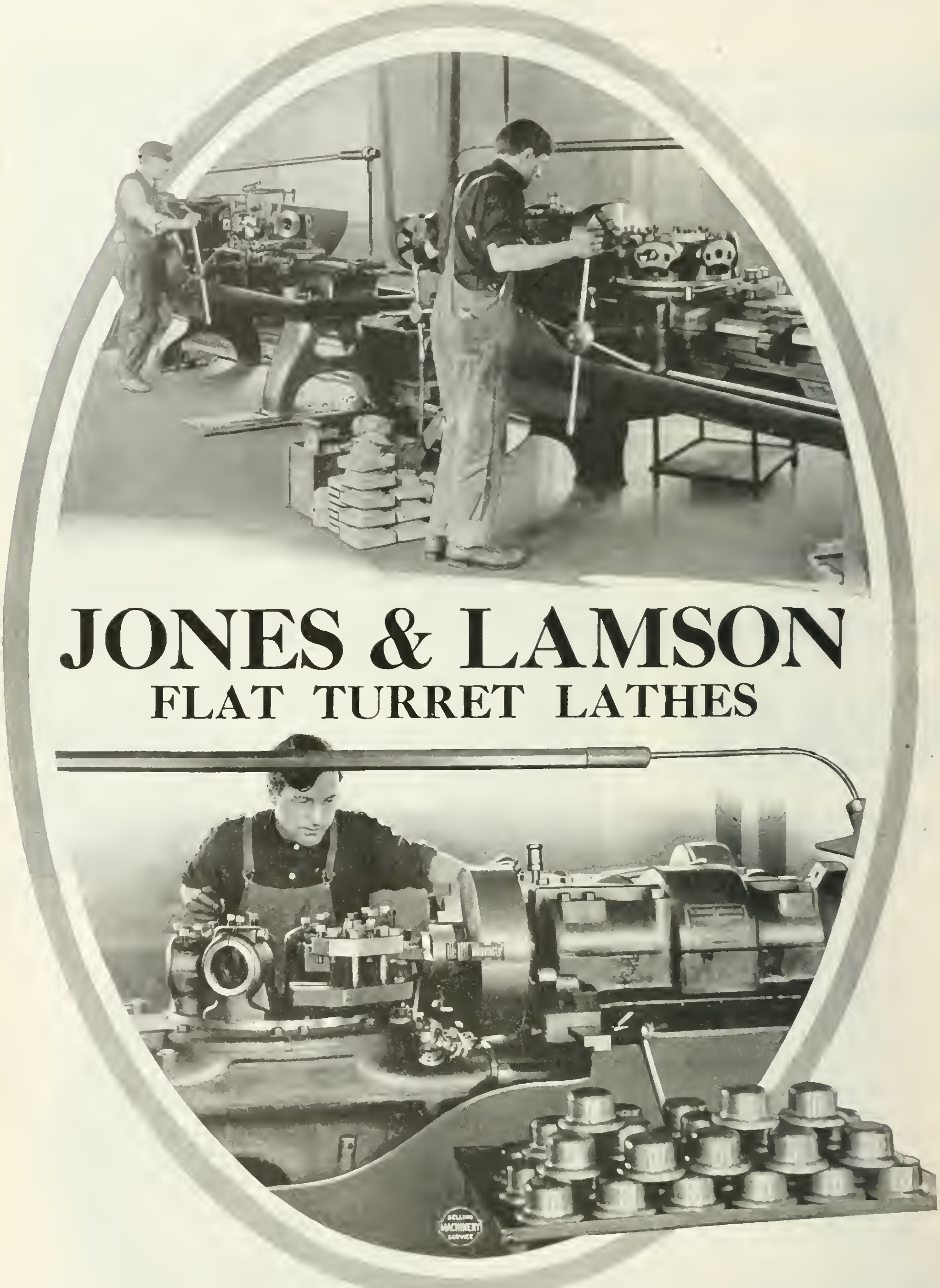
Do you know we make a heavy lathe? No? We do, and it's a good one, too—much like other "American" Lathes except for size; just as well built and carefully designed; as popular, too, with the concerns which own them and the men who run them.

The Morgan & Wright Company, Detroit, owns one of these heavy "Americans"—a 42″ lathe that is considered just about the finest ever. The work shown is small compared to some handled on this machine. It is one of four columns for a big hydraulic press for crushing rubber—12″ x 164½″. The diameter is being reduced 1¼″ at 10 R. P. M., ⅛″ feed. Time to complete, 12 hours.

We'll be glad to send complete descriptions.

THE AMERICAN TOOL WORKS COMPANY,

LATHES SHAPERS PLANERS



Springfield, Vermont
U. S. A.

JONES & LAMSON

Germany, Holland, Switzerland, Austria-Hungary, M. Koyemann, Charlottenstrasse, 112 Dusseldorf, Germany.

Speed is Not the Only Advantage of the Flat Turret Lathe

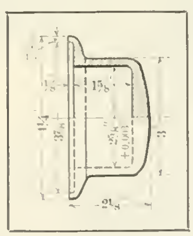
Among the many users of Flat Turret Lathes there is, probably, no better satisfied concern than the Bessemer Gas Engine Company, Grove City, Pa. We've shown, in past advertisements, several pieces of work performed on the three Single Spindle Flat Turret Lathes which comprise the Bessemer installation. The valve cap shown below is another good example of this work.

Writing us about these machines, President John Carruthers of the Bessemer Company says:

> "Rapid production is not the only good quality of your machines, for they can be set to limits of within one thousandth of an inch and turn out work in duplicate, a very great advantage in our line. We have found them very valuable in this respect in machining parts for our new line of No. 4 oil engines which we are making up in sizes of from 20 to 165 H. P. and which require close machining on the valve and pump fittings. We also use these machines almost exclusively on the valve work for our line of air compressors and gas engines."

A satisfied customer is the best advertisement—can you doubt the satisfaction in this case?

The valve cap is made from machine steel which is first cut off into blocks. The first operation is to turn the small end, taking a cut 9-16" deep with a feed of 0.033" per revolution at a cutting speed of 99' surface speed per minute. The finishing cut is taken at the rate of 203' surface speed, using a J & L standard box turner. The second operation is to turn the large end and bore the 2⅝" hole. This is done with a large boring tool, made from Novo Superior Steel, in one cut. The most interesting facts about this job are the comparative engine lathe and flat turret lathe production figures. The former time on the engine lathe was 45 minutes for each piece. Flat Turret Lathe time is 19 minutes. A saving of 26 minutes on each piece.



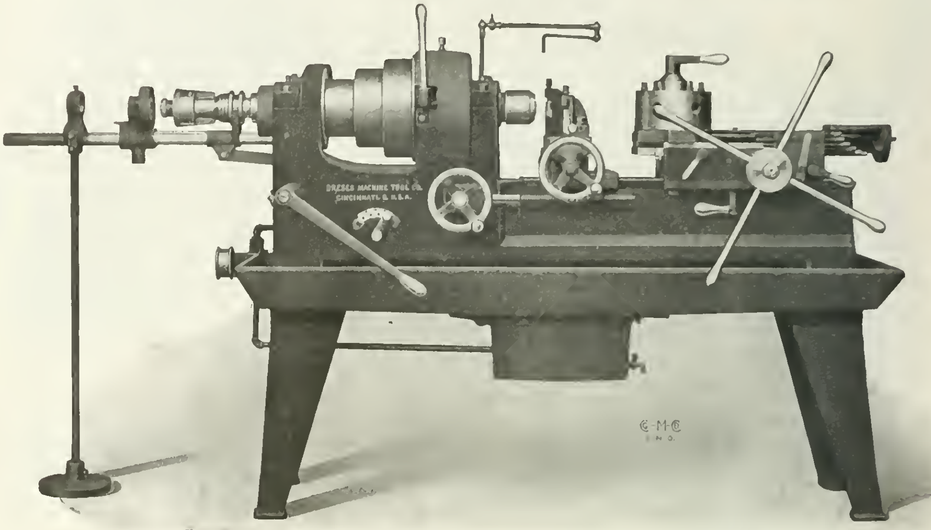
MACHINE COMPANY 97 Queen Victoria St. London, E. C.

France, Spain, Belgium, Fr Auberty & Co., 91 Rue de Maubeuge, Paris.

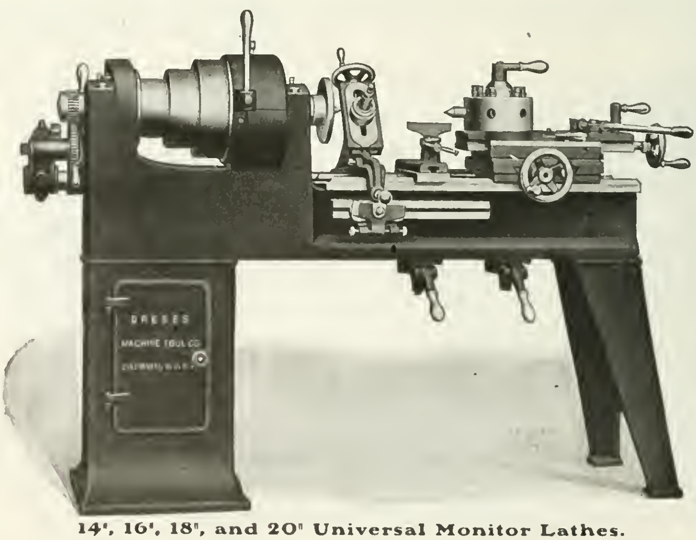
Design and Quality

DISTINGUISH OUR

TURRET LATHES



1", 1 1-2", 2 1-4" Screw Machines. 13", 15", 18" Turret Brass Lathes.



14", 16", 18", and 20" Universal Monitor Lathes.

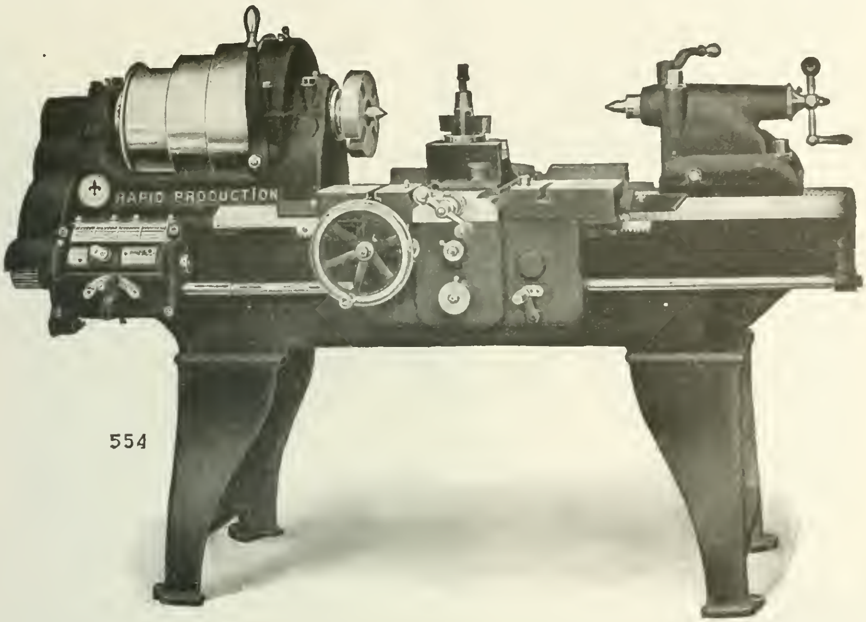
We build complete lines of all styles

DRESES MACHINE TOOL CO.

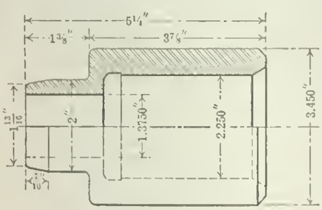
CINCINNATI, OHIO, U. S. A.

REPRESENTATIVES: The Fairbanks Co., New York, Boston, Philadelphia and Buffalo; Carey Machinery & Supply Co., Baltimore; E. L. Essley Machinery Co., Chicago; Badger-Packard Mchy. Co., Milwaukee; Wm. C. Johnson & Sons Mchy. Co., St. Louis; The Chas. A. Strelinger Co., Detroit; Canadian Fairbanks-Morse Co., Montreal and Toronto; Selson Engineering Co., Ltd., London; E. Sonnenthal, Jr., Berlin and Koln; Stussi & Zweifel, Milan, Italy; Manning, Maxwell & Moore, Inc., Mexico City and Yokohama, Japan.

SPEEDING UP—in the Reo Shops with "The LeBlond Rapid Production Lathe"

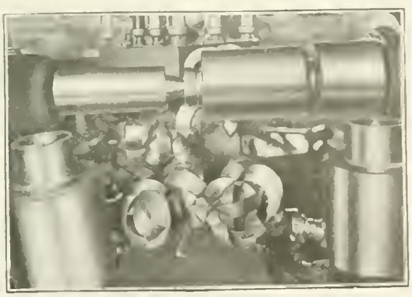


This is the second operation on drive shaft universals for the Reo automobile. The shafts are bored and reamed before they are delivered to the lathe. They are chucked from the bore by an expanding air chuck and the tail spindle brought up to absorb the thrust of the cut. The 1½ inch reduction, ¾ on the side, is taken at a single cut consuming just thirty-one seconds; the turret tool post indexed, bringing in a set of tools for squaring out the shoulder, cutting to length and forming all bevels. The turret is again indexed, bringing up a round nose turning tool which reduces the rest of the body to grinding size. Measuring is entirely eliminated. Cross stops size the diameter and longitudinal stops gauge the length.



Made from .15 Carbon O. H. Steel
FINISHED EXTERNALLY COMPLETE IN TWO MINUTES

Write for catalog describing this machine in detail.



DETAIL VIEW OF OPERATION

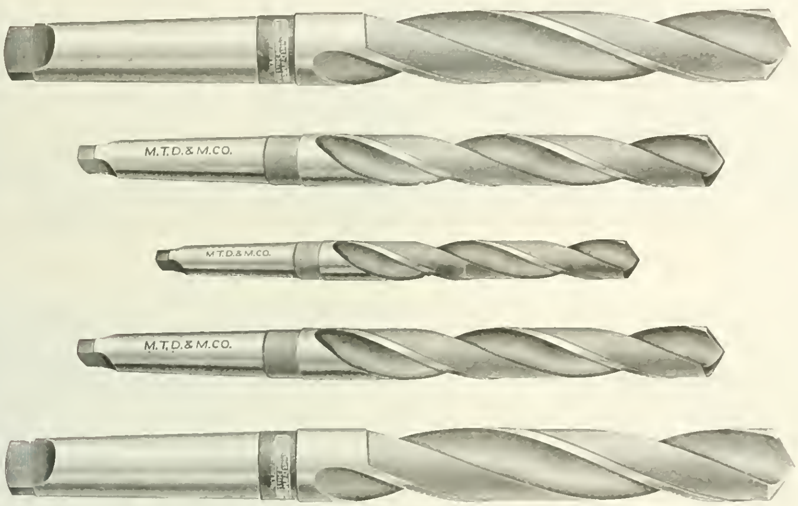
We believe this production is unusual. It is the direct result of LeBlond Heavy Duty Features worked out to the last degree of simplicity.

THE R. K. LEBLOND MACHINE TOOL COMPANY

CINCINNATI, OHIO, U. S. A.

DOMESTIC AGENTS: Niles-Bement-Pond Co., Birmingham, Ala.; Boston, Mass.; Chicago, Ill.; New York, N. Y.; Philadelphia, Pa.; Pittsburgh, Pa.; St. Louis, Mo. Eccles & Smith Co., Los Angeles, Cal.; Portland, Ore.; San Francisco, Cal. Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo. Cleveland Tool & Supply Co., Cleveland, O. J. L. Osgood, Buffalo, N. Y. The E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind. Rumley Wachs Mchy. Co., Chicago, Ill. F. E. Satterlee Co., Minneapolis, Minn. Oliver H. Van Horn, New Orleans, La. Peninsular Mchy. Co., Detroit, Mich. **FOREIGN AGENTS:** Henri Benedictus, Antwerp, Belgium. Benson Brothers, Melbourne, Australia, Sydney, Australia. J. F. Berndes & Co., Havana, Cuba. C. W. Burton, Griffiths & Co., London, England. A. R. Williams Mchy. Co., Ltd., Toronto, Ont., Montreal, Que.; Winnipeg, Man.; St. Johns, N. B. Alfred Herbert, Ltd.; Milan, Italy. J. Lambercier & Cie, Geneva, Switzerland. Schuchardt & Schutte, Copenhagen, Denmark; Berlin, Germany; Stockholm, Sweden; Vienna, Austria; Budapest, Hungary; Prague, Austria. Van Rietschoten & Houwens, Rotterdam, Netherlands.

ARMOR



Worn as a protection to fighting men is again in use, but do you suppose the efficacy of the present devices was tested for the first time on the firing-line?

Why then should you fill your shop with tools bought by price alone or at the instance of some adviser?

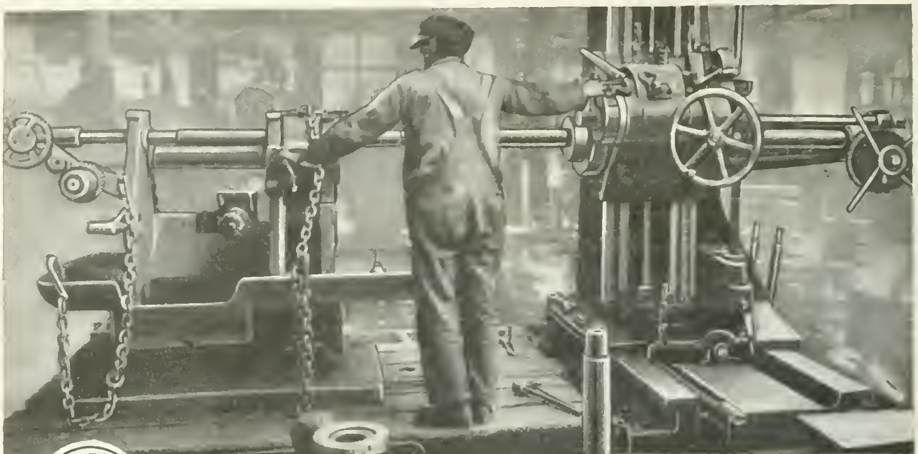
If you wait to test your armor on the battlefield its quality will be proved but you may not know the result.

Make the tests yourself and your next requisitions will specify "Morse" Drills.

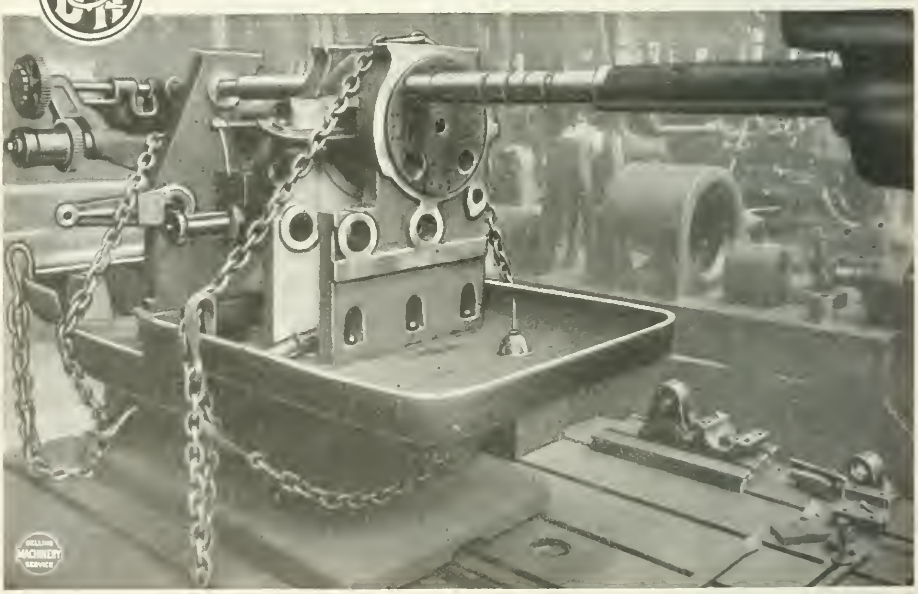
"MORSE" Means Service Every Time

Morse Twist Drill & Machine Co.

New Bedford **Massachusetts**



FLOOR BORING MACHINE



A Necessity in Machine Building

DETRICK & HARVEY MACHINE COMPANY
BALTIMORE
MARYLAND U. S. A.

You may have any number of boring machines that can take *parts* of your machine for milling, boring and facing operations; but unless you have a good boring machine to take your *whole* machine in a unit you will find yourself "up against it" one of these days. Many aligning and transferring operations *must* be performed after the machine is practically done.

The National-Acme Manufacturing Company, Windsor, Vermont, has used a Detrick & Harvey Floor Boring Machine for seven or eight years for boring operations that must be done on the larger parts of the machine or on the assembled machine, such as boring through the spindle holes, as shown in the accompanying photograph. Operations performed in this manner are sure to be in line.

If you are performing work of this kind you can save money by doing it *right*—on a D & H Floor Boring Machine. Let us show you.

OILING

THE DRIVING SHAFTS are oiled by the gravity system from oil reservoirs. The oil is strained through felt pads and fed drop by drop into the bearings where it is continuously circulated by endless spiral oil grooves turned in the solid bushings.

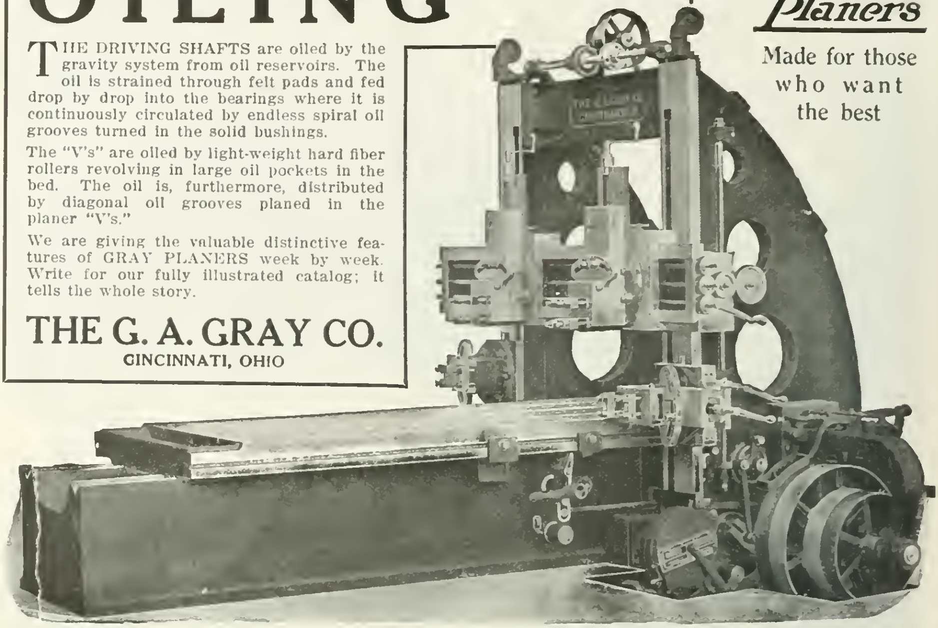
The "V's" are oiled by light-weight hard fiber rollers revolving in large oil pockets in the bed. The oil is, furthermore, distributed by diagonal oil grooves planed in the planer "V's."

We are giving the valuable distinctive features of GRAY PLANERS week by week. Write for our fully illustrated catalog; it tells the whole story.

THE G. A. GRAY CO.
CINCINNATI, OHIO

Gray Planers

Made for those who want the best



Rigid and Accurate

The "Cleveland" Open Side Planers

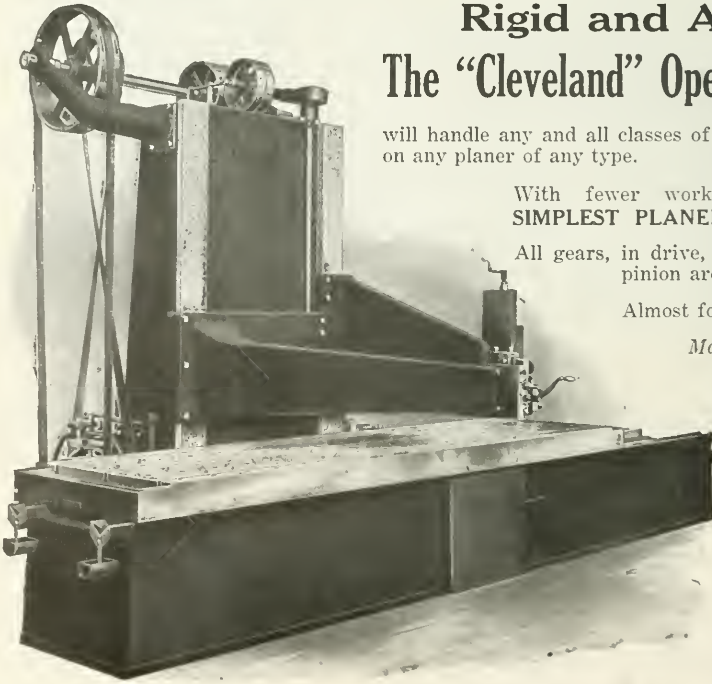
will handle any and all classes of work equal to that done on any planer of any type.

With fewer working parts, it is the SIMPLEST PLANER ON THE MARKET.

All gears, in drive, except bull gear and its pinion are enclosed and run in oil.

Almost fool-proof.

May we send you a catalog?



CLEVELAND PLANER WORKS

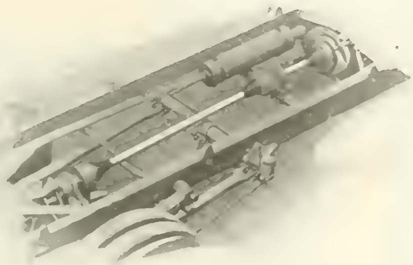
JAMES G. DORNBIRER
GEO. W. FORD

3150-3152 Superior Ave., CLEVELAND, OHIO, U. S. A.

The Story of the Motor Truck and the Lo-swing Lathe

No motor truck manufacturing equipment is complete without its LO-SWING Lathe department. We can cite many motor truck factories to prove it—where the LO-SWING is making big savings turning special rods and shafts. Here are two motor truck parts on which the LO-SWING outclasses all other machines.

The propeller shaft, which transmits the power from the engine to the rear axle, is made from extremely hard, tough steel. It is difficult to turn, and more difficult to finish accurately. It is, therefore, a LO-SWING job.



The rear axle live driving shaft is another tough piece of steel, built to withstand great torsional strains. There are several shoulders and tapers and all are turned simultaneously on the LO-SWING. If you build motor trucks, or any product with shafts having several diameters, you must have the LO-SWING Lathe if you are going to stay in the game. We'll be glad to figure production estimates on your work if you'll send blueprints.

Photos through courtesy Pierce-Arrow Motor Car Co., users of three LO-SWING Lathes

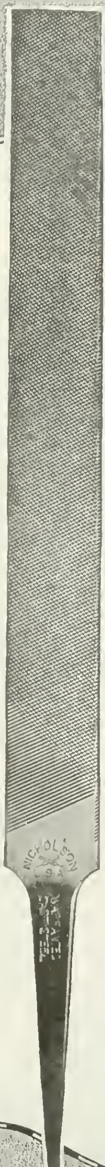
"Get the Multiple Turning Habit."

Fitchburg Machine Works
FITCHBURG, MASS.

SOLD DIRECT BY OUR REPRESENTATIVES IN THE UNITED STATES AND CANADA

FOREION AGENTS: Allied Machinery Co. of America, 3 Rue Paul Dubois, Paris, for France, Switzerland and Italy. Buck & Hickman Ltd., London, Birmingham, Manchester, Glasgow. The F. W. Horne Co., Tokio, Japan.

Write us for the LO-SWING booklet anyhow.



For Those Un-get-at-able Places—

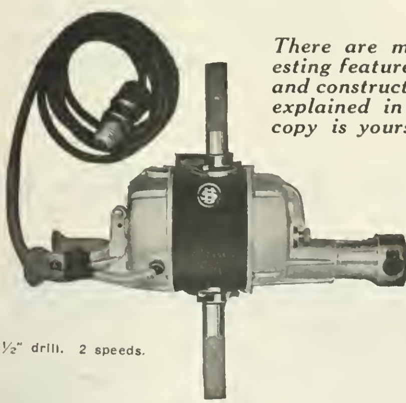
Those inaccessible corners where it is necessary to drill or grind—a U. S. "Portable" is indispensable. They are big time and money savers because

Made in two sizes. 3/8"—1/2".

United States Portable Electric Tools

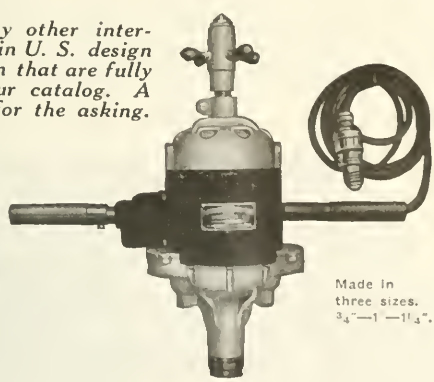
often eliminate the necessity of dismantling machinery or equipment to make changes and repairs. They are compact, light in weight, and can be operated at any angle or in any position.

The motors in U. S. "Portables" are like the tools themselves—first grade. They are designed to give the greatest possible horsepower in a small space, thus keeping the tools light and handy, yet very powerful. Motors are air cooled. Ball bearings take the thrust on the chuck spindle. All gears are hardened and run in grease. The tools are under instant control at all times.



½" drill. 2 speeds.

There are many other interesting features in U. S. design and construction that are fully explained in our catalog. A copy is yours for the asking.



Made in three sizes. 3/4"—1"—1 1/4".

THE UNITED STATES ELECTRICAL TOOL CO.

6th Avenue and Mt. Hope Street **CINCINNATI, OHIO, U. S. A.**

STOCK CARRIED IN BRANCHES

New York Office
30 Church Street, New York City

Chicago Office
549 West Washington Boulevard

St. Louis Office
610 Commercial Building

Boston Office
12 Pearl Street

Detroit Office
2425 West Grand Boulevard

Kansas City Office
2541 Tracy Avenue

Philadelphia Office
The Bourse

BARDONS & OLIVER

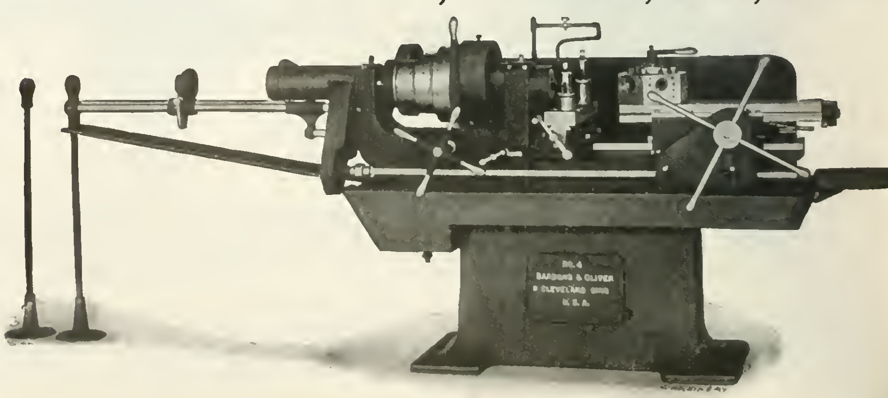
TURRET LATHES

Favorites Alike With Operator, Foreman and Shop Manager

B. & O. Turret Lathes are popular all along the line. The operator likes them because they are quickly set up and easy to run. Consistently accurate work is assured and no great exertion is required to meet production demands. They meet with the foreman's approval because of their dependability. He can be sure, when he puts a job on a "Bardons & Oliver," that it can be done right, and on time. No worry, trouble or delay. The reason for the manager's O. K. is obvious; when he has machines that are continuous producers on accurate work, with low operating cost, small maintenance expense, and low depreciation he has a real asset and a sure source of profit.

Would you like to hear the story in detail?

BARDONS & OLIVER, Cleveland, Ohio, U.S.A.



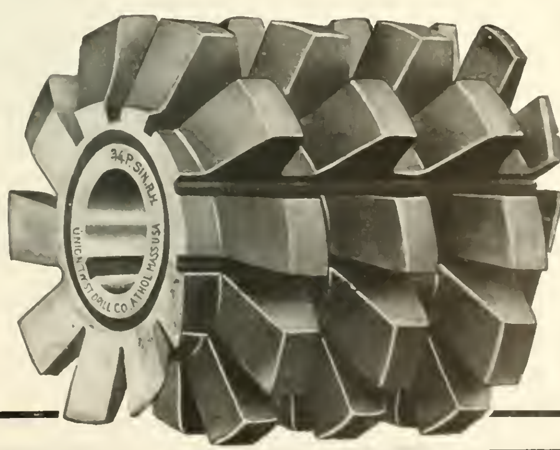
UNION GROUND HOBS

Before ground hobs were introduced, a frequent and justifiable objection to hobbing gears was the inaccurate results obtained, due to distortion in the teeth of the hobs. Union Ground Hobs have removed that objection. These hobs are *ground all over after hardening.* Any inaccuracy that may have developed in hardening is thus removed. We are able to harden Union Hobs to a greater degree of perfection, as we no longer fear the effects of distortion. These hobs turn out accurate, smooth running gears.

Another big feature is that Union Ground Hobs may be set up without reference to any particular tooth, as all are exactly alike. This is a point of economy, as the hob can be moved along successively until the entire length is dull. Our "Book of Information," Edition G, is a complete reference manual on cutting tools. Send for a copy.

Union Twist Drill Co.

Athol, Mass.



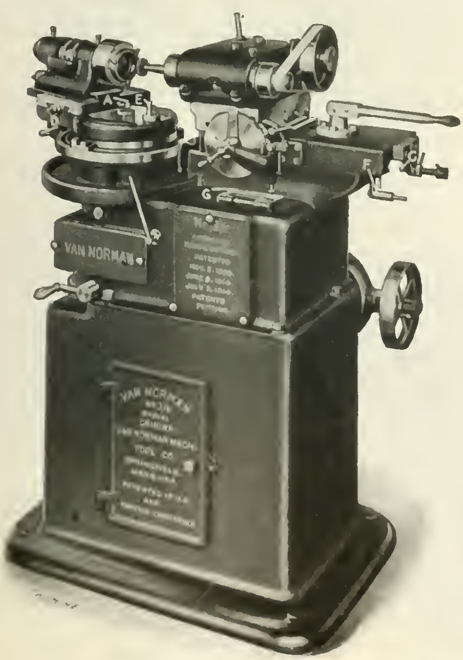
NOTICE

TO BALL BEARING MANUFACTURERS

THE automatic and other essential features pertaining to the VAN NORMAN BALL-RACE GRINDERS are *fully covered by patents* in the United States and Foreign Countries.

Manufacturers of Ball Bearings and Ball Bearing Machinery are hereby notified that action will be instituted on infringement of the following United States Patents:

Reissued Patent	**March 16, 1915**	**—No.**	**13,892**
(Original Patent, July 7, 1914—No. 1,102,558)			
Patent Issued	**June 9, 1914**	**—No.**	**1,099,218**
Patent Issued	**Sept. 28, 1915**	**—No.**	**1,155,176**
Patent Issued	**Nov. 2, 1909**	**—No.**	**938,803**



The patented features and improvements in the

Van Norman Automatic Ball-Race Grinders

have resulted in the highest perfection of quality, with reduced cost of production, in this extremely difficult branch of the grinding art.

VAN NORMAN MACHINE TOOL CO.

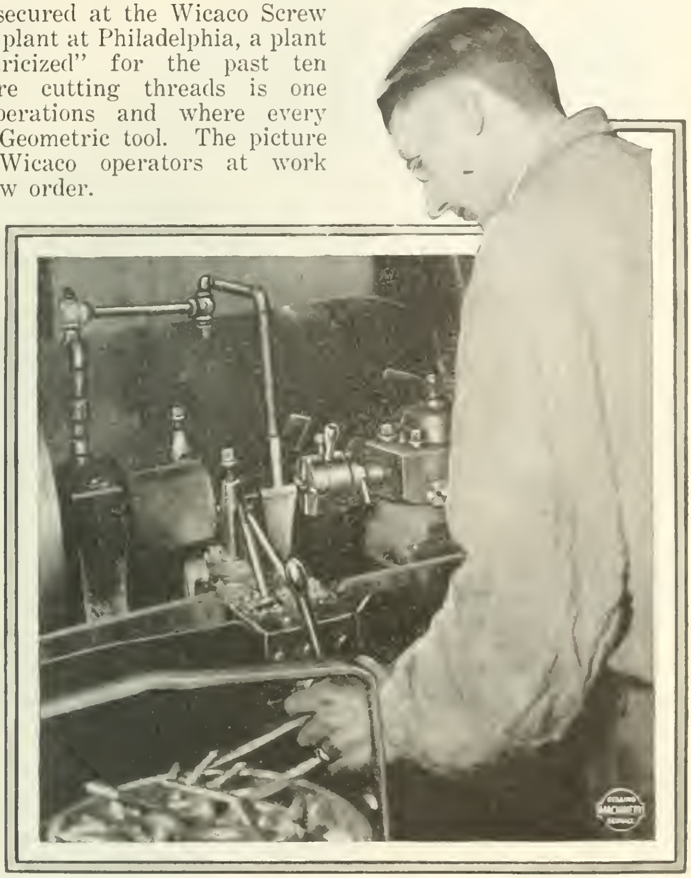
Waltham Avenue

SPRINGFIELD, MASS., U. S. A.

Are You "Geometricized?"

Meaning—are you alive to the possibilities of Geometric Threading?

Here's a photograph secured at the Wicaco Screw & Machine Company's plant at Philadelphia, a plant that's been "Geometricized" for the past ten years—a plant where cutting threads is one of the important operations and where every thread is cut with a Geometric tool. The picture shows one of the Wicaco operators at work on a 5000 thumb screw order.



It takes him just four minutes to machine one of the screws complete. The shortest part of the job is cutting the thread with a Geometric Die Head, and a clean, accurate, finely finished thread it is.

Manufacturing plants of every description, in all parts of the country—government arsenals included—are using Geometric Tools. You will eventually, why not make the start now?

Geometric Die Heads and Geometric Collapsing Taps are cost saving tools—ask us to prove it

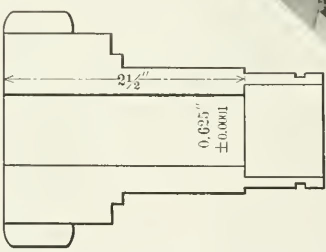
THE GEOMETRIC TOOL COMPANY

NEW HAVEN, CONN. **Chicago Office: 545 West Washington Boulevard**

REGULAR AGENTS: The Chas. A. Strelinger Co., Detroit, Mich.; Hill, Clarke & Co., Inc., Boston, Vandyck Churchill Co., New York and Philadelphia; Brown & Zortman Machinery Co., Pittsburgh, Pa.; The E. A. Kinsey Co., Cincinnati, O.; Strong, Carlisle & Hammond Co., Cleveland, O. **PACIFIC COAST:** General Machinery & Supply Co., San Francisco, Cal., Perine Mchy. Co., Inc., Seattle, Wash. **CANADA:** The A. R. Williams Machinery Co., Ltd., Toronto, Winnipeg and St. John, N. B.; Williams & Wilson, Ltd., Montreal. **FOREIGN AGENTS:** Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, Glasgow. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao, Lisbon and Petrograd. Donauwerk Ernst Krause & Co., Vienna. V. Lowener's Maskinforretning, Sverre Mohn, Norway. Bevan & Edwards Pty., Ltd., Melbourne, and White & Rae, Sydney, Australia. Also all manufacturers of Screw Machines and Turret Lathes.

Heald Internal Grinding

On Which the Actual Limit is only 0.0001"



Machining or grinding actually held to 0.0001 part of an inch limit is extremely rare even in these days of close work. Many times you will be told work is within these limits when as a matter of fact it is nearer 0.0005 inch. But at the North East Electric Company's plant in Rochester, N. Y., through whose courtesy this photograph was taken, the limits on this grinding job actually are plus or minus 0.0001 inch. The sketch shows the job, the grinding of a hole in a 3½ per cent nickel steel heat-treated sprocket used on an electric starter. There is 0.005 inch of stock to come out, and production is over 300 pieces in eight hours.

In working down to this close limit the gages do not last over two weeks before they are worn down too small for use. In spite of the fact that the work is held so close, this Heald Machine is giving excellent satisfaction—as are the four other Heald Machines working on electric starter parts in this plant.

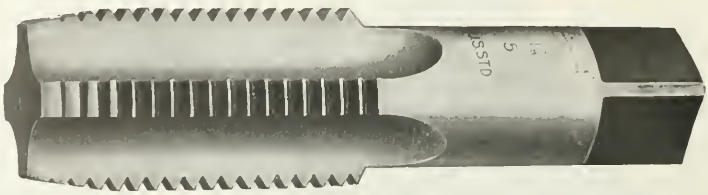
Your grinding cannot be too accurate to be handled in a Heald Grinder. Catalogue shows both Internal and Cylinder Grinders. Send for a copy.

THE HEALD MACHINE COMPANY

20 NEW BOND STREET **WORCESTER, MASS.**

CHICAGO, 24 So. Jefferson St.
DETROIT, 303 Majestic Bldg.
← BRANCHES →
CINCINNATI, 602 Provident Bank Bldg.
CLEVELAND, 710 Engineers Bldg.

DOMESTIC AGENTS: Prentiss Tool & Supply Co., New York, Boston, Syracuse, Rochester, Buffalo, Scranton. Smith-Booth-Usher Company, Los Angeles, Cal. Eccles & Smith, San Francisco, Cal. **FOREIGN AGENTS:** Alfred Herbert, Ltd., England, Italy, France, Belgium, Switzerland, Spain and Portugal. Ludw. Loewe & Co., Germany and Austria. F. W. Horne Co., Japan. Wilh. Sonesson & Co., Ltd., Sweden, Denmark and Norway. Post van der Burg & Co., Rotterdam, Holland.



CARD TOOLS

Fully Guaranteed

If they're CARD taps and dies, you're using just what hundreds of other manufacturers have adopted exclusively. CARD Tools have been found to give greatest satisfaction, often under seemingly impossible conditions.

CARD Taps and Dies are fully guaranteed. You are assured of more than ordinary service from them—they will do everything a thoroughly good tool *should* do.

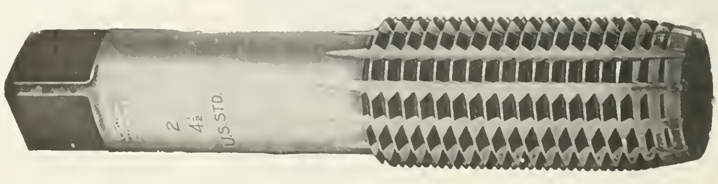
CARD Service is at the disposal of every machinery manufacturer. If you are not getting the right results from your taps and dies and you find difficulty in knowing "why," put it up to CARD Service to answer. We will cheerfully recommend the proper tap or die to use. All we ask you to do is to *try* CARD Tools. There's a big difference in the quality and quantity of service CARDS give and the service you may now be getting.

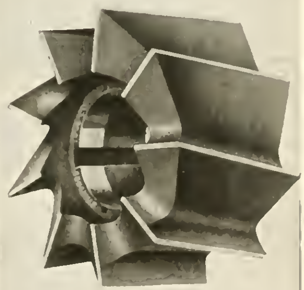
Write for a copy of new Catalog 28.

S. W. Card Manufacturing Co.

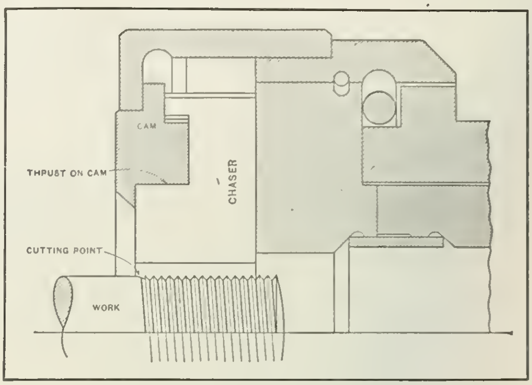
MANSFIELD New York Office, 62 Reade St. **MASS., U. S. A.**

EUROPEAN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Glasgow; Markt & Co., Ltd., Paris; Fenwick Freres & Co., Turin; Ignacz Szekely, Budapest; V. Lowener, Stockholm, Copenhagen, Christiania; R. S. Stokvis & Zonen, Ltd., Rotterdam; R. S. Stokvis & Fils, Brussels; Andrews & George, Yokohama, Tokio, Osaka; J. Lambercier & Co., Geneva; R. D'Aulignac, Barcelona, Spain; Arthur Kayser, Berlin S. W. 68, Oranienstr., 126, Germany.





The Chasers are held to their work in the Hartness Automatic Die



The faults of taper threading, stiff action and undue wear of mechanism in a die holder are due principally to improper provision for resisting the thrust of the chasers.

The proper place to support the chasers is directly over the cutting edge. This is where the closing cam should take its bearing, and this is where it does take its bearing in our die holder. See illustration. It then makes little difference whether or not the rear end of the chaser tips up under the pressure of the work. The front end, which is the cutting end, is held closely to size. A closing cam applied to the rear face of the chaser is not in good position for maintaining the diameter throughout the length of the cut.

JONES & LAMSON MACHINE CO., SPRINGFIELD, VERMONT, U. S. A. 97 QUEEN VICTORIA ST., LONDON, E. C.

DOMESTIC AGENTS: Boyer-Campbell Co., Detroit, Mich.; E. L. Essley Mchy. Co., Chicago, Ill.; Robinson, Cary & Sands Co., St. Paul, Minn.; Carey Mchy. & Supply Co., Baltimore, Md.; Barwood-Richards Mchy. Co., The Bourse, Philadelphia, Pa.; Machinists' Supply Co., Pittsburgh, Pa.; The E. A. Kinsey Co., Cincinnati, O.; The E. A. Kinsey Co., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; The W. M. Pattison Supply Co., Cleveland, Ohio. **FOREIGN AGENTS:** F. Auberty & Co., 91 Rue de Maubeuge, Paris, France; M. Koyemann, Charlottenstrasse 112, Dusseldorf, Germany; McPherson's Pty., Ltd., Melbourne, Australia.

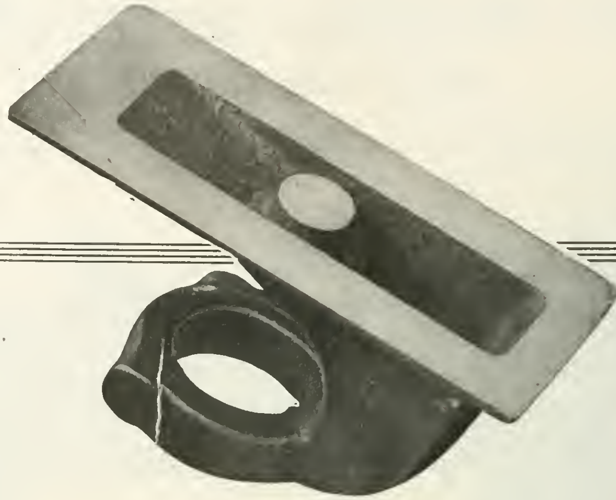
OHIO PLANERS

Heavy Pattern Several Sizes
Plain or Reversing Motor Drive

Latest designs in metal planing machines. Built for accurately machining the heaviest classes of work at the maximum capacity of high speed steel tools. Powerful machines, yet simple and economical to operate.

OHIO PLANERS—Built for 30 years on a Quality basis—now Better than Ever. Let us send complete description.

THE OHIO MACHINE TOOL CO.
KENTON, OHIO, U. S. A.



BECKER

CONTINUOUS

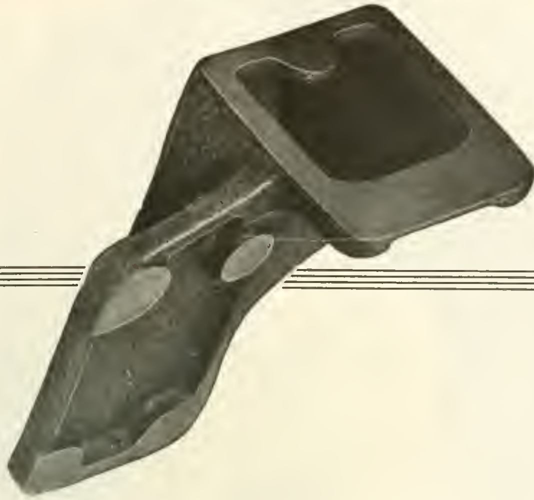
Increased Production 600%

A similar case presented itself in the manufacture of these malleable iron Fan Brackets. This manufacturer too, was satisfied with his production until we showed him the possibilities of continuous milling. He tried it. Now one Becker Continuous Milling Machine finishes as many brackets as *six* of the horizontal machines. The experience of these manufacturers indicate money saving production, increasing possibilities for *you*. You are decidedly the loser if you fail to investigate them. Write us *to-day*.

BECKER MILLING

HYDE PARK

AGENTS: Manning, Maxwell & Moore, Inc., New York, Philadelphia, Pittsburgh, Chicago, St. Louis, San Francisco, Seattle, Milwaukee and Cincinnati. H. B.



MILLING

MILLING

Increased Production 400%

When the manufacturer of these Ignition Brackets finished them on horizontal milling machines, his output was 135 pieces per machine in a 9-hour day. He considered that good production until he heard of the Becker way. He decided to try Becker Continuous Milling, with the result that his daily output jumped to 540 pieces per machine—just four times as great. Needless to say he is now a Becker enthusiast.

MACHINE COMPANY

Slate, Hartford, Conn. National Supply Co., Toledo, O Selson Engineering Co., Ltd., London. Schuchardt & Schutte, Berlin. Allied Machinery Co. of America, Paris.

MASS., U. S. A.

10 Miles of VIM Leather Belt for Jones & Laughlin Steel Co.

THE two rolls in the center of photograph are for a 10-inch Skelp Mill drive designed by Morgan Construction Co., Worcester, Mass., for Jones & Laughlin Steel Co., Pittsburgh, Pa.

One belt is 125 ft. long, 3-ply thick, 60″ wide, and the other is 65 ft. long, 2-ply thick, 60″ wide, both to work over the same driving pulley. The former belt transmits 1400 H. P. and weighs 1865 lbs., nearly a ton, while the latter transmits 600 H. P. and weighs 650 lbs.

The roll on the left end is 146½-foot two-ply VIM Belt 34 inches wide, and the one on the right is 118-foot two-ply VIM Belt 48 inches wide. The four belts required 485 French steer hides, the equivalent of 52,800 ft. (10 miles) of 1″ single belting. While the goal of the VIM Shop is quality and not "miles per day," this shipment is an example of our facilities for *quantity of quality belting.* One VIM Leather Belt will win you.

LEATHER TRADE VIM MARK BELT

"The Belt that puts the pull in the pulley"

Since 1865

E. F. HOUGHTON & CO.

Publishers of The HOUGHTON LINE

Third and Somerset Streets Philadelphia, U. S. A.

NEW YORK, BOSTON, HARTFORD, SYRACUSE, BUFFALO, BALTIMORE, PITTSBURGH, CLEVELAND, CINCINNATI, ST. LOUIS, DETROIT

England and Wales: Edgar Vaughan & Co., Ltd., Birmingham, England. Scotland: Jas. S. Crawford & Sons, Glasgow. Spain: La Maquinaria Anglo-Americana, Barcelona.

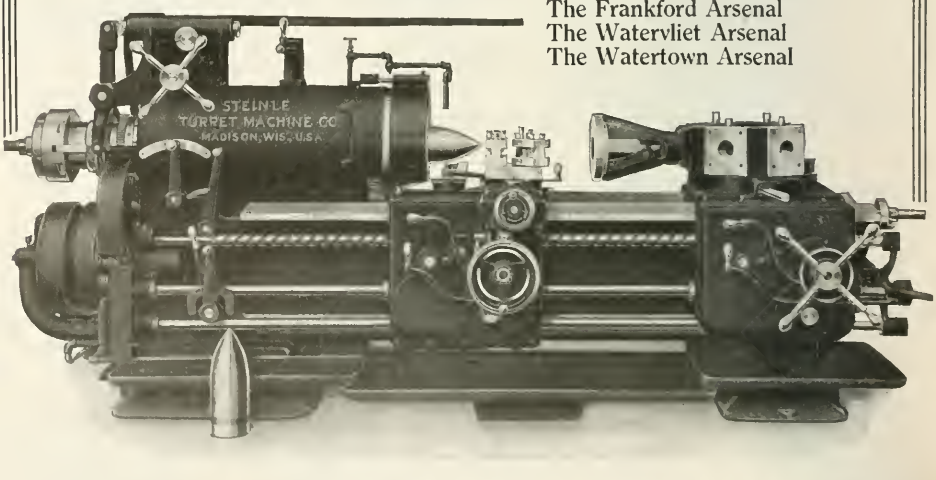
The Bethlehem Steel Company Uses 150 Steinle Turret Lathes

A formidable battery indeed—one that enables the Bethlehem people to turn out projectile work on contract time. An order for 150 machines from a firm like that is evidence of the ability of the Steinle Full Swing Turret Lathe to meet exacting production requirements under unusual conditions. It is, in fact, an ideal tool for projectile work. Strongly built and exceptionally powerful. A pacemaker that piles up substantial profits and makes prompt deliveries possible.

Another big point: Fitting a Steinle Lathe for projectile work in no way interferes with its capacity as a general manufacturing machine. That's important. The Steinle is no single-purpose war investment. It is a standard machine, long famous as a consistent producer—it is a long-time investment that will pay big dividends. For the present rush and for future expansion, we can show you where this machine will fill a real need in *your* shop. Write us about it.

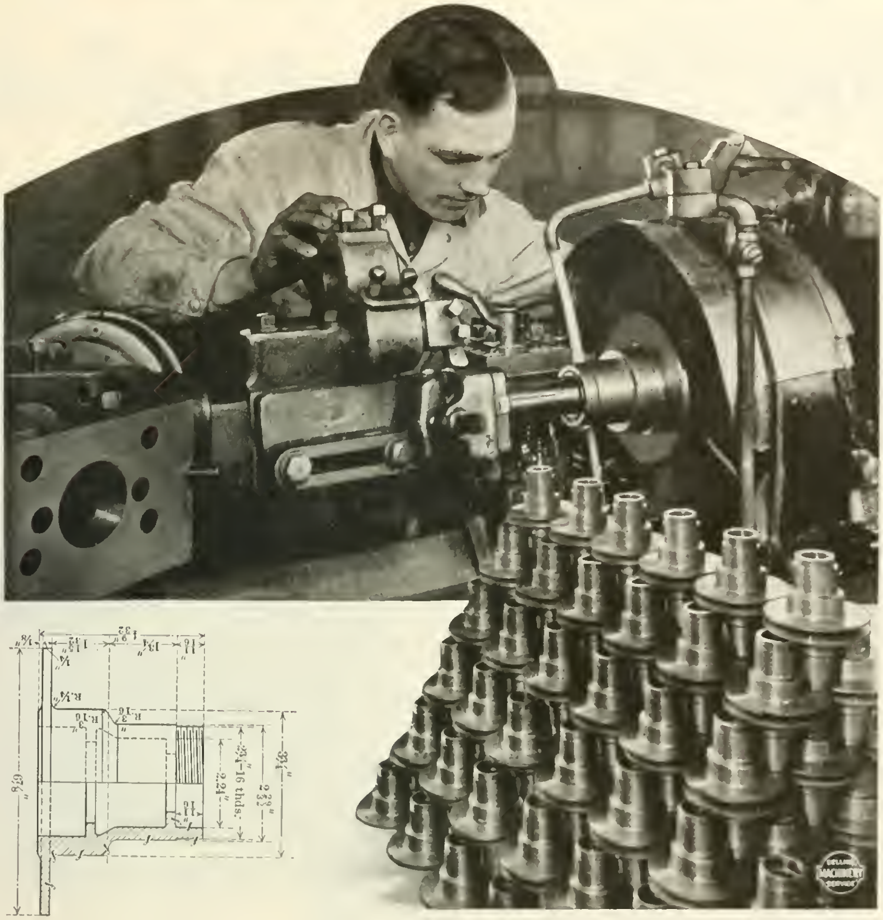
Among Other Prominent Users of Steinle Turret Lathes for Projectile Work are

Crucible Steel Co. of America
Washington Steel and Ordnance Co.
Westinghouse Electric & Mfg. Co.
The John Inglis Co. (Canada)
Coburg Steel Co. (Canada)
The Krupp Co. (Germany)
The Frankford Arsenal
The Watervliet Arsenal
The Watertown Arsenal



STEINLE TURRET MACHINE COMPANY

MADISON, WISCONSIN, U. S. A.



A BETTER DAY'S WORK

After several years' steady service, the Universal Hollow-Hexagon Turret Lathe turns out a better day's work on hubs for gas tractor front wheels than any other machine in the plant of the J. I. Case Threshing Machine Company—and within exceedingly close limits.

The hubs are 6 7-8″ across the flange, 4 9-32″ long—machined on all outer surfaces and inside one end for bearings. The limit on the flange is 0.004″; on thread, 0.001″; in bearings, 0.001″.

The Universal Hollow-Hexagon Turret Lathes turn out a better day's work because they take two cuts at one time—face or undercut or form with the carriage while boring or turning with the turret.

Write for descriptive literature explaining many advantages.

The Warner & Swasey Company

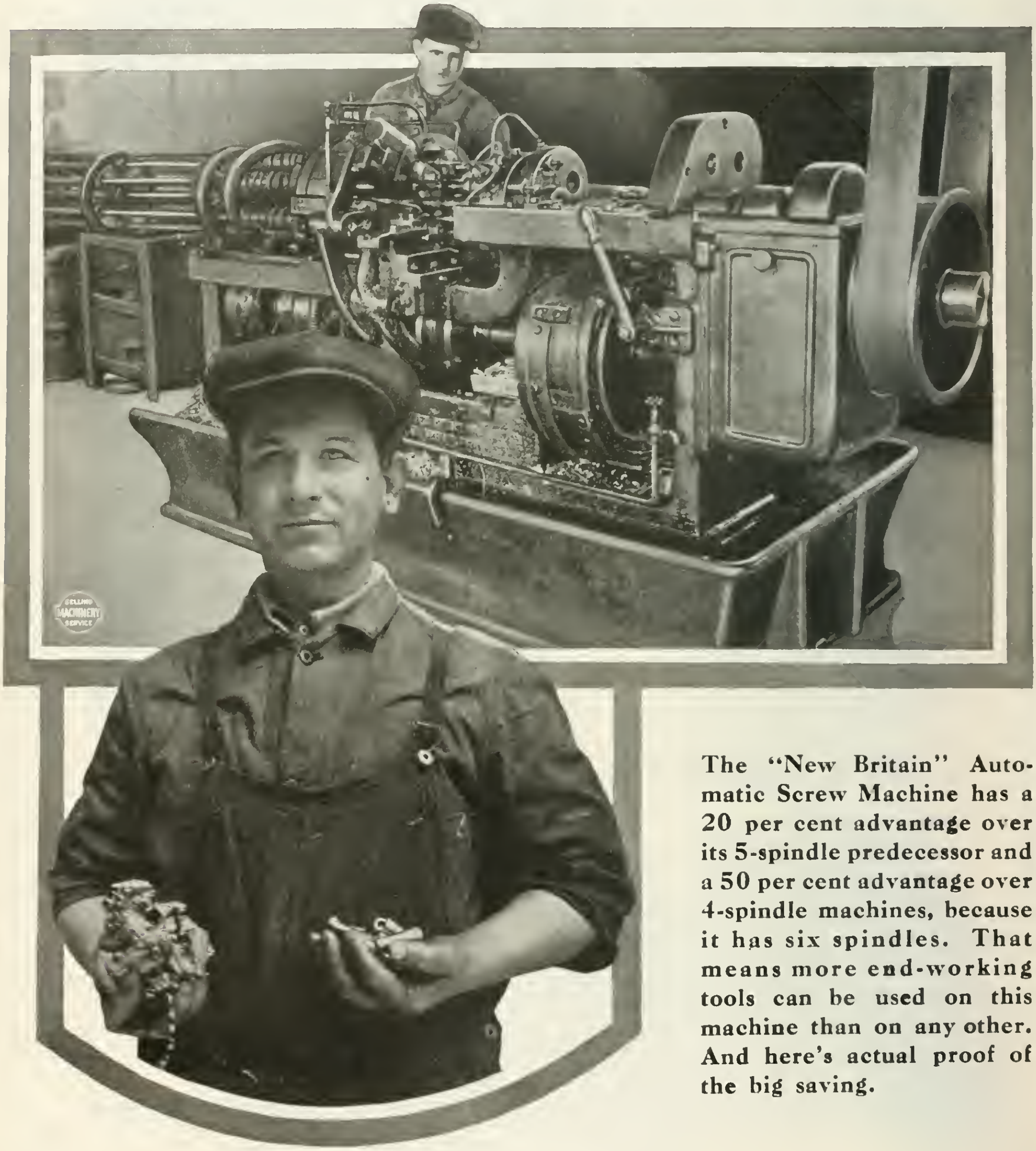
CLEVELAND, OHIO, U. S. A.

TURRET LATHES—TURRET SCREW MACHINES—BRASS WORKING MACHINE TOOLS

New York Office—Singer Bldg. Boston Office—Oliver Bldg. Buffalo Office—Iroquois Bldg. Detroit Office—Ford Bldg.
Chicago Office and Show Rooms—618-622 Washington Blvd.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle on Tyne, and Glasgow. Schuchardt & Schutte, Berlin, Vienna, Budapest, Petrograd, Stockholm, Copenhagen, Shanghai and Tokio. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Bilbao and Barcelona. Benson Brothers, Sydney. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

The "New Britain" Six-



The "New Britain" Automatic Screw Machine has a 20 per cent advantage over its 5-spindle predecessor and a 50 per cent advantage over 4-spindle machines, because it has six spindles. That means more end-working tools can be used on this machine than on any other. And here's actual proof of the big saving.

THE NEW BRITAIN MACHINE

Engineering Opinion

Writing of S K F Ball Bearings and his experience with them, Mr. Conradson says:

"I have used them with perfect success in my Multiple Spindle Automatic Lathe, and also in the Duplex Helical Drive Engine Lathe, built by the Phoenix Manufacturing Company, and in other machines.

"When correctly proportioned for the work to be done and properly installed, they give complete satisfaction as regards durability, reliability and efficiency.

"New designs now going through the drawing room include machines using S K F bearings from 10 mm. to 270 mm

"In some cases the use of S K F bearings actually lowers the cost of construction of a machine.

"This is caused by the compactness made possible by their use.

"In my judgment no new design should be made without considering the use of ball bearings.

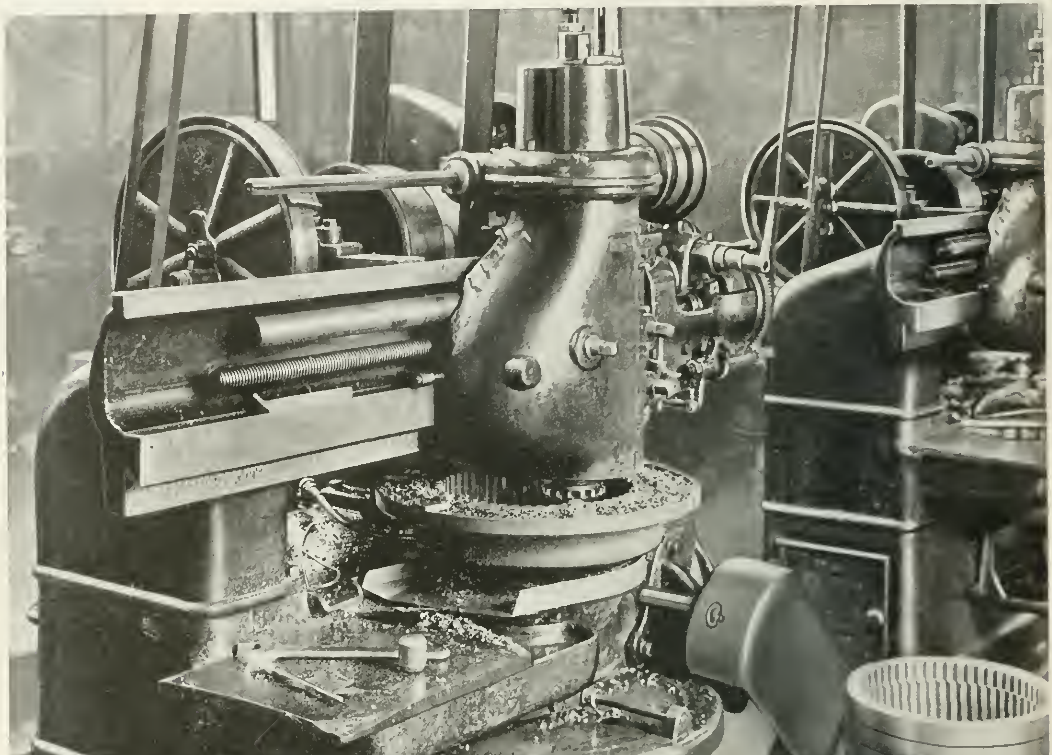
"In a few years their use will be universal"

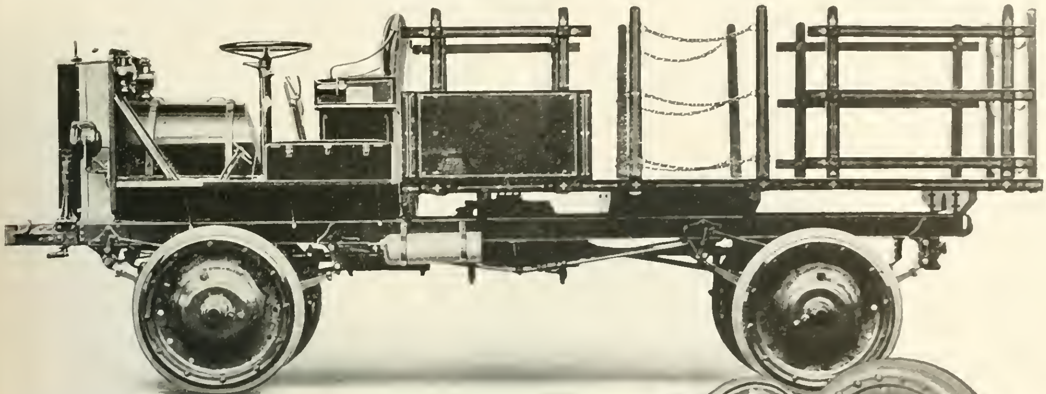
Who's Conradson?

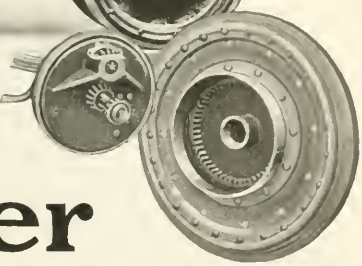
C. M. Conradson is a genius; the designer of many labor-saving machines and accessories; known wherever machine tools are made or used.

What he says about S K F Ball Bearings and how their use actually lowers the cost of building a machine is particularly interesting.

SKF BALL BEARING CO., Hartford, Conn.







Gear Shaper

Jeffery Quad—Internal Drive

The Jeffery Quad is a wonderful truck, not because it drives, brakes and steers on all four wheels, but because of the wonderful things this method of construction makes possible. The Quad travels through mud, sand, snow and over hills where no other motor truck in the world can go. It is the truck selected for U. S. Army use. About 3,000 of them have been sold in the last two years—which is a record for any 2-ton truck of any one make.

The success of the Quad lies in the four-wheel drive. The success of the drive is due, to a large extent, to the large internal gears in each wheel—and these are machined on the Gear Shaper. In a catalogue description of this drive, the Jeffery Company says:

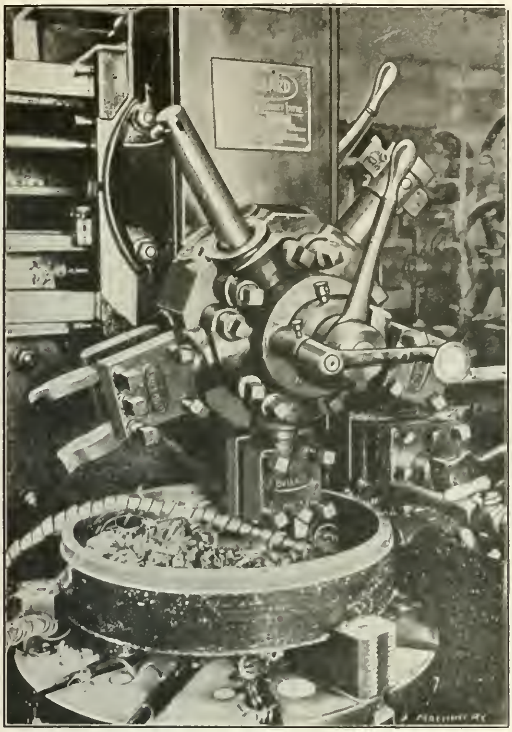
> "The extreme simplicity and ruggedness of the final drive in the Quad is plainly shown in this illustration. The large internal gear in the steel wheel of the truck should, barring unforeseen accidents, outlast any of the parts of the truck. The only other wearing parts in this construction are the bearings and the small spur pinion."

The illustration mentioned is shown above.

Cutting internal gears is one of the things the Gear Shaper does well and economically—and internal gears are growing in popularity for many purposes. May we tell you more about them—and the way the Gear Shaper produces them?

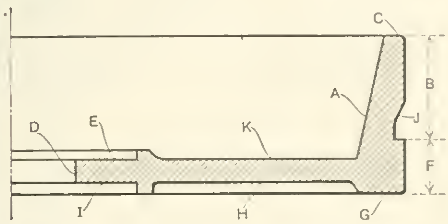
COMPANY, Springfield, Vermont

India: M. Koyemann, Dusseldorf, Germany, and Switzerland, White, Child & Beney, Vienna, Austria.



Same Work, Same Tooling, Same Operator—but an Increase of 65% in Production

That is the story of the Bullard New Era Vertical Turret Lathe in the shops of the Pierce-Arrow Motor Car Company, Buffalo, N. Y. The photographs show the operations in machining steel flywheels, the blanks for which come to the lathe in a very rough turned condition, weighing 125 to 140 pounds each. In the first setting from 35 to 50 pounds of hard steel are removed in 46 minutes, including handling.



The Bullard New Era Vertical Turret Lathe

turns the bevel sides of 13 of these flywheels per day, an increase of 65 per cent over former production—and former production, 8 pieces per day, was good too, because it was Bullard production on an earlier model Vertical Turret Lathe.

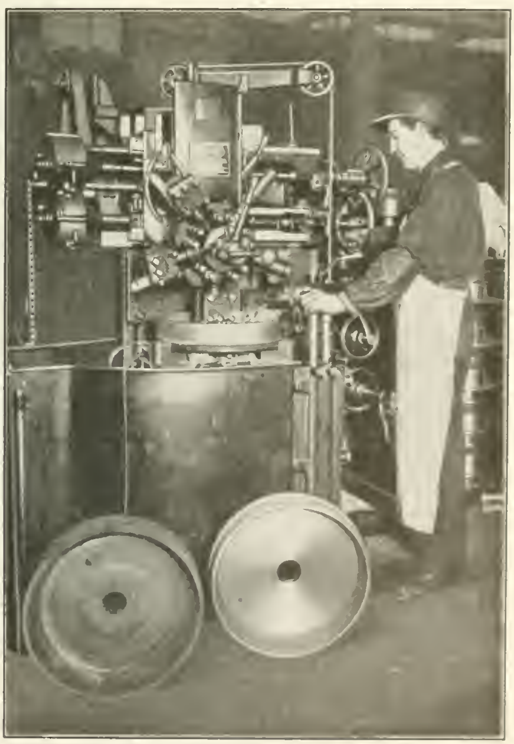
The order of operations on this work is as follows:—

Bevel side uppermost. Rough turn outside diameter B to chuck jaws.
Rough face edge C. Rough bore angular face A.
Finish face web K. Bore D, and Counterbore E.
(Finish turn outside diameter F, B and groove J.) Finish edges C & G and angular face A.

It takes plenty of power to do this job—and stiffness to get the accuracy required. These are characteristic of Bullard tools, and *Convenience* is inherent.

The New Era Bullard is as far ahead of earlier Bullard models as these machines were ahead of other turning methods on many classes of work. Let us tell you more about it.

The BULLARD MACHINE TOOL CO.
BRIDGEPORT, CONN. UNITED STATES OF AMERICA



AMERICAN SWISS FILES

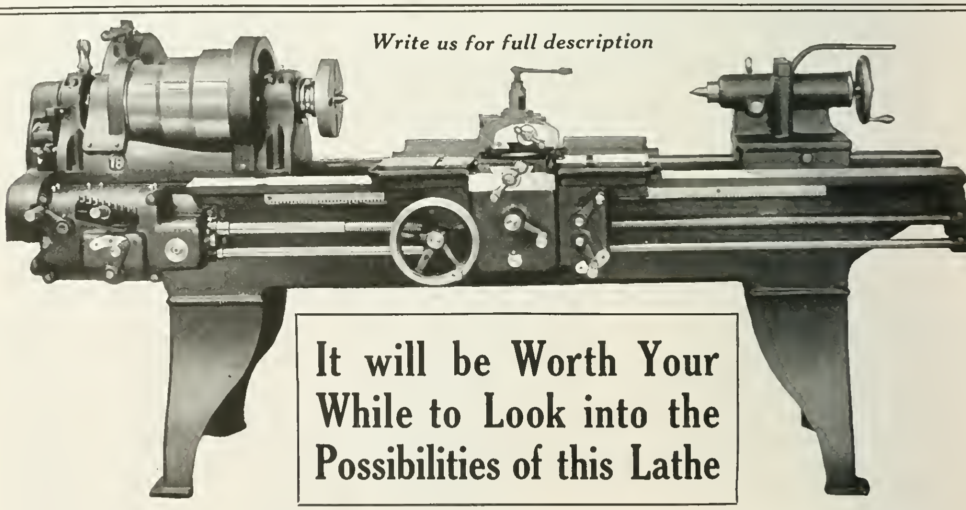
When you buy a file—buy as carefully as if it were a thousand dollar machine. Look for the trade mark. Look into its performances. Think about it—it will pay you.

For fine work, for the finishing stroke, for a careful job—special or every day—the file with the **"American Swiss"** trade mark is the one you need. Be sure you get it.

AMERICAN SWISS FILE & TOOL COMPANY

24 JOHN STREET, NEW YORK, U. S. A.

Write us for full description

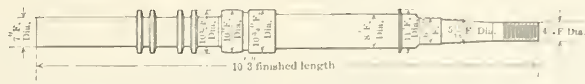


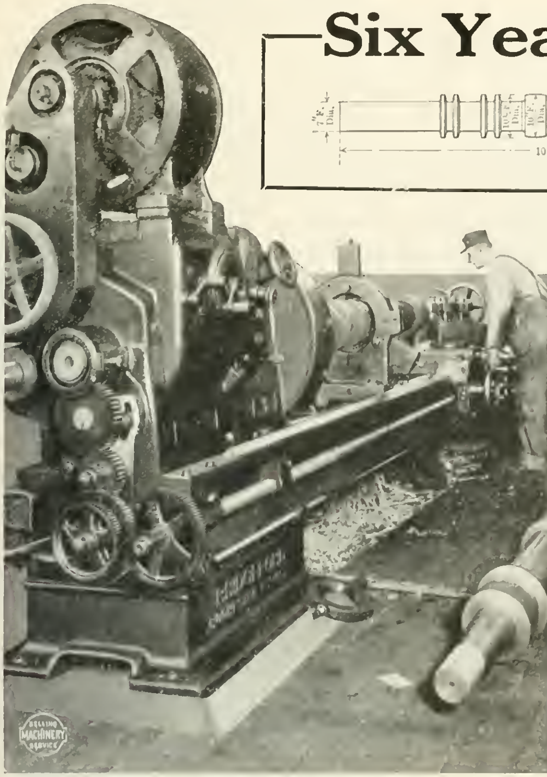
It will be Worth Your While to Look into the Possibilities of this Lathe

MORRIS Quick Change Engine Lathes have proved paying investments for shops that are using them. Better work and more of it—a wider range of possibilities has been realized in every case. Morris refinements in design are responsible. Some of the more important include: a patented quick change gear mechanism which gives 45 changes—range of threads 2 to 60; change gears to cut special pitches and metric threads; a patented one-piece apron, cast in box form, with all bearings integral; steel gears in apron with double bearings for shafts; feed frictions operated by single lever and an interlocking device which prevents thread and feed mechanisms engaging at once.

MORRIS MACHINE TOOL CO., Cincinnati, O.

Six Years of This



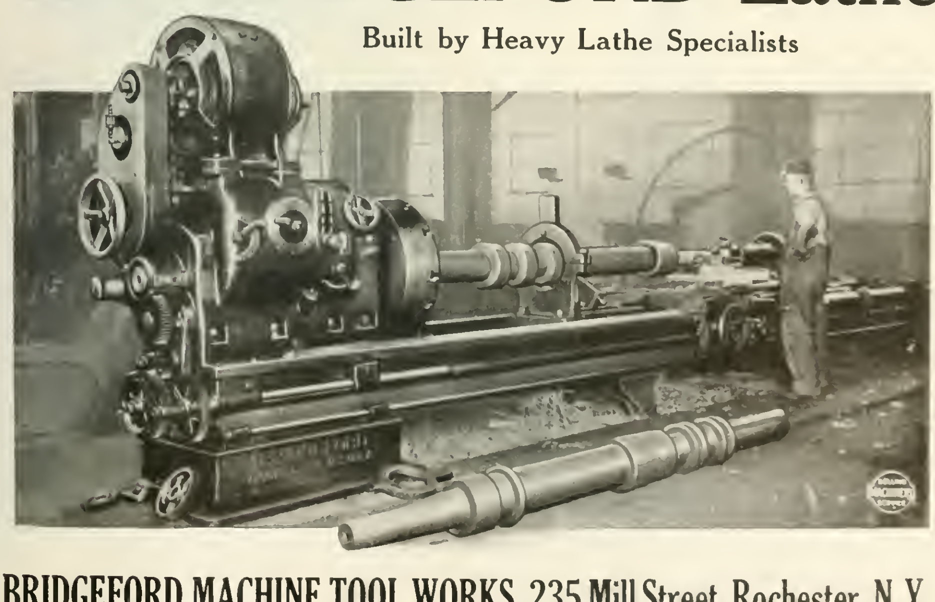


FOR SIX YEARS this Bridgeford Lathe has been turning shafts and other big brick-making machinery parts for The Bonnot Company, Canton, Ohio—and its newness hasn't even worn off.

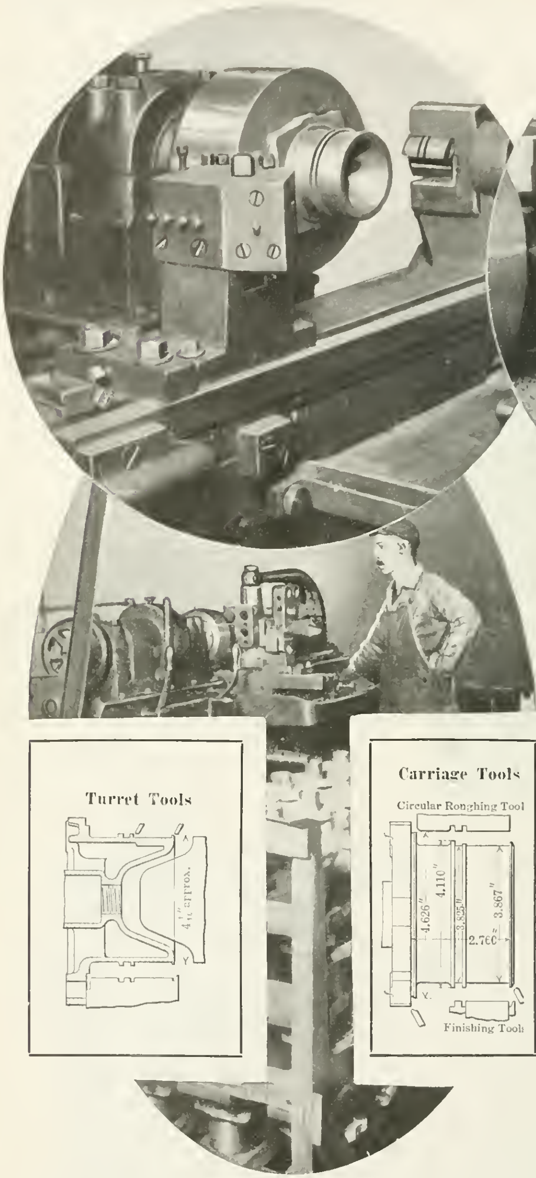
Some of this work is 26½ feet long; some of it smaller. The piece shown is machined all over and threaded, ¾" stock being removed, to limits of plus or minus 0.0015", in a total of 22 hours—and this is but one of many good examples of Bridgeford production in this plant. There's power and strength and rigidity in any Bridgeford Lathe sufficient to perform any work, no matter how heavy, in the most efficient manner. We'll be glad to show you.

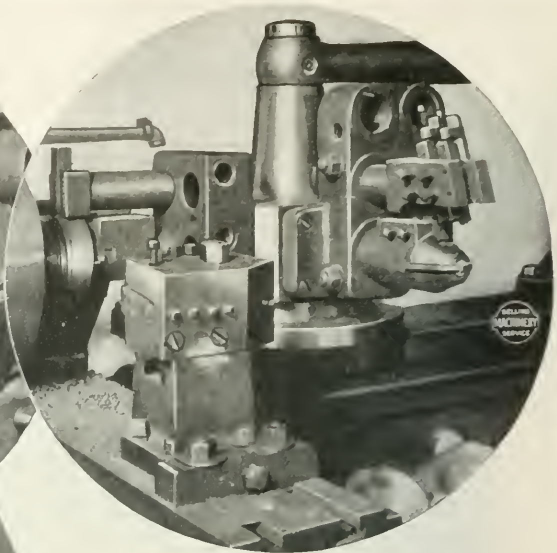
The BRIDGEFORD Lathe

Built by Heavy Lathe Specialists



BRIDGEFORD MACHINE TOOL WORKS, 235 Mill Street, Rochester, N. Y.





Do It Automatically When You Can

These cylinder heads for Willys-Knight motors were formerly tooled up on hand turret machines—and production per machine was 15 a day (10 hours).

They are now machined on Potter & Johnston Manufacturing Automatics at the rate of 70 per day, each machine. Note the tool set-ups in the accompanying sketches—interesting, aren't they?

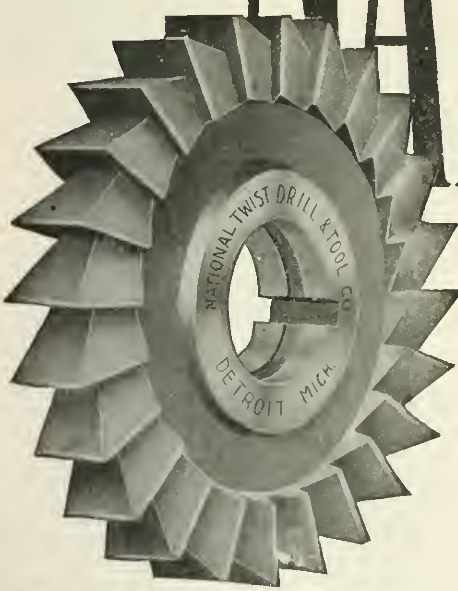
We'll be glad to furnish production estimates on any of your work adapted to automatic manufacture—to show you in more detail the reasons why your choice of automatics should be Potter & Johnstons. Write us.

Potter & Johnston Manufacturing Automatic

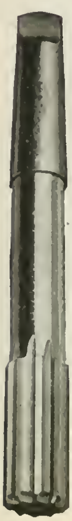
POTTER & JOHNSTON, Pawtucket, R. I., U. S. A.

OFFICES AND REPRESENTATIVES: Office for Great Britain and France: 68 Avenue de la Grand Armee, Paris, J. Ryan, Manager. New York Office: Fulton Bldg., 50 Church St., Walter H. Foster Co., Managers. Detroit Office: Modern Machinery and Engineering Co., 1514 Ford Bldg. Chicago Office: 4213 Sheridan Road, Chas. H. Shaw, Manager. Toronto Office: 1501 Royal Bank Bldg., E. C. Roelofson, Manager. **FOREIGN AGENTS:** Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England, and Glasgow, Scotland. Schuchardt & Schutte, Berlin, Vienna, Stockholm, Copenhagen and Budapest. Ercole Vaghi, Corso Porta, Nouva 34, Milan, Italy.

NATIONAL



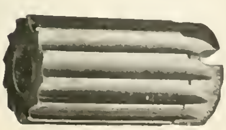
If neither cost nor quality counts in selecting tools, one tool is as good as another. But to the man who discriminates there is no tool like a "National" for producing quality work at low cost. "National" Twist Drills, Reamers, Cutters, etc., are specified by the wide-awake shop manager because they have repeatedly proved their economy and cutting efficiency. High-grade steel, correct cutting clearance and uniform temper give "National" tools their work-producing qualities. Extreme care and rigid inspection guarantee this kind of service from every tool we ship.

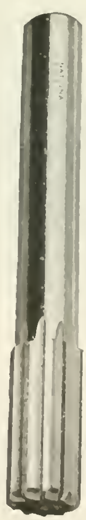


The "National" line is complete.

Arbors, Bits, Chucks, Countersinks, Counterbores, Cutters, Twist Drills, Reamers, Mandrels, Mills, etc.

All styles and sizes.



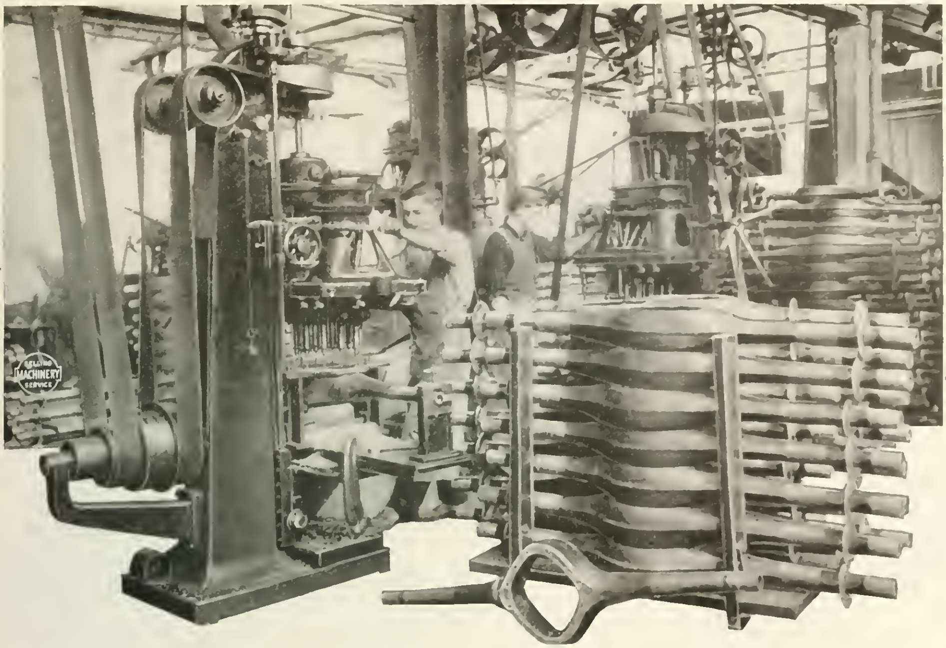


Our catalogue should be on your desk for constant reference.

National Twist Drill & Tool Company

DETROIT MICHIGAN, U. S. A.

117 to 119 Leonard St., New York, N. Y.
104 South Jefferson St., Chicago, Ill.



230

Rear Axle Housings Per Day

or

$2\frac{6}{10}$ Minutes Each

on a

Fox

MULTIPLE DRILL

THOUSANDS of holes in hundreds of rear axle housings in one 10-hour day on one machine! The machine, the Fox Multiple; the plant, that of the Weston-Mott Company, manufacturers of automobile parts, at Flint, Michigan, or any other shop where Fox machines do the drilling.

In this particular case 12 holes 5-16″ diameter are drilled on each side of each housing. 12 spindles are in operation drilling 12 holes at a time. Production is 230 housings or 5520 holes per 10-hour day, per machine. As there are two "Foxes" on this work, total output per day is 11,040 holes. The only break in drilling is the time required to load and unload the table and turn the work for the second operation.

Fox production is fast; Fox output is accurate; Fox costs are low. Fox machines are built for service and give it. Centralized controls; independent speed and feed changes; as few or as many spindles in operation as desired; other advantages. Send for the catalogue.

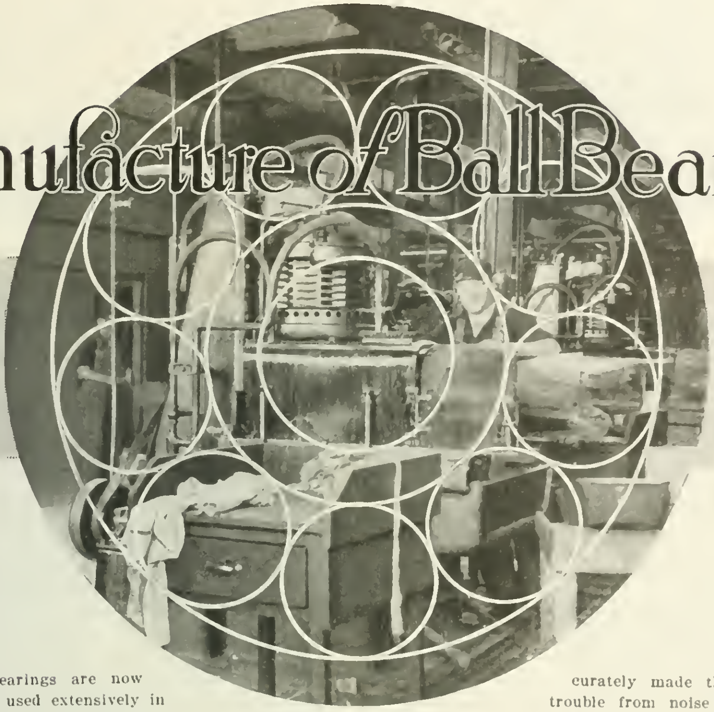
Fox MACHINE COMPANY

1401 W. Ganson Street, JACKSON, MICHIGAN

NEW YORK OFFICE: 30 CHURCH STREET


"Sammy Showme"
Investigator of
Simonds Saws
THE QUEST OF
SAMMY SHOWME
SIMONDS' INVESTIGATOR
IN 12 REELS
REEL Nº1
KEEP THIS SAW SHARP
The Simonds Saw
WORKS
FITCHBURG, MASS. CHICAGO, ILL.
U.S.A.
UNEQUALED IN QUALITY AND UNIFORMITY
BRANCH HOUSES
NEW YORK, NEW ORLEANS, PORTLAND, OREGON,
SEATTLE, WASH. SAN FRANCISCO, CAL.
LONDON, ENGLAND.
THIS is "SAMMY SHOWME."
He's in search of the best in metal sawing practice, the country over.
What he finds he'll tell you on this page every month.
Keep your eye on "SAMMY."
Simonds
Simonds Manufacturing Company
"The Saw Makers" Established 1832
FITCHBURG, MASSACHUSETTS
17th St. and Western Ave., Chicago, Ill.
90 West Broadway, New York City.
St. Remi Street, Montreal, Que.
Memphis, Tenn
Portland, Ore.
New Orleans, La.
Seattle, Wash.
St. John, N. B
San Francisco, Cal.
Vancouver, B. C.

Manufacture of Ball Bearings



BALL bearings are now being used extensively in motor cars, machine tools, and other machinery to reduce friction and increase the life of moving parts. For example, manufacturers have employed ball bearings on lathe spindles with remarkable results; high-speed drilling machines constructed with ball bearing spindles have given complete satisfaction. Satisfactory use of ball bearings has been made in internal grinding wheel spindles where speeds as high as 30,000 R. P. M. have been obtained without any perceptible chatter or heating of the bearings. The advantage gained by rotating a grinding wheel spindle at speeds as high as 30,000 R. P. M. is that small wheels can be operated at their highest cutting efficiency. Objections have been raised in the past to the use of ball bearings in machine tools, but many of these have been unfounded; the present ball bearing is so accurately made that there is little trouble from noise or vibration even at high speeds. But this condition was realized only after the heat-treatment of steel had been fully developed and ball and race making had been perfected.

Excluding special sizes and shapes, ball bearings are made in three distinct types, *viz.*, radial or annular, thrust, and a combination of both. The radial bearing is the type most extensively used, and consists of inner and outer races with grooves in their opposing faces, between which a row of balls is retained in a cage. Some radial bearings are made with one row of balls, whereas others have two rows and are adapted for carrying heavier loads than the single-row type. The following description is confined to the manufacture of single-row ball bearings as followed by the U. S. Ball Bearing Mfg. Co. of Chicago, Ill.

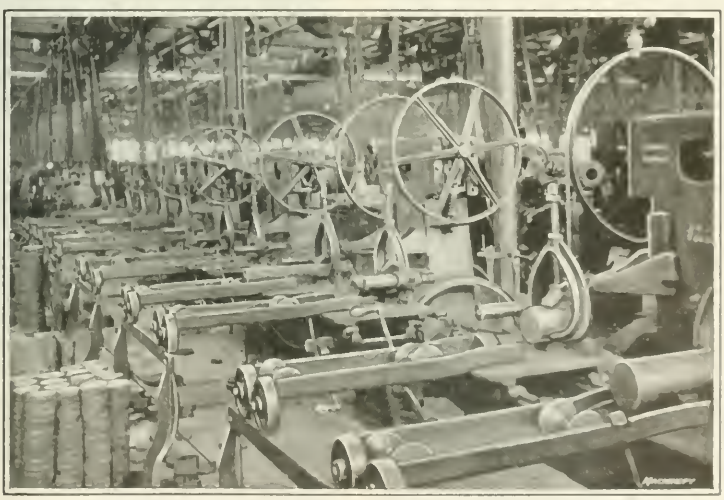


Fig. 1. Group of Duplex Band Sawing Machines used in the U. S. Ball Bearing Mfg. Co.'s Plant for cutting off Bar Stock for Ball Bearing Rings when only a Small Number of One Size is required

Preliminary Operations

The U. S. Ball Bearing Mfg. Co. employs several

and 2. The bar is clamped in a vise as shown in Fig. 2, and located endwise by a stop set to give a blank of the required thickness. The band saw used is 1/32 inch thick, ½ inch wide, and approximately 12 feet, 9 inches long. It is guided by four hardened and ground rollers. The carriage carrying the vise in which the bar is held is advanced toward the saw by a weight acting through a rack and segment gear. The hardened rollers that guide the saw blade keep it taut and at the same time enable the machine to cut a bar off straight with the least waste of stock. The amount left for finishing on the sides is about 1/32 inch. Following the cutting off of the blank, it is bored, reamed, faced, turned, trepanned, etc., and is then ready for hardening.

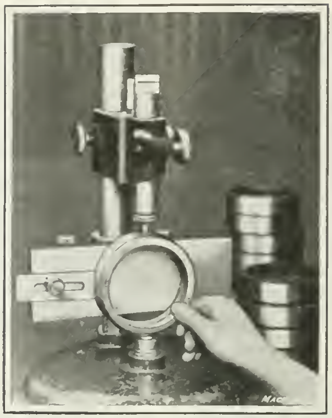


Fig. 16. Inspecting External Diameter with a Hirth Minimeter—Limits allowed are Standard — 0.0002 to 0.0004 Inch on Diameter

Machining Ball Bearing Rings on Gridley Automatic

Ball bearing rings up to 4¼ inches in diameter are finished on Gridley single-spindle automatics, and, as a rule, two rings are made from one bar. This is accomplished as shown in Fig. 3 by using a trepanning tool which cuts an annular groove in the end of the bar, producing two rings when cut off. This is much more economical than making one ring from a bar, and as high-grade alloy steel tubing suitable for this work cannot be obtained at the present time, this has been found to be the most economical method. On a Gridley single-spindle automatic, the feeds per revolution of the work used are: drilling, 0.015 inch; trepanning, 0.010 inch; and forming, 0.0015 inch. The surface feed for forming is about 60 feet per minute. On a 2¼-inch Gridley automatic, 200 completed bearings—two rings—are turned out in ten hours, and 97 of the same size are turned out on the single-spindle automatic in the same time.

Disk-grinding Sides of Bearings

After the bearing rings have been cut off in the automatic, they are brought to a Gardner disk grinder, where about 0.005 inch is ground from both sides, leaving about 0.004 inch on each side for finishing on the Blanchard vertical surface grinder. The sides are ground by passing the rings between two face grinding wheels. The bearing rings are then taken to a turret lathe, where the ball races are turned in the inner and outer rings and the corners broken on both the inside and outside. The bearing rings are then taken to a punch press, where they are stamped and inspected to see that the previous operations have been properly carried out.

Hardening and Tempering

After the ball bearing rings have passed inspection, they are taken to the hardening department, where they are heated in a gas furnace to from 1450 to 1500 degrees F., as shown in Fig. 4. It requires from fifteen to twenty minutes to bring up a batch of these ball bearing rings to the required temperature, depending on their size, and the temperature is regulated and controlled by means of a Leeds-Northrup recording and indicating pyrometer, as shown in Fig. 6. When the rings in the furnace have been heated above the critical point, they are removed and immersed in a special quenching oil kept at a constant temperature of 55 degrees F. by circulating water through coils cooled by a refrigerating plant. The ball bearing rings are then drawn or tempered in the same oil as that used for hardening, which is kept at a temperature of 350 degrees F. For tempering, the rings are put into the oil when it is cool, and the temperature is gradually raised to the desired point, which requires about twenty-five minutes.

Testing

All ball bearing rings, after hardening and tempering, are tested by what is known as a bounding test. The smaller rings are thrown onto an iron block, and the larger rings are rolled down an incline and bounced up against a cast-iron block. The tester can tell by the ringing sound whether it is too soft, is cracked or has any other defect. If this is so the sound is deadened. If the race, on the other hand, is too hard it will break. This test may appear to be rather drastic, but after long experiments with other testing apparatus, it has been found that the most accurate results can be obtained in this way, provided the man making the test knows his business. Of course, other tests are also taken with the scleroscope to check up the bounding test, and in addition, all rings are given a file test in the races.

Surface Grinding

After the rings have been tested by bounding and with a scleroscope, they are taken to the Blanchard surface grinder, shown in Fig. 5, where both sides are ground to the required thickness. On a 2½-inch race 120 pieces are held on the magnetic chuck at one time, and the production is 500 in two hours. The down feed of the wheel is 0.001 inch, and the speed of the table, 17 R.P.M. When extreme accuracy is required, the Heald piston ring grinder shown in Fig. 7 is used.

After grinding the rings on the sides, they are demagnetized by a simple apparatus consisting of two coils fastened to the under side of a work bench which has a hole cut through the planks. The races are slowly passed down through the hole and subjected to an alternating current, with the result that practically all of the residual magnetism is removed. The rings are now inspected for thickness. This is done with a dial test indicating gage, as shown in Fig 8; the variation in thickness on these rings is standard — 0.001 inch. The multiplying lever arrangement is not used in this case.

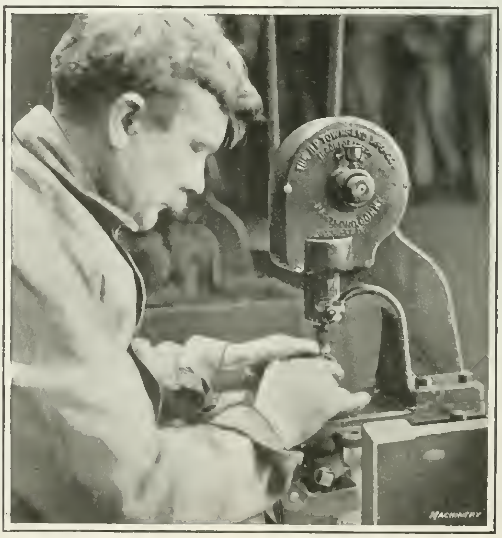


Fig. 17. Heading Rivets in a Townsend Riveting Machine—Rivets hold Halves of Ball Bearing Retainer together

Grinding and Inspecting Outer Ring

The outer rings are now brought from the inspection department to the cylindrical grinding machine where the external diameter is ground to the required size. As will be seen in Fig. 9, ten rings are held on a mandrel at one time and the external surface is ground to the required size. The rings are a free fit for the mandrel and are clamped from the end by a washer or nut. The limits

on the external diameter are standard — 0.0002 to 0.0004 inch, depending upon the size of the ring. After grinding the external diameter, the outer race is tested for accuracy by a Hirth minimeter, as shown in Fig. 16. The ball measuring point of this Hirth indicator is set by means of a Johansson block, and the inspector gages the external diameter by rotating the ring on the lower ball anvil, holding the race meanwhile against the centering block and at the same time watching the movement of the indicating needle, which has a measuring ratio of 10 to 1. This particular gage is inspected every day, and when the balls become flat they are rotated to bring a spherical surface in contact with the work.

Continuing the operations on the outer ring, the next step is to grind the race for the balls. This operation is accomplished in Van Norman or special race grinding machines. The method of grinding ball races on the Van Norman race grinding machine was described in the August, 1915, number of MACHINERY.

Grinding Operations on Inner Ring

The first grinding operation on the inner ring, after it leaves the Blanchard surface grinder, is accomplished in a Heald or Rivett internal grinder, depending on the size of the race. Fig. 10 shows a Heald internal grinding machine set up for grinding an inner ring for a 2½-inch bearing. The limits on the hole are standard — 0.0002 to 0.0004 inch, depending on the diameter. The gaging of this diameter is accomplished by means of the standard "go" and "not go" plug gages. Fig. 11 shows a Rivett internal grinding machine set up on a smaller race. The race groove in the inner ring is ground on Van Norman race grinders, and a battery of special machines built for this work by the company. During this operation the ring is held in a special chuck, as shown in Fig. 12. After finish-grinding, the races are ready for inspection prior to assembling.

Making Ball Retainer

The ball retainers are made from sheet steel in several operations in the punch press, and are then assembled under a riveter. The first operation is to blank out a ring in an inclinable punch press, as shown in Fig. 13, using a combination blanking and piercing punch and die. Second, this ring is rough-formed with a punch and die having a series of circular projections; then it is taken to another punch and die where the final operations are accomplished, and at the same time the holes are pierced for the rivets. Following this, the retainers are taken to the assembling department, together with the rings, for final inspection and assembling.

Assembling Balls, Retainers and Rings

For assembling, the rings are placed eccentrically and the required number of balls inserted. The two sides of the retainer are then assembled and the rivets inserted by a girl. The loosely assembled bearing is now passed on to another assembler, as shown in Fig. 14, who sets the rivets to prevent them from falling out, and then the bearing is taken to the riveting machine shown in Fig. 17. The rivets are of the headed type, so it is only necessary to rivet one end.

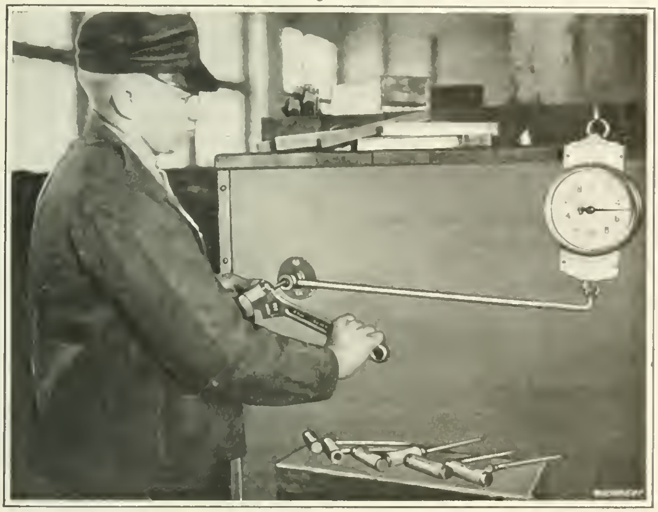
The bearings are now carefully looked over for imperfections and are then given the noise test, as shown in Fig. 15. Here the two bearings are located on a shaft and are held in grooves in a special bench fixture. This shaft is provided with a grooved pulley over which a belt runs, connected to a ½-horsepower motor. The speed of these bearings is then increased to about 1200 R. P. M., and if any noise is detected it is a sure sign that the balls are out of round, have soft spots or other imperfections. After testing for noise, they are carefully coated over with a vaseline compound, packed in tissue paper and stocked.

D. T. H.

* * *

APPARATUS FOR TESTING CRESCENT SCREWDRIVERS

On page 144 in the October, 1915, number of MACHINERY was described a hydraulic testing apparatus used by the Crescent Tool Co. of Jamestown, N. Y., for testing the strength of wrenches. In the following is described another device used by the Crescent Tool Co. for testing the strength of screwdrivers and detecting soft blades or other hardening defects. The particular tools shown being tested in the accompanying illustration are Crescent hammer-handle screwdrivers, but all Crescent screwdrivers are tested on this apparatus after being hardened.


How Crescent Screwdrivers are tested

The apparatus is so extremely simple that it needs little description. Upon the side of the testing wall a central stud is located on which a long lever is pivoted. The fulcrum point of this lever is slotted to receive the screwdriver blade. The lever is approximately twenty-four inches long and is attached at its outer end to the weight hook of a spring balance the weighing pan having been removed.

The inspector inserts the blade of the screwdriver in the slot at the center of the pivoted arm, and with a wrench turns the arm and pulls down the scale beam or slide until the indicator reaches a predetermined number of pounds, according to the size of the screwdriver blade being tested. If the scale indicator reaches its mark without causing the blade to bend or break, the screwdriver is adjudged perfect and put through the finishing department. If, on the other hand, it fails in the test, it is rejected. The operation is extremely simple and rapid.

C. L. L.

* * *

Careful cleaning of castings for machinery that is highly finished like machine tools pays, as less filler is required to cover the scabby places. The less filler used the better the results, as heavy filler is likely to crack and peel off in use. In order to produce the most satisfactory condition, portable grinders should be used freely to grind off all roughness. This preliminary work costs considerable, but it is more than made up in saving of time and filler when preparing for painting. The job is more durable, too; the less paint and filler used to cover a surface evenly, the better the job.

TESTING NON-FERROUS METALS FOR HARDNESS

APPLICATIONS OF THE BRINELL METHOD IN REGULATING METHODS OF MANUFACTURE

BY HUGO FRIEDMANN*

A NUMBER of satisfactory types of apparatus for testing the hardness of metals are now available, but we still have much to learn about interpreting the results of hardness tests. The results so far attained are just sufficient to excite interest and to cause new efforts to be made in this direction. One of the chief obstacles to a satisfactory interpretation of the results of hardness tests has been that there are no uniform hardness standards for different classes of metal. Satisfactory methods have been developed for testing other properties which are inherent in different metals and the results of such tests are expressed in well defined terms, but the relation between the hardness numbers of metals and other physical properties varies in so many ways that no general law has been established to connect these properties. Despite these limitations the results of hardness tests have already been found of great practical value, particularly in the case of groups of metals of similar chemical compositions. In such cases the results of hardness tests show certain standard relations to each other and to other physical properties of the metals. The chief advantages of the method of conducting hardness tests, as compared with other methods of testing, are the rapidity with which the work can be done and the fact that the making of a hardness test does not destroy the test piece.

Extensive researches have been made with the view of determining the relation of the hardness values of iron and steel of various chemical compositions to other properties of the metal. But less attention has been paid to the determination of similar data for the non-ferrous metals, and information relating to the practical value of the hardness test on non-ferrous metals is quite meager. The purpose of the present article is to present a number of facts concerning the results of hardness tests on aluminum, copper, brass, bronze and certain other non-ferrous alloys. Part of this information is only negative, but it should nevertheless be of value in pointing out the possible uses and applications of the hardness test in factory work.

Method of Making Hardness Tests

Most of the data presented in this article have been obtained through the use of the Brinell ball tester, and we will assume that this apparatus and the principle upon which it operates are generally understood, so that only a brief description will be presented, outlining distinctive features of the apparatus as applied to the testing of non-ferrous metals. It was recommended by the International Congress for Testing Materials that only loads of 500 kilograms and 3000 kilograms should be used in making tests with the Brinell machine, owing to the fact that hardness tests determined with other loads are not strictly comparable. As the 500-kilogram load was recommended for testing the softer classes of material, it would appear that this should be the proper load to employ in making tests of non-ferrous metals, but in practice it has not been found advisable to make tests in this way. Although brass is usually too soft to be tested with a load of 3000 kilograms, the 500-kilogram load makes very small impressions, the limited dimensions of which reduce the accuracy of the measurements and the range of differences in hardness which can be determined. In making tests on non-ferrous metals, experience has shown that it is advisable to employ a load of 1000 kilograms, bearing in mind the fact that the results of such tests cannot be compared with the results of tests made with some other load. In testing sheet metal of less than 1/8 inch thickness, some other standard must be adopted, as the application of a load of even 500 kilograms is found to be too severe. In conducting the tests, the use of a sand-glass which runs for one-half minute will be found convenient in maintaining a uniform time limit.

* Deceased, February 20, 1916.

Method of Testing Castings

It is a difficult matter to secure accurate results from hardness tests of castings. Ordinary castings of brass, aluminum or bronze which have not been subjected to some mechanical treatment, do not show clearly defined circular impressions when it is attempted to determine their hardness by the Brinell method. The circumference of the impression is irregular, making it a difficult matter to measure the diameter accurately; and to secure reasonably accurate results, it is necessary to take three or four measurements of each impression and use the average value. The irregularity in the form of the impression is largely dependent upon the method of making the casting, and although it might reasonably be assumed that the indentations around the circumference of the impression would be governed by the crystalline structure of the metal, experience has shown that this is not the case. In order to secure definite information on this point, the writer made a series of combined microscopic and Brinell hardness tests. The test samples were first etched on a highly polished surface, after which the ball was pressed in. In a series of such tests the microscope failed to reveal any relation between the irregularities of the outline of the impression and the crystalline structure of the metal. The indentations in the outline of the impression appeared on thoroughly annealed samples where the structure of the metal was quite uniform, but where the casting had received no mechanical treatment; on the other hand, this was not the case on rolled samples of metal in both the hard and annealed condition. It seems likely, therefore, that the indentations in the outline of the impression are caused by minute holes in the metal rather than by its crystalline structure, but as neither explanation indicates a means of eliminating the difficulty, the fact remains that it is necessary to make three or four measurements of the impression in order to secure a trustworthy average value.

Difficulty arises from the fact that unless the metal is annealed, hardness tests on castings are likely to show varying results on different parts of the same casting, owing to the differences in the speed at which the metal cooled. In cases where it is desired to determine such variations in the hardness of a casting, the Brinell method of testing affords a very satisfactory means of investigation; but where the hardness test is conducted to determine an average value of the hardness of the entire casting, this variation is naturally objectionable, as it makes it difficult to secure a fair average value. For these reasons the results of hardness tests of castings are likely to be unreliable, but the tests offer a convenient means of securing information regarding the general characteristics of the metal.

Another useful application of the hardness test is in cases where castings of similar appearance but composed of different metal mixtures have been accidentally mixed. The application of the hardness test enables such castings to be rapidly sorted out or identified, and the method is far more rapid than a chemical test. Furthermore, the hardness test does not interfere with the subsequent use of the pieces on which the tests were made. In such cases, the difference in hardness of the parts is usually so marked that a ready means of identification is afforded. For instance, pure annealed aluminum will show an impression of at least 5 millimeters diameter, while an alloy containing 97½ per cent aluminum and 2½ per cent copper shows an impression of only 4 millimeters diameter.

Testing of Mill Products

A useful application of the hardness test of non-ferrous metals is in the investigation of the influence of mechanical and thermal treatment on such materials. Any mechanical treatment increases the ultimate strength and hardness of the metal, while the ductility is reduced; the application of heat

has the opposite effect, making the material weaker and softer but more ductile. The hardness test affords a convenient method of determining slight differences in the process of manufacture, and it is an easy matter to establish standards that may be used in checking up the work of the factory. As it is of the highest importance to obtain exactly the required values of the different physical properties just referred to, in order to make the metal suitable for different purposes, the application of the hardness test as a means toward this end is of considerable value. Data obtained from hardness tests have also been employed in investigating the influence of different methods of annealing, in determining the most advantageous duration of the annealing operation and in deciding upon the best temperature to employ, the advantage being that the test serves to eliminate variations resulting from the personal equation.

Hardness tests may also be profitably employed as a means of guidance in the purchase of factory supplies. For instance, sheet metal is frequently ordered in various degrees of stiffness, specifications being made according to an arbitrary scale of ¼ hard, ½ hard, or ¾ hard; or a sample of metal may be submitted with an order calling for duplication of the sample. The old method of determining the quality of the metal delivered to the factory was to bend the samples by hand in order to estimate their flexibility. The results of such a test were necessarily unreliable, and the substitution of the hardness test eliminates the factor of personal judgment, in place of which a definite scale is substituted. If complete standards are established, the test definitely indicates whether the material complies with the required standard. In case the material does not comply with the standard, the test also indicates the treatment which is necessary to bring it to such a condition. Table I shows an example of standards developed in one factory for use in testing aluminum plates which are rolled down from the same size slabs to a thickness of 0.04 inch. The method of treatment differs in each case and the upper line of the table shows the thickness of the plates at the time the final annealing operation was performed, while the lower line shows the diameter of the Brinell impression, in millimeters, for a test made on the finished plate. These figures are of particular value where the metal is to be drawn up into cups and similar products. When it is desired to duplicate material, and data of this kind are available, it is an easy matter for the mill to produce the desired results. While the data presented in Table I happen to be for aluminum plates, similar figures may readily be developed for copper and brass.

Another application of the hardness test is shown by the following: The diameter of a rod of electrolytic copper was reduced by cold drawing from 1½ inch to 1⅜ inch; then it was tested at different distances below the surface, as shown in the diagram which accompanies Table II, and the results of the hardness tests are shown in this table. The results clearly show that the drawing operation has the greatest effect on the physical characteristics of the metal near the surface of the rod, but that even a comparatively slight reduction of the diameter by drawing—as in the present case—does affect the properties of the metal at the center of the bar. That the difference between the properties of the metal at different distances from the surface cannot readily be determined by other methods is clearly shown from the results of the following experiment: Standard tensile test bars were taken from the same copper rod and turned to diameters of 1¼ inch, 1 inch and ⅝ inch, respectively, the purpose being to remove different amounts of metal from the surface. It might readily be expected that when these bars were subjected to a tensile test they would show differences in ultimate strength, but as a matter of fact all of the bars were broken by the application of the same unit stress.

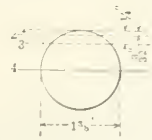
TABLE I. HARDNESS OF ALUMINUM SHEETS 0.04 INCH IN THICKNESS

Thickness of sheets when annealed for the last time, inches.....	0.20	0.15	0.12	0.10	0.08	0.06	0.05	0.04*
Diameter of impression made by ball, millimeters	4.00	4.15	4.25	4.35	4.45	4.50	4.70	5.20

Machinery

* Dead soft.

TABLE II. HARDNESS OF COPPER ROD AT DIFFERENT LEVELS, SHOWING EFFECT OF DRAWING



Level No.	1	2	3	4	Test on Annealed Metal at any Level
Diameter of impression made by ball, millimeters	2.85	3.05	3.15	3.25	3.55

Machinery

This result is striking and might reasonably lead one to believe that the result of one or the other of the methods of testing is not reliable, but the true explanation lies in the fact that fibers which are in various conditions of hardness impose stresses upon each other, thus destroying a portion of their resistance against the action of exterior forces. In this way part of the strength due to hardening the outer layers of the metal is lost. Practical advantage may be taken of the results of this investigation in connection with the manufacture of hard drawn brass rods. Rods made of certain metal mixtures are likely to develop cracks at the surface, and such cracks may appear months after the rods are finished. The trouble is due to the stresses which are developed between the outer layers of metal and the core, and as these stresses are proportional to the local differences in hardness, it is possible to make hardness tests which will determine whether the variation in the stresses exceeds safe limits. The tests may be made right in the mill after the last drawing operation has been completed, thus saving trouble if the material proves defective after it has been delivered to the consumer.

In addition to tests of the character previously referred to, this method of testing may often be employed to indicate slight differences in quality. For instance, sheet metal which shows impressions of uniform diameter at various points on its surface is composed of metal of more uniform composition than is the case where the diameters of the impressions show considerable variation. Both of these conditions are often found in the case of aluminum plates, and metal in which the diameters of the impressions are uniform will be found to possess the highest degree of ductility, even if the average hardness is the same in both cases. The same is true of copper sheets. The ultimate strength of the metal in heavy copper sheets appears to depend on certain properties of the material which are not yet clearly understood, but the strength of the material is found to be in direct proportion to the regularity of the diameters of impressions made in conducting the Brinell hardness test. From the foregoing it will be evident that this method of testing is a valuable guide for both producers and users of various classes of metal.

A peculiar condition is revealed by the fact that there is sometimes a tendency for the hardness test impressions to be elliptical in shape rather than round. Such impressions are usually formed where the material has been subjected to severe mechanical treatment in one direction only, and they are usually found in cold-rolled sheet metal. The differences between the long and short axes of the impression afford an indication of the amount of cold treatment to which the metal has been subjected; for example, if an aluminum sheet shows considerable hardness, it may be judged from the appearance of the impressions whether it is pure hard rolled aluminum, or an alloy in which the hardness is due to the chemical composition of the metal rather than to the mechanical treatment to which it has been subjected. It is interesting to note the relation which exists between the dimensions of these ellipti-

TABLE III. RELATION OF HARDNESS, TENSILE STRENGTH AND PER CENT ELONGATION

	Length of Long Axis of Elliptical Impression made by Ball, Millimeters	Tensile Strength, Pounds per Square Inch	Elongation, Per Cent
In same direction that rolling was done....	3.55	53,480	4
In opposite direction to that in which rolling was done............	3.42	57,680	4

Machinery

cal impressions and the other properties of the material, and Table III shows the results obtained in testing a piece of sheet copper 1/16 inch in thickness. Referring to these data it will be noticed that the strength of the material in the direction of the fibers is less than its strength across the fibers. Similarly, the larger diameter of the impression indicates a lower degree of hardness and strength, and is usually found in the direction in which the rolling was done.

Wearing Tests

It might reasonably be supposed that the resistance which the metal shows to wearing by friction bears a definite relation to the hardness of the metal, but experiments have shown that this is not true. At least there is no well defined relation between the properties which are revealed by the tests commonly employed to determine the hardness of the metal and its resistance against wear, although both of these properties can be said to constitute the hardness of the metal. From the results of a number of such tests, one striking example may be quoted. A certain exceptionally hard copper alloy showed an impression 2.90 millimeters in diameter when tested by the application of a load of 1000 kilograms, while a plain gun-metal showed an impression 4.70 millimeters in diameter when similarly tested. These figures would naturally lead to the belief that the gun-metal was a much softer metal, but a wearing test conducted for both materials showed that the gun-metal possessed twenty times as much resistance against wear as the copper alloy. As neither the Brinell apparatus nor the scleroscope can be used for determining resistance against wear, information on this point has to be obtained by special apparatus. Probably the most satisfactory machine for conducting this class of tests is the one which has recently been developed in the Belgian steel mill of E. G. Derihon.

* * *

RESISTANCE OF FIREBRICK*

The average person and some who should know better have exaggerated ideas of the temperature to which their bricks are subjected in their furnaces, especially when not checked up by pyrometers. I have in my files of catalogues of refractories many statements made by manufacturers that their brand of brick will withstand temperatures from 4000 degrees F. up. Being modest, few claim over 7000 or 8000 degrees(!), but I am glad to say that the average manufacturers are becoming more and more conservative in their statements. The best results obtained by the Bureau of Standards in determining the melting points of fifty-six samples of the best brands of fireclay brick showed but one fireclay brick which withstood a temperature of 3135 degrees F. before it melted. The average was considerably under 3000 degrees F.

* * *

Iron ore production of the United States increased 14,000,000 tons in 1915, according to figures recently made public by the United States Geological Survey. The iron ore mined in 1915 was 55,526,490 gross tons, and its average value was \$1.83 per gross ton. It is estimated that the production of iron ore from the Lake Superior district alone in 1916 will be nearly 60,000,000 tons and that it will net an increase in price of from seventy to seventy-five cents a ton. The production of pig iron was 29,191,600 gross tons in 1915.

* Extract from paper "Tests on High-temperature Furnace Cement," by W. S. Quigley, read before the Philadelphia Foundrymen's Association, May 3, 1916.

EMPLOYMENT OFFICE SYSTEM

BY H. SUNDERMAN*

The following describes a system used by the writer in managing a factory employment office, and the results obtained have been very satisfactory. We have a spacious waiting room adjoining the employment office and this room is furnished with comfortable armchairs and writing tables with pencils, pens, ink and application blanks for the use of those who are anxious to obtain employment with our company. As each applicant enters this waiting room the first thing that attracts his attention is a notice hung in conspicuous places, printed with large black type on cards 7 by 11 inches. This reads: "Fill out your application completely and answer all questions or it will not receive proper consideration. If you need any assistance the clerk will gladly help you."

After reading this notice the applicant immediately fills out both sides of the card reproduced in Figs. 1 and 2; and after this has been done the form is presented to one of the employment office clerks, who asks the applicant questions, upon the result of which he is given a grade of from

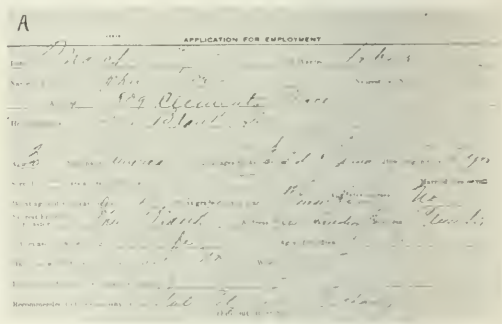


Fig. 1. Front of Card used to record Applicant's Qualifications

A to G according to the nature of his replies. The following shows the qualifications for the different grades.

A—Good appearance, strong, healthy, active, and possessed of all qualifications required.

B—Disposition appears satisfactory, bright, polite, but does not appear to be in the best of health.

C—Slow and awkward.

D—Appears to be older than age given.

E—Previous employe of our company with past record not of the best; if re-hired, caution man about future conduct and attendance.

F—Result of questioning makes it appear that man would be a disturber.

G—Not truthful or appears to be a heavy drinker, loud and boisterous; in other words, don't hire this man.

If there are no vacancies at the time application is made, the applicant is so informed and his card is filed according to the class of work desired; then when there is a vacancy those who have the best qualifications are notified.

* Address: 4224 30th St., Oakley, Ohio.

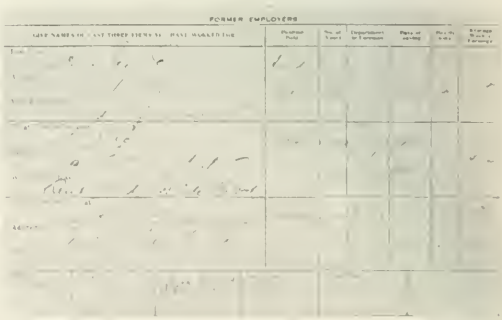
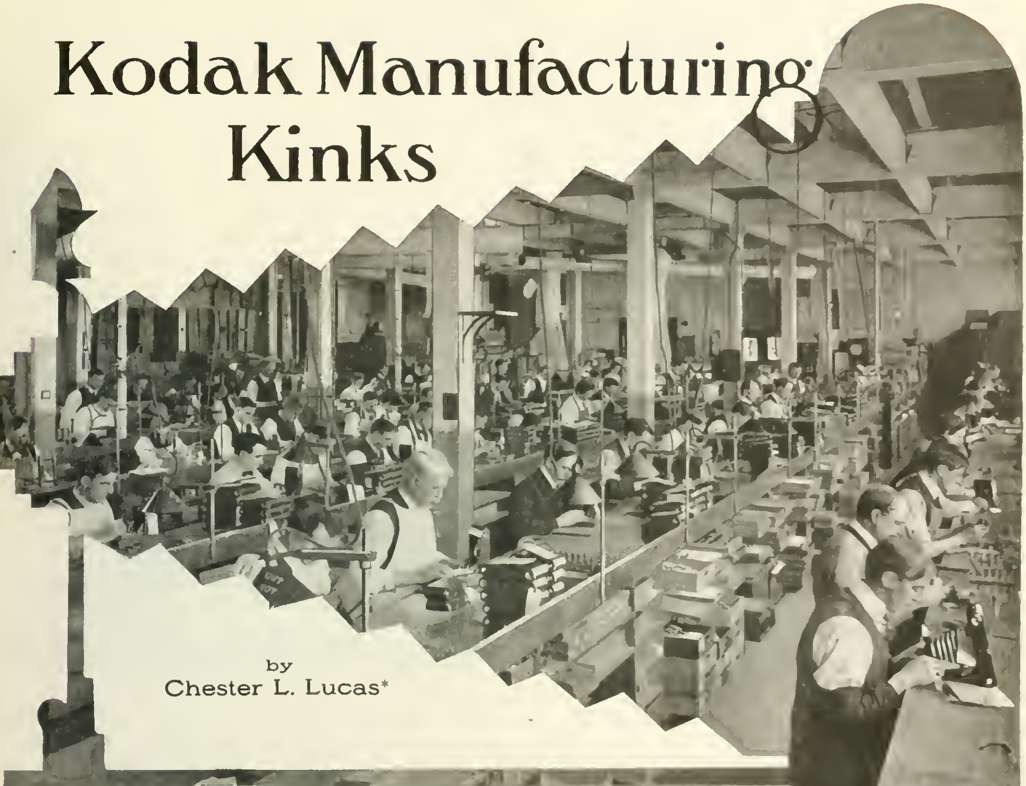


Fig. 2. Back of Card on which is recorded Applicant's Past Experience

Kodak Manufacturing Kinks



by
Chester L. Lucas*

IN the big plant of the camera division of the Eastman Kodak Co., Rochester, N. Y., there are hundreds of operations that are out of the ordinary because the work—the kodak—demands a diversity of operations. As the kodak is a product of wood, leather and metal, many of the most ingenious operations, such as the covering of the bellows with leather, are not strictly in MACHINERY'S field, but a few of the kodak kinks that are of general interest are here presented.

Rivetless Assembling

Figs. 1, 2 and 3 represent three different assembling "wrinkles" used for joining cross bars to the posts of spool keys. In every case the joint is made without the use of rivets, and in fact the rivet-metal is "stolen" from the post itself. In Fig. 1 the round bar is dropped from the screw machine with a shallow grove cut at the center. The key-post is cut from the bar with a cutting-off tool that leaves a little projection in the center of the end. The assembling of the two parts consists of slipping the bar through the post and giving the top of the post one sharp blow with a hammer. This drives the projecting metal down into the groove in the bar and securely locks the two parts.

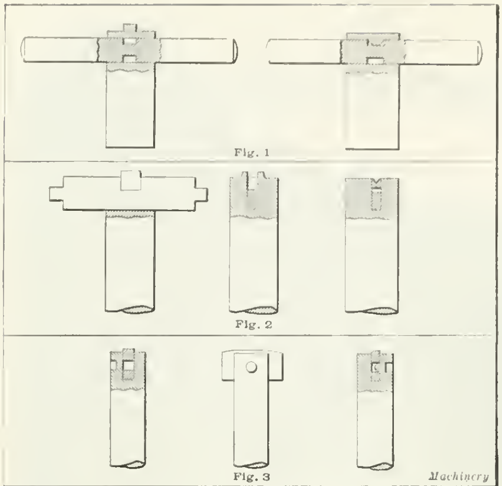
Fig. 2 shows how a flat bar is joined to a key-post without rivets. The key-post is cut off so that a projection is left on the end, and is then slotted to receive the flat bar. This bar is blanked with a recess at the center, and when put together the two pieces appear as in the center illustration of Fig. 2. To rivet, the assembler merely drives over the two lugs that were formed when the central slot was milled through the key-post center projection. These lugs fill the space.

Still another method used for joining two similar parts is shown in Fig. 3. The bar is prepared with a punched hole; the two parts are placed together in a die, after which the punch descends and throws metal from the stem inward, locking the key-bar in place as shown in the last view.

An Eccentric Screw Machine Job

One of the excellent screw machine jobs done in the Eastman Kodak Co.'s screw machine department is the making of the brass bed brace stud that is shown approximately full size in Fig. 7. The set-up of the screw machine for producing this part is illustrated in Fig. 4. The hexagonal brass rod from which this stud is made is 5/16 inch diameter across flats. It will be noticed that the threaded section is eccentric to the remainder, its location being about 1/32 inch off center. The stock is held in a hexagonal collet and the threaded eccentric section is outermost on the bar. The method of cutting the eccentric is to offset the turret tools required for the eccentric machining; these tools are rotated, of course, as they must work on the stationary bar. After the stock has been fed to the stop at the first turret position the spindle is stopped, and the turret indexed to bring it to the second position. Here a box milling tool machines the bar down to the thread diameter. Then the turret is again indexed to bring into position a tool that chamfers the shoulder back of the thread. The turret indexes once more, bringing the threading die into position and cutting the thread. The next indexing of the turret brings the pointing tool that cleans off the end of the screw into position. The spindle is now rotated and the front forming tool advances in the usual manner and feeds into the rotating bar to form the concentric section of the stud back of the thread. The final step is cutting off the completed stud with the rear forming tool

* Associate Editor of MACHINERY.



Figs. 1, 2 and 3. Methods of assembling Kodak Spool Keys without Rivets

Bending on a Screw Machine

Another of the unusual screw machine jobs done in this plant is the making of the plate-holder slide locks. This plate-holder slide lock is made of brass wire 0.100 inch thick and the extreme end is reduced and drilled as shown in Fig. 8. It will be readily appreciated that the actual machining on this job is not difficult, but the interesting part is the fact that the work is bent as a part of the operation, and it drops from the machine turned, cut off and bent, complete. The tools for doing this job are shown in Fig. 5, and consist of the cutting-off tool *A*; the turret bending tool, one side of which is shown at *B* and the opposite side at *C*; pusher block *D* that goes on the front turret slide; and rocker arm *E* for operating the turret tool. At the center of the illustration is shown one of the slide locks made

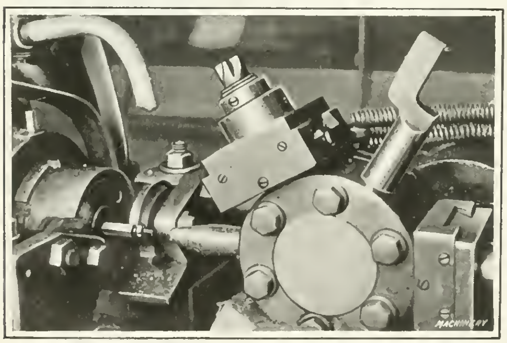


Fig. 4. Producing Eccentric Screw shown in Fig. 7

with these tools. The tools for reducing the diameter and drilling the hole are very simple and are not shown.

The bending tool shown at *B* and *C* is fitted for the turret of the screw machine and carries a hinged yoke with a roller at the outer end. The drilling and forming is done first and then the bending tool is presented to the work. The wire passes to one side of the roller arm and at the right point the arm is moved against the wire and makes the bend. This is done by the action of the front turret slide, carrying block *D* that acts on the cam on rod *E* and swings the bending tool through its connection with it.

A Press Job from the Screw Machine

In turning out the brass tripod nut illustrated in Fig. 9, an interesting use of the screw machine is in evidence for throwing up lugs by punching. The machining operations on this part, except for the punching, are comparatively simple, and after feeding to the stop, consist of forming, centering, drilling and counterboring. Just before cutting off, the upsetting operation takes place. It will be seen that the four lugs of the part are thrown out from a turned shoulder. The punch has four chisel-like projections for doing this work. It is held in the turret like any turret tool, but is mounted on a bearing and is free to rotate. After the other turret tools have done their turning, this punch comes forward in the same way and the turret advance carries it into the work and throws up the four lugs. As soon as it "bites" into the work it turns freely with it and thus does not upset the stock except at the four points desired. The operation works out very successfully and is no more complicated nor troublesome than any screw machine operation.

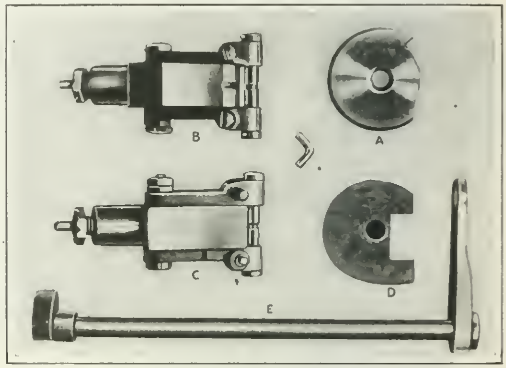


Fig. 5. Screw Machine Tools for making Bent Slide Lock shown in Fig. 8

Piercing Spool Center Eyelets

The spool center eyelet for a kodak is shown in Fig. 10. This is a brass shell 3/8 inch diameter and about the same length, and the operation to be described here is the punching of the slot through the 0.020-inch wall.

Fig. 12 shows the punch and die used for this work. The die is in the form of a stud having the shape cut through it with the necessary clearance. This is held in the side of a block on the die base. The stud is long enough to reach through the eyelet and its end is supported by a short post as shown. After the work is in place on the stud it is held there by the long lever shown. The end of this lever fits into a spring catch that holds it firmly while the piercing is being done. The punch, shown at right, has a projection that fits into a non-cutting part of the die and supports it before it begins to cut. The punchings drop through the stud and pass through a hole in the die base.

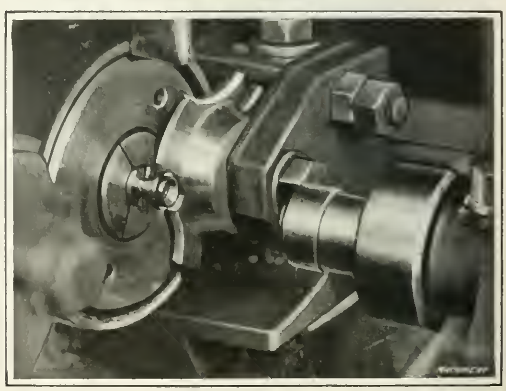


Fig. 6. Punching Tripod Nut shown in Fig. 9, on Screw Machine

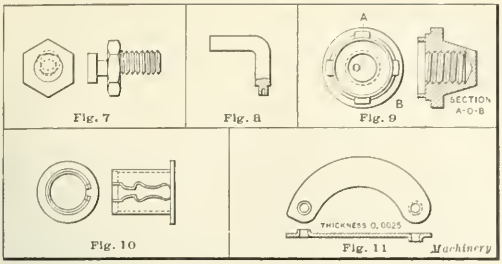


Fig. 7. Eccentric Screw; Fig. 8. Plate-holder Slide Lock; Fig. 9. Tripod Nut; Fig. 10. Spool Center Eyelet; Fig. 11. Diaphragm Wing

Blanking Bronze 0.0025 Inch Thick

In making diaphragm and shutter wings the thinnest of bronze punchings have to be produced. A common thickness for such parts is 0.0025 inch. To make a die for this class of work and to keep it cutting free from burrs is a real job. A good instance is the production of the diaphragm wing shown in Fig. 11. The thickness is 0.0025 inch, but it is greatly exaggerated in the illustration to show the way in which the metal is drawn up around one hole and down around the other.

The die and punch used are shown in Fig. 13. These are sub-press in type and because of the extreme thinness of the metal and consequent danger of shearing, they are guided by four heavy sub-press pins at the corners. The stock is used in ribbon form, being fed from front to rear of the die through the gage pins that may be seen on the die at the left. Inasmuch as the metal is drawn into a bushing form around each hole, the piercing punches must draw as well as cut. As the metal is drawn up around one hole and down around the other, one piercing punch must work from above and the other from below. The stock is fed to these dies and the scrap removed by power roll feeds, and the blanks are cleared from the die with a jet of compressed air.

* * *

Nickel-chromium alloy is largely used for the resistance coils of electrical heating apparatus. This alloy has a peculiar physical characteristic when heated to the rolling heat as regards water. An ingot at a bright red may be laid in a shallow pool of water without sissing or causing steam to rise in appreciable amount. This phenomenon may be noticed in rolling the ingots where they fall into the water used to cool the necks of the rolls. What is the reason that this alloy acts so differently from steel at the same temperature when immersed in water?

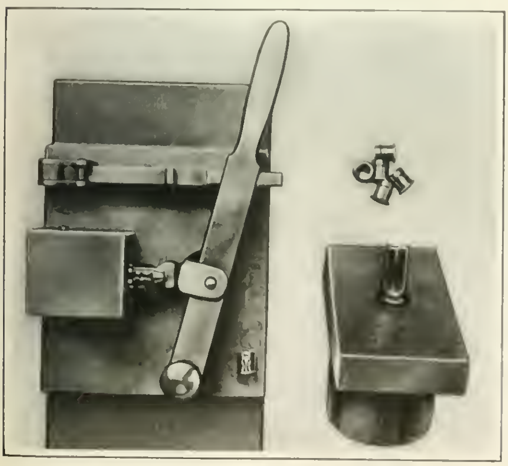


Fig. 12. Piercing Tools for Spool Center Eyelet

SPECIALIZATION CARRIED TOO FAR

BY ERIC LEE*

An incident came to my attention a few days ago which appeared quite amusing at first, although subsequent consideration showed that it was really no laughing matter. In a certain plant Jack Robertson had made all of the cutters used on a special class of wood turning machines for the last twenty years. The price paid for them was $3.25 each, which was established when the standard toolmaker's rate was very low. From 200 to 250 of these cutters were required every year, and they were usually made up in lots of twenty or twenty-five at a time. When some of these cutters had to be made the tool-room foreman invariably gave the work to Jack Robertson, as he had "specialized" on this job and it was thought that he could do it cheaper than any of the other men.

One day while Robertson was away, it was found that the supply of these cutters in the store-room had been exhausted, and a rush order was sent to the tool-room to make twenty-five

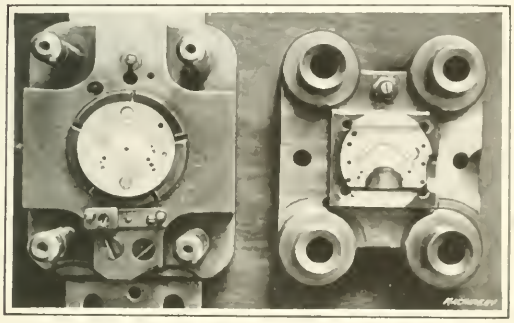


Fig. 13. Diaphragm Wing Die that punches Metal 0.0025 Inch Thick

more. This brought the tool-room foreman face to face with a crisis; he was called upon to produce twenty-five cutters at short notice, and his "specialist" on this work was away on sick leave. As all the other experienced men were also engaged on work that was wanted as soon as possible, the foreman decided that he might just as well assign the making of the special cutters to a "green" man who had just been taken on in the tool-room, it being a foregone conclusion that they would cost much more if Robertson did not do the work.

After the cutters had been finished and passed by the inspector, it naturally created somewhat of a sensation when it was found that they cost $1.75 each, notwithstanding the fact that toolmakers' wages had increased 25 per cent since the time that the original price of $3.25 was placed on this job. Taking a conservative view of the situation, the following is a comparative analysis of the cost of cutters for a year when made by the two men:

200 cutters at $3.25 =	$650
200 cutters at $1.75 =	350
Saving per year	$300

An investigation that was started to find out how this economy had been effected revealed the fact that the "specialist" had been backing off the cutters by hand, while the "green" man had looked over the requirements of the job and seen that the use of an eccentric arbor would enable the backing off to be done on the Brown & Sharpe milling machine; consequently, he made an arbor with the required 1/16 inch of eccentricity, and by substituting machine work for a hand filing operation he had made a change that was worth $300 a year to his employers.

* * *

A 500-kilowatt Westinghouse-Parsons steam turbine is stated to have been in continuous operation for thirty-two months, after which it was stopped in order to determine its condition. It was found to be in first-class shape, and was immediately started without requiring any repairs.

* Address, 191 Bassett St., New Haven, Conn.

ALUMINUM WELDING*

WELDING ALUMINUM WITH OXY-ACETYLENE FLAME

BY HARRY B. HOOVER†

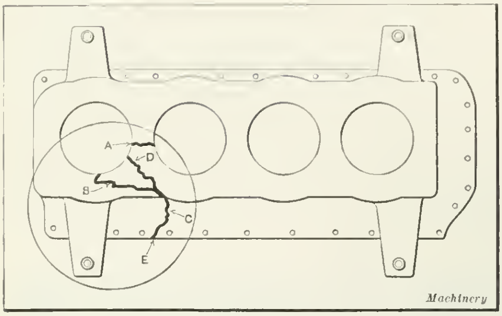


Fig. 1. Diagram showing Method of welding Broken Aluminum Crank-case

THE process of welding aluminum is somewhat difficult to learn, but it can be applied to work which would be difficult to repair by any other means. There are a number of methods in use, but the writer, after several years of successful experience in aluminum welding, has found that the following is the most successful and practical method. Some of the most difficult things to contend with in aluminum welding are the rapid oxidation of the metal, the low fusion point, rapid conduction of heat, contraction and expansion, shrinkage, and in automobile parts the chances of warping which make it difficult to keep the work in perfect alignment. The various points in connection with overcoming these difficulties will be taken up and explained separately.

Oxidation

Aluminum oxidizes very rapidly under the welding flame, the oxidation forming a film or skin over the molten metal which prevents it from flowing as freely as other metals, such as iron and steel. As the oxide melts at a much higher temperature than the metal itself, this makes it rather troublesome for the beginner. The fact that this oxide is chemically inert makes it exceedingly difficult to decompose with the flux, even at the temperature of melting aluminum. Owing to this fact, the fluxes must be chemically active, and one disadvantage of most fluxes that the writer has used is the subsequent effect on the aluminum. Many cases have been known where the metal has been seriously injured by the after effects of the flux, although some time was required for the damage to develop. It is important that the work be thoroughly brushed in boiling water to remove remnants of the flux and prevent this action after the welding has been done. Another point of importance is that after a weld has been made with flux, any crack which may later develop in or near it cannot be welded without considerable difficulty; in fact, it cannot be welded at all unless the surface has been thoroughly cleansed and the metal in the old weld has been removed.

While it is theoretically advisable to use a flux, and even necessary in welding sheet aluminum, there are other difficulties to contend with besides those mentioned. In repairing castings, such as automobile crank-cases, transmission cases, and the like, the use of a flux is difficult, principally because of the condition of the surface before welding. The importance of thoroughly cleansing any surface on which a flux is to be used, cannot be over-emphasized. However, in many cases it is not possible to do this, although the use of strong acids and alkalies, such as hydrochloric acid and caustic soda (applied to the work separately) followed by a thorough washing and brushing in hot water, will remove the dirt and grease from the exposed surfaces. It will not remove the oxide, however, nor as a general thing will it remove the grease and dirt from the crack or break, because at these points the metal is more or less porous, allowing the absorption of the grease. The absorption extends in from the break for some distance in many cases, and unless such metal is entirely cut out, the use of a flux will be found unsatisfactory. The nearer the weld, the less the contraction and distortion of the piece; hence the less metal removed, the better.

Sheet aluminum work is generally a manufacturing proposition and a flux is necessary for the proper performance of the work, but as the surfaces are cleaned, the same objections to the flux do not exist in the case of broken parts, so that the flux will make the weld just as tough and strong as the original sheet. When the metal is clean, a very small amount of flux is all that is necessary, but it must be remembered that the flux must be washed off as mentioned. In many cases a weld can be made without the use of a flux in the time taken to prepare the piece so that the flux can be used.

Puddling System

For practical purposes the puddling system is by far the best. This is accomplished by the use of a paddle made from a small steel rod flattened on one end like a flat scraper or screw-driver, and ground or filed off smooth, the edges being left sharp. As aluminum, unlike some other metals, does not change color when it becomes hot, it is necessary to watch it very closely during the process of welding, and at the time when the edges begin to fuse, the paddle is used to puddle them together. The mode of operation is as follows: First take the paddle edgewise and force it down into the molten metal along the crack or break, making sure at the same time that the metal is being welded entirely through. Now the filler rod must be used to fill up the deficiencies, the metal being kept in a molten state and the end of the filler rod rubbed into the weld, allowing the flame to come in contact with the rod and the weld at the same time. This keeps the oxide broken up and allows the metal to flow together. When enough metal has been added from the filler rod, the paddle is again brought into use, this time using the flat side to smooth the weld and rub off the surplus metal. It is essential that the paddle should be kept warm, clean and smooth, but it should never be heated more than red hot. If it gets so hot that it partly melts, it is best to replace it with a new one, a number of which should be kept on hand. When a weld is made in this way, it will be just as good as any other part of the metal, and if sufficient care is taken it can be made as smooth as the remainder of the work.

Low Point of Fusion and Rapid Conduction of Heat

The temperature at which aluminum melts is between 1100 and 1200 degrees F. With its low point of fusion and rapid

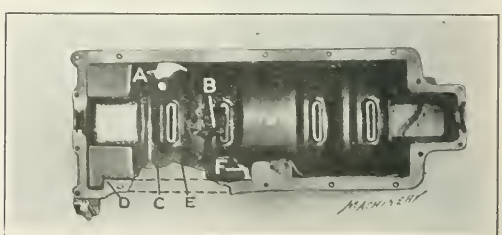


Fig. 2. Broken Aluminum Crank-case before welding

* See also "Oxy-acetylene Welding of Aluminum," June, 1916, and February, 1916, and articles there referred to.
† General Manager, Oxy-Acetylene Products Co., Chicago, Ill.

conduction of heat, it is necessary for the operator to watch it closely, and the fact that it does not change color under heat makes it still more difficult for a beginner. The greatest care must be used when preheating as well as when welding aluminum, not to get it too hot. An indication of overheating is the formation of little bright balls on the surface of the metal. This is called sweating, and when aluminum begins to sweat it is almost at the melting point. The rapid conduction of heat through the metal allows it to become molten for a large area around the point where the heat is applied almost as quickly as it does at the point of contact with the flame. By overheating a piece like this, it is possible to melt a whole crank-case into a puddle almost without warning, or to melt the side of it, or a hole in the case, according to the size of the flame being used. These difficulties must all be guarded against in order to make a successful weld in aluminum.

Contraction, Expansion, Shrinkage and Alignment of Broken Automobile Parts

The contraction and expansion of aluminum are greater than of any other metal, and it is the belief of the writer that 90 per cent of the failures in aluminum welding are due to a lack of precaution in regard to these points. If the expansion and contraction are not properly taken care of, a case which is being welded will warp or shrink out of alignment to such an extent that it is entirely useless. However, in some instances such cases can be reclaimed if not too badly damaged.

The writer remembers one case in particular which was reclaimed after it had been warped 5/8 inch out of alignment and was 1/2 inch short on one side and 1/4 inch short on the other. By cutting the case in two and aligning it properly, allowing for shrinkage when remelted, the case was made as good as new and is now in service. The contraction and expansion are taken care of by preheating and cooling properly. The shrinkage and warping are also taken care of to a certain extent by proper preheating. The most satisfactory of all the different methods is the use of a torch, such as an ordinary blow-pipe, using city gas and compressed air, or a gasoline or kerosene burner. Each of these methods has its own good points, but either can be used with good results.

A preheating torch (as it is called by the writer) is used in preference to a charcoal fire or gas oven because the heat is under the absolute control and regulation of the operator at all times. There is therefore less chance of overheating which might cause the case to warp or shrink, and as the preheating torch is more flexible and allows the piece to be manipulated in any position, any portion or all of the case can be heated at will. It will be understood that the operator must be supplied with a helper who controls the preheating flame under his direction, and there are times when the operator could use two helpers to advantage, as will be explained subsequently. It is seldom that two aluminum castings are found to be of exactly the same composition, some having a higher percentage of zinc and some more copper, etc.; hence, they must be handled in a slightly different manner.

For example, take a case that is composed of an alloy having a high percentage of zinc which melts at a lower temperature and is more brittle and soft when at a high temperature; it shrinks more under certain heat conditions and is therefore more likely to get out of alignment from overheating and to crack in contracting and expanding. In welding a case of this kind, it is extremely important not to preheat any more of the case than is absolutely necessary, and even this work must be done as quickly as possible. By using the preheating torch in a case of this kind, the work can be accomplished quicker, better, and with greater economy than by any other process, so that it is much more practical for general use.

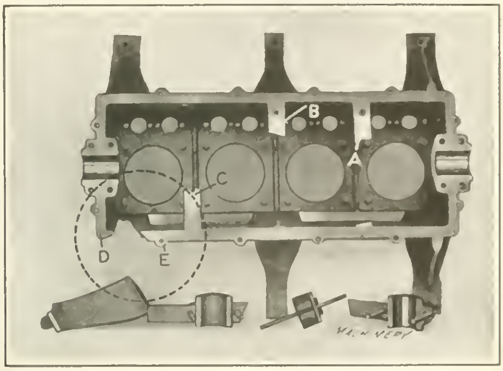


Fig. 4. Example of Badly Broken Aluminum Crank-case


Fig. 3. Case shown in Fig. 2 after welding

Welding a Broken Aluminum Crank-case

An explanation will now be given of the method used in welding the crank-case shown in Fig. 1. In the first place, the case should be thoroughly cleaned, removing all grease and dirt, especially around the end to be welded. The next thing is to see what condition the case is in; if it has been twisted or sprung out of alignment, it will be necessary to pull or force it back into shape with clamps and straightedges. One straightedge should be placed along the bottom of the case where it is bolted fast to the under side, and very small clamps should be used, say, 2-inch C-clamps.

The straightedges should be of cold-rolled steel about 3/8 by 1 inch, and should be a little longer than the case. In putting on a straightedge it should be clamped edgewise, instead of using the flat side, which gives it more strength so that it is less likely to warp under the application of heat. The clamps should not be drawn up very tightly, enough force being used to draw the case up to the straightedges, using the hands only. If a wrench is used and the clamps pulled too tight, the case may be smashed or pulled out of shape where the clamps rest against it, especially near the point at which the heat is applied, as the heat softens the aluminum as before mentioned. At least two more straightedges should be placed on this case, one at the top where the cylinders bolt on, which should run the full length of the case, and one under the two arms shown, fitting in the same as the frame members of the car to which the case would normally be fastened. After the case has been properly aligned and the pieces put in place, it is ready to be preheated. The first step in preheating is to warm the case all over just enough to take off the chill, after which the preheating can be confined to that part where the fractures have occurred, as shown at *A*, *B*, *C*, *D* and *E* in Fig. 1. It is assumed that the devices for preheating are the same as those recommended herewith. In starting the work, the arm should be preheated gradually, extending the heat around over the area shown inside the circle, watching it very closely and keeping the arm hotter than any other part of the case. By using a paddle, as recommended previously, to scrape or "feel" the aluminum in this way, it is easy to tell when the case is hot enough to commence welding. By scraping the aluminum with the edge of the paddle where it

is cold, it will be noticed that the metal is hard and the paddle will slip across very easily, hardly leaving a mark, but when the aluminum becomes hot, the paddle digs right in, and when this condition is reached it is time to begin welding. The preheating flame should be kept on the arm during the entire operation, keeping it at about the same temperature all the time. It is possible for one man to do this work if he is properly equipped, but two men can do it much easier and obtain better results. In explaining the method, however, let us consider that the work is being done by one man.

In the first place, the fracture at *A* would be welded, a tip being used just large enough to bring the metal into a molten condition, having the flame absolutely neutral. After the metal has started to fuse or melt, take the paddle edgewise and force it down into the crack or break, in this way breaking up the oxidation and allowing the metal to flow together. It may be necessary to dig out some of the metal along the crack in thick places to get to the bottom of the fracture. After the bottom has been reached and the metals have amalgamated, the filler rod should be used and the deficiencies filled up, keeping the edges of the metal molten and stirring with the filler rod so as to keep the oxide broken up and allow the metals to flow together. The greatest care must be taken not to get the metal too hot, as it will drop through or collapse, leaving a hole which will require much more work to fill up. This could be avoided by lifting the flame for an instant, allowing the metal to cool partially and at the same time working it with the paddle or filler rod; as it cools, again apply the flame, bringing it up to a molten condition, work it for a few seconds, and then lift the torch once more. This process should be kept up during the entire operation, although, of course, when the parts are heavy, they do not need to be cooled so often, but when the metal is thin, it is absolutely necessary that it be allowed to cool in this manner. The under side of this weld should be smoothed up just before commencing to fill in with the filler rod, and should not be touched subsequently.

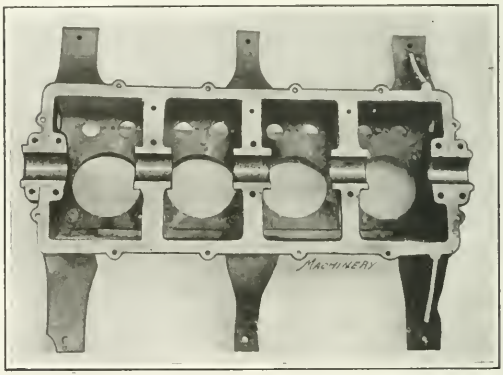


Fig. 5. Case shown in Fig. 4 after Repairs have been made

Fracture *B* is the next weld to be made. This portion of the work should be started at the inside edge and welded down to the fracture *C*. To get at the bottom of this weld, it will be necessary to go down through from the upper side, welding about $1\frac{1}{2}$ to 2 inches in this manner. Then smooth up the weld on the under side, keeping up the process until the work is completed. A point of considerable importance in connection with the welding of this piece is that fracture *C* has been left open during the previous operation, thereby allowing the case to contract and expand without throwing any strain on the welds. It will be necessary, before beginning to make the last weld, to preheat the case as before, after which weld *C* can be started, beginning at the inside edge or top of the case as indicated by *D* and welding down to the outside edge *E*, carrying out the work as directed for the previous operation. After turning the case or straightening the weld up on the inside, it would be advisable to use the preheating torch again for a few seconds in each instance. After the weld has been finished, the preheating torch should be kept on the arm until the weld has become as cool as the surrounding metal; then the hole should be covered with asbestos and allowed to cool in this manner.

Aluminum should never be welded from one side only, except in rare cases, such as welding small lugs, magneto stands or similar parts where the expansion and contraction would take care of itself and would not put any strain on the body of the case. In welding aluminum from one side, the operator should have a helper, and the case should be placed in such a position that both sides are conveniently accessible at the same time, the operator working from the outside and welding all the way through, while the helper uses a paddle on the inside. Then when the metal has been brought into a molten condition on the inside and the two edges of the fracture are puddled together by the helper and smoothed off, they can be kept that way until the weld is finished on the outside. In this way the metal is welded all the way through and finished up at the same time, which saves time and makes a strong weld. After the weld has been made half way through from one side, the piece is turned over and finished from the other side as in ordinary cast-iron work. It is almost impossible to make a first-class job of it, as this method causes unequal contraction and expansion, and the metal cracks or shrinks to such an extent that the case is warped out of alignment. If the job is a large one and requires a long time to weld, a second helper is sometimes necessary to handle the preheating torch. In this way the operation can be carried straight through without the loss of time caused by stopping to preheat occasionally.

Welding a Difficult Crank-case

The case shown in Fig. 2 is a rather difficult job, since it has a false or double bottom, and it is hard to keep the two bottoms expanded evenly; it will also be noted that the parts which are broken out of the case are entirely missing. To fill in the missing parts, the best method known to the writer is to form a piece of sheet iron to fit the case on the outside, covering the broken out place and making it fit snugly. The outer edge should be flanged in the same way as the case and clamped in such a position as to assist in making the mold. A mixture can be made of plaster-of-paris and ground asbestos, just about as thick as mortar, and then poured into the mold. The mold should be filled a little more than even with the case, so that when it dries it will still be thicker than the case. After this piece has been dried out, it can be used for a pattern from which a casting can be made at the aluminum foundry. If there is no foundry of this kind in the vicinity, a ladle of melted aluminum can be used and the mold poured as nearly full as possible, after which it is allowed to cool. After this has been done, the hollow places can be filled in with the filler rod when welding. The former method is by far the more practical except in small openings, when the latter method is better.

When welding the case shown, two straightedges are used, one along each side, the full length of the case. The pieces that have been cast are fitted into place and clamped or fastened so as to hold them in alignment. The case is preheated all over until the chill has been taken off and then the preheating is confined to the parts adjoining the surfaces to be welded, using the preheating equipment previously mentioned, and playing the flame first on the inside and then on the outside so as to expand the double bottom evenly. The weld at *A* is made first (by the two-man system, as we may call it), and the preheating flame should be kept on the case all the time. The weld at *B* is next made entirely from one side, as it is impossible to get at it from the other. The flame is kept on the underneath or outside during the weld at *B* so as to keep the bottom half fully expanded. Weld *C* is made next. This should be spot-welded or tacked at the corner *D* and then at the center of the weld *E*. The weld is started at point *F* and continued up to the top of the case and around weld *C*, finishing at *D*. Fig. 3 shows the case after the repairs have been completed.

Welding a Crank-case with Broken Out Bearings

Fig. 4 shows a badly broken crank-case and Fig. 5 shows the case after it has been repaired. In preparing to weld this case, the babbitt should first be removed from the bearing, and a mandrel should be made of steel tubing the size of the bearing and as long or longer than the case, for aligning the broken out bearings and holding them in place during the entire operation. One of the important things to consider in a piece of repair work like this is the shrinkage, and sufficient allowance must be made to take care of this. By placing a thin sheet of asbestos 1/32 inch thick under the mandrel at the two end bearings, the center bearings will be raised 1/32 inch higher than their original position, which is sufficient to take care of the shrinkage. It is, of course, necessary to place the bearing caps in position just as if the crankshaft were being put into the crank-case, so as to hold all bearings and mandrels in proper alignment. After placing the bearings in position for welding, it is necessary to preheat the case sufficiently to take off the chill, as already described, but an extensive preheating of this case is not necessary. The first weld to make is the bearing at *A*, this being tacked at one side and then welded on the other side around to the first tack. By using a helper on this job, it is done more rapidly and with much better results. The bearings *B* and *C*, respectively, are next welded the same as bearing *A*, and as each weld is made the bearing caps should be loosened to allow the bearing to settle into its original position. The mandrel used for aligning, however, should not be taken out until the case is finished and is perfectly cold. In welding the arm, it should be placed in position and clamped there with straightedges, one of which is placed on the bottom of the case where the bottom half is bolted, one on the top where the cylinders bolt on, and still another one on the outer edge of the arms. All straightedges should be the full length of the case.

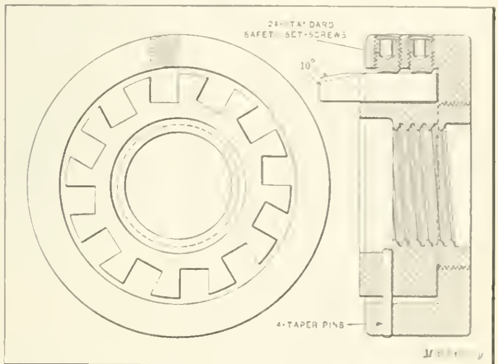
The case is now ready for preheating, the heat being confined to that part of the case shown inside the circle; then the heat is brought up gradually, keeping the arm hotter than the body of the case and leaving the preheating flame on the arm during the entire operation. This weld should be started on the outside edge as shown at *D*, then the inside upper edge should be welded as shown at *E*, continuing around the arm the same as with the bearings and finishing at *D*. The arms should be kept hot until the weld is as cool as the surrounding metal, thus preventing strain, after which the case should be covered with asbestos and allowed to cool slowly.

It may be necessary in some cases to allow a greater or less amount for shrinkage, according to the thickness of the metal. In this particular instance, the case was about 3/16 to 1/4 inch thick. In preheating and cooling, as before mentioned, the shrinkage cracks are prevented which ordinarily occur when the case is preheated all over. As the weld cools before the arm does, the expansion of the arm keeps the metal from contracting on both sides of the weld at the same time. After it has cooled, it will stand as much strain as any other part of the case; so letting it cool before the arm does, makes it really stronger than the heated metal, so that the strain has really been removed from the weld and the only expansion left is in the arm. By cooling this gradually, the contraction is taken care of very readily. A case welded in this manner has not been subjected to any great danger in warping or shrinking out of alignment, as the greater part of it has not been heated very extensively, although some heat has been acquired through radiation. As the larger part of the case has been kept cool, it has held its shape and made it easier for the operator to handle; it has not been subjected at any time to the danger of collapsing from handling or from overheating. If a charcoal fire is used in preheating this case, the chances for warping and cracking are much greater, as the whole case is heated to about the same temperature, making it necessary to handle it very carefully; rough handling under this temperature might cause the case to collapse, or if it were not properly blocked up, it would easily get out of alignment, which might not be noticed until the case had been finished. In addition to this, it is inconvenient to work over a case which has been heated in this manner, on account of the extreme heat.

INSERTED-TOOTH FACING MILL

The illustration shows a facing mill in use at the Vermont Farm Machinery Co.'s plant, Bellows Falls, Vt., for facing the ends of round forgings about 3 inches in diameter. The amount to be removed from these forgings varies from 1/8 to [illegible] inch. After experiencing considerable difficulty with the ordinary solid type of face mill, a cutter was made with inserted teeth as shown, which has worked out very successfully in service.

The mill is made up of an inner ring or core that screws on the nose of the spindle. This core is slotted with twelve slots for the reception of the square tool bits which were made from 5/8-inch square high-speed steel. Surrounding the core is a ring that is threaded to the base of the core and held stationary by four tapered pins. This outer ring is for receiving the set-screws that lock the facing cutters in place. The set-screws are of the regulation safety type and are distributed two to each of the inserted teeth. The face and cutting side of each of the inserted tools are relieved to a clearance of 10 degrees in both directions.



Facing Mill with Inserted Teeth

This facing mill has proved very successful, and the milling operation is carried on with little vibration. The great amount of chip room frees the edges of the teeth of chips at all times. This cutter construction also has the advantage of permitting broken or badly dulled cutters to be replaced quickly.

C. L. L.

* * *

Specialization may be carried out in the building of one size of engine lathe with somewhat the same advantage as in building one size of motor car only. We know what a tremendous success has been achieved by one concern which has built only one size of chassis for a number of years. It has been due to developing special machinery and methods which were practicable only when a large number of cars were made. The same holds true in a lesser degree with the manufacture of engine lathes. Where lathes are built in several sizes they are put through in lots of ten, twenty, fifty or perhaps more but no matter how many there are in a lot it is a distinct division of the production. The next lot will usually be of another size. Now if a few castings are defective—say three cones have blow-holes and are rejected—it means that three lathes are held back until new castings can be made. But if the production of one size is going through steadily, the output is not perceptibly checked because a few castings are thrown out. Of course the chief advantage is in the economies effected by the development of jigs and fixtures and time-saving methods that are feasible in quantity production.

* * *

One machine tool builder met the difficulty of getting steel forgings required for lathe spindles by putting in a Nazel pneumatic cushion hammer and forging them from old car axles. He purchased a large quantity of axles, new and used, for $1.20 a hundred-weight and turned them into high-quality spindles with the aid of the hammer.

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THE VALUE OF MOVING PICTURES IN SELECTING TRADES

Many boys waste valuable years of their lives before finally settling down to the kind of work for which they are best fitted, because they take up a trade with little knowledge of the nature of the work, and after spending months or years, reach the conclusion that they will never like it. This means dissatisfaction, loss of time, and perhaps eventual failure to find an agreeable and profitable occupation.

This state of affairs is unprofitable not only to the employe but also to the employer. It is estimated that it costs an employer from forty to sixty dollars for every employe taken on and taught the rudiments of his work. Of course, if he stays long enough to become proficient, the investment is returned with profit. But how is the employer or the employe to know that the relation will be mutually satisfactory until the employe has acquired some experience? One possible solution is to reproduce the conditions of work by means of moving pictures, and present a fairly accurate idea of the conditions of work, the surroundings, the wages earned, the types of employes and other facts of vital importance to one about to begin an occupation.

If films were available showing the conditions in the principal trades, they could be made useful not only for sifting out undesirable employes, but also for attracting to a given trade those who are naturally well fitted for it. Some real educational work is needed that will attract young men from banks, department stores, offices and other "genteel" occupations to the really productive pursuits which yield large returns for the intelligent and ambitious. If a boy were shown in his impressionable years a picture outlining the career of two average young men of equal intelligence and ability, one entering a banking office and the other taking up mechanical work, he might be in a better position to judge of future values in these occupations. He would see that the "genteel" occupation seldom offers very much in the way of a career, while the job that looks undesirable because the work is harder may have great possibilities for the lad who works, and studies while he works.

* * *

DIRECTION OF WORK IN PROCESS

Should a piece of work be moved to the right or left after or during the machining operations? This is a question which would be rather unlikely to occur to the average person engaged in mechanical work, and anyone who had not previously considered the matter might easily say that it should be moved to the right, or that it was of no great importance anyway. As a matter of fact, when machining operations are to be done consecutively on adjacent machines, and when the jig or fixture is to be pushed from one man to another during the process, it will be found that the work can be accomplished to better advantage if the fixtures are moved from right to left.

This practice will be found to be of considerable importance in handling very heavy fixtures, such as those used for gas engine cylinders in automobile work, or other heavy work on which several operations are to be performed before removing it from the fixture; the reason is that it is easier to push anything with the right hand than with the left, always assuming that the operator is not left-handed.

Going a step further and assuming that the fixtures used are of small size and can be easily handled, it will be found more convenient for the operator to push the fixture from *left to right* if several spindles on a drilling machine are being used. That is to say, a drill jig which is to be used in several positions under different spindles of a machine can be handled by the operator to better advantage working from left to right than if pushed from right to left.

It will be found advisable to look into the handling of any jig or fixture which is to be used consecutively on several machines, in order to see that the machines are so placed that the fixture can be transferred from one to the other with the least possible exertion by the operator.

* * *

SAFETY AND THE MAN

In a conspicuous place at the American Museum of Safety, New York City, is a safety bulletin on which appears the following: "The best safety device is a *careful man*." This statement has more than ordinary significance to those who are informed as to the conditions existing in many factories and shops. Is it not a fact that, because machines are being adequately guarded and equipped with safety devices, the operators themselves have become more or less indifferent to danger, assuming that the guarding equipment is sufficient to keep them from harm? If this is the case, there is another phase of safety propaganda which shop owners and executives should consider.

Most well regulated shops, factories and offices today, especially in congested districts, have a periodical fire drill which is more effective than issuing written or printed instructions to each individual telling him how to act in case of fire. Written instructions alone are very likely to be forgotten in a sudden emergency, if they have been read, which is doubtful. But if the employe has actually gone through the necessary routine a few times, he will remember what exit to use as well as the other essential points. The best fire escape ever devised will not save a man from burning if he forgets where it is or how to get to it. Likewise the best safety device will not prevent an accident if the operator does not know how to act in relation to the different parts of the machine. Why are not safety lectures with practical instruction given in every shop and factory periodically? The memories of operators of machinery in factories will respond more quickly to practical drill, accompanied by oral instruction, than to any kind of printed rules, and if the dangers are illustrated, as, for instance, by the instructor showing the several ways in which the fingers may be cut off on a circular saw, and the means of avoiding such accidents, the instructions are more likely to make a lasting impression.

Accidents are largely the result of an indifferent mental attitude on the part of the operator. The necessity for safety must exist first in the mind of the individual. Then and then only will it be effective. The mental attitude of the operator is almost as important a factor for safety as the careful guarding of the machine. The latter may be accomplished by state legislation, but the former cannot. That must be an individual matter. Everyone who has machines to operate or who comes in contact with machinery in any way should remember that "the best safety device is a *careful man*."

INFLUENCE OF RIGHT BUYING ON BUSINESS*

BY H. B. TWYFORD†

There is ample scope in the profession of the buyer to solve some of the problems connected with bringing the buyer and the seller together, and to secure for both of them the economic advantages that would be attained by closer cooperation. The improvement of the present conditions depends largely upon the use of more efficient methods of buying. Scientific salesmanship has its limitations. It has failed to meet and cannot meet some of the situations created by unscientific buying. Education in selling has been devoted to schemes for getting business, and this has given highly satisfactory results; but more could be accomplished by treating it as an economic study. This viewpoint must almost wholly govern developments in the art of buying.

To illustrate this point, an instance is given of an unscientific buying transaction which actually occurred. The purchaser was in the market for a large quantity of steel forgings, and on referring to his records found he had a list of eight manufacturers of forgings, to each of whom he sent a request for quotations. From two of these, bids were received; but the remaining six were unable to quote for various reasons. Four made only drop-forgings; one was not equipped for forgings as large as those required; and for another the forgings were too small. The result was that the buyer had only two bids on which to base his order, whereas if he were working at an efficiency of 100 per cent he would have had eight bids. It is not to be expected that this percentage of efficiency can always be attained, but that much better results than 25 per cent can be secured is beyond question. This is not an isolated example for it exists to some extent in every purchasing agent's office.

In the instance related, 75 per cent of the buyer's efforts were fruitless; and the same percentage of manufacturers of forgings who were asked to quote incurred an addition to their selling expenses with no prospect of any business eventuating from the loss of time, trouble and expense to which they were put. Every business house is up against this condition, and it is expected and provided for, but if better methods of purchasing were able to eliminate even half of these non-productive activities of the sellers, an enormous saving would be effected. It is conceivable that many concerns could reply immediately to such an inquiry, stating that they were unable to quote, and the resultant wasted effort and expense would be small; but in this particular instance, the question of making the forgings was in three cases referred to the estimating department, and in one case to the shop superintendent before the firms declined to bid.

Another source of unnecessary expense to manufacturers and wholesale houses, caused entirely by inefficient buying methods, arises in those cases where requests for quotations are worded in such an ambiguous manner that there is some perplexity on the part of the bidders as to what is actually required. Sometimes a size is incorrectly given or the careless specification can be interpreted to cover two entirely distinct articles. This involves requests for additional information by telephone or letter, or sometimes salesmen are sent to make inquiries for the purpose of clearing up uncertain points. This also happens with orders when issued, and it is a fault which is entirely too common.

Any betterment of these conditions would tend to reduce the selling expense and consequently lower the selling price. Thus the buyer would be likely to derive a material benefit, but such a benefit could only be brought about by using more scientific methods. Scientific salesmanship cannot cope with certain phases of unscientific buying. The remedy lies with the buyer, and the economic advantages will not only be secured for his own concern but for all those with whom he does business. If one considers the wide ramifications of business, and the successive buying and selling from the raw material to the finished product, it will be realized that this question of right buying has a broad significance and that its influence on business is universal.

The real salesman is the man who discovers live prospects and sells goods. The real buyer is not the man who merely places orders but the one who discovers live prospects among those concerns who are able to sell him what he wants when he wants it and at the right price. The educational efforts made to improve the conditions of buying have not yet reached the stage or been given sufficient prominence to correct many of the evils that still exist, but much is being accomplished. The art of selling is much more highly developed, probably because it is more spectacular and also because it is the means of getting business. It has been governed too largely, perhaps, by the natural ambition of every salesman to increase his sales and of every manufacturer to see his business grow, with insufficient consideration of the economic aspects of the situation. If education in buying brings about a readjustment of the two functions, the present disproportion between the buying and selling expenses of a concern will be brought into the proper relation to each other. Not that the expenses of buying will be materially increased, but the application of better methods should make an appreciable difference in selling expenses.

What is the remedy? It is absolutely essential to know where to buy to the best advantage; and as already indicated, promiscuous requests to manufacturers for quotations will work to the disadvantage of the purchaser. It is important that every buyer should collect accurate information regarding the available sources from which he can make his purchases; and it is not sufficient for this to be just a list of manufacturers or firms dealing in the particular commodities he may be called upon to buy. By a process of selection and elimination he can make this list accurate, complete and confined to those concerns which are in the best position to supply his requirements; and he can then practically concentrate his entire efforts upon them. This method cannot fail to secure for the buyer the most efficient results, and the business will go to the seller with the minimum amount of wasted effort on the part of competing concerns.

In compiling and tabulating information regarding sources of supply there are several factors to be taken into consideration. Not only must the firms to whom the business is given, and with whom negotiations are conducted, be able to make the goods, but they should also be geographically located so that an unfailing supply is assured. Recent freight embargoes have demonstrated to many concerns the wisdom of distributing their purchases in such a manner as not to be dependent upon one manufacturer or one transportation line. Scientific buying precludes the possibility of failure to obtain delivery of goods at the time required and where required. The serious losses that might ensue if proper precautions were not observed are obvious, and provision must be made for keeping records of the character, reliability and financial responsibility of the concerns dealt with.

The recent industrial activity has demonstrated to many buyers the necessity of maintaining these records and the serious losses that may occur by not keeping them up to date. With many buyers the main question today is not one of price, but of getting the goods at some definite date. Orders are being placed and distributed on geographical considerations only. To those actually engaged in buying, many curious and instructive situations have arisen, in some of which the purchaser was able to show the seller from the information he had on file that he was unable to make delivery in the time he had undertaken. A manufacturer who had been accustomed to taking orders for certain material for shipment in one month, but who kept no proper records, continued soliciting business on the same time basis and accepting additional orders from new customers until his factory was booked with work for six months ahead. Against these conditions the buyer must protect himself.

Another manufacturer is doing business in a succession of "waves." He quotes low prices until he has secured all the work he can handle, and then he promptly quotes ridiculously high prices; but just as soon as he has worked off

* For additional information on the subject of purchasing see "Tool System of Cadillac Motor Car Co." published in MACHINERY for June, 1916.

† Address: Care of Otis Elevator Co., 11th Ave. and 26th St., New York City.

the accumulation of orders, he commences to cut prices again. This is a condition against which the buyer must take precautions; otherwise, the loose methods of the manufacturer will probably cause him serious trouble and losses. Scientific buying does materially reduce the cost of selling and this should be one of its chief claims to greater recognition. In addition, it is a measure of safety against loose methods on the part of suppliers and manufacturers, which are likely to cause trouble for the buyer.

* * *

POSITIVE INDICATOR STOPS APPLIED TO LATHE WORK

The following article describes how two very accurate dial indicators were attached to the cross and longitudinal slides of a lathe in such a way as to make it possible to machine work to the highest degree of accuracy without the use of a measuring tool. To understand the operation of this device, reference should be made to Fig. 1, which shows the work—a drill press spindle—in a lathe. A drawing of the spindle is shown in Fig. 3. This shaft is held at its outer end in a specially constructed steadyrest; the other end is grasped by a spring collet in the head of the lathe. The steadyrest is built rigidly and made very accurate. The shaft runs in a split bronze bushing, half of which is screwed into the main body of the steadyrest and the other half into the hinged portion of the steadyrest. The hinged portion is accurately lined up with the lower portion by the latch which is clearly shown in Fig. 1, thus causing the two faces of the bronze bushing to be accurately lined up. It is on the hinged portion of the steadyrest that one of the dial indicators is mounted.

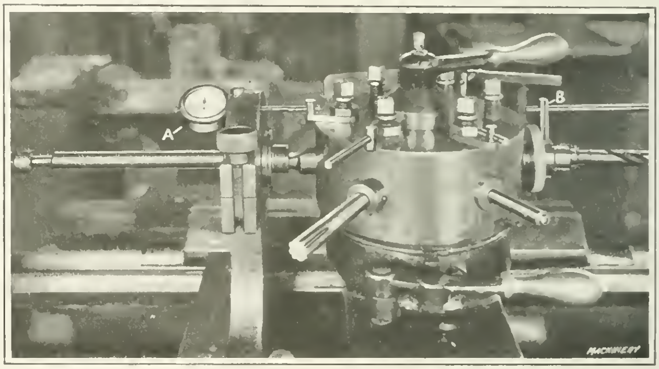


Fig. 1. Lathe equipped with Indicator for gaging Longitudinal Dimensions

In placing the shaft in the steadyrest, the hinged portion is thrown back, the shaft laid in, one end projecting into the spring collet, and the hinged portion brought over and tightened; then a 0.010-inch shim is slipped between the large shoulder on the shaft and the front of the steadyrest bushing. The shim is afterward removed and the spring collet tightened, which takes up the 0.010 inch and draws the shoulder of the shaft snugly against the steadyrest. It is essential that all the shafts be accurately located from some point and this is the point chosen from which to take all longitudinal dimensions.

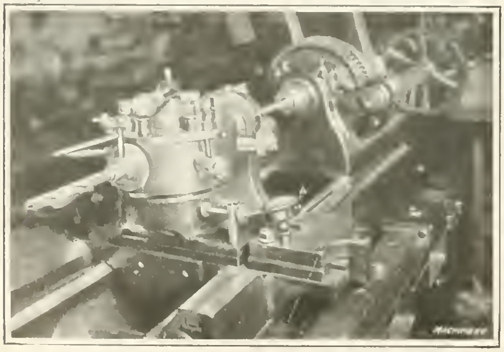


Fig. 2. Lathe equipped with Indicator for gaging Crosswise Dimensions

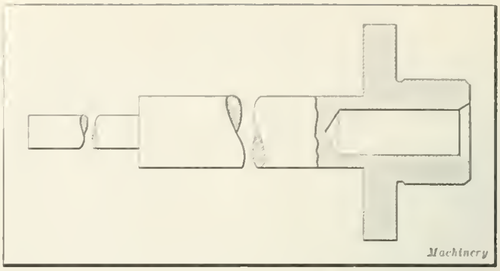


Fig. 3. Detail View of Drill Press Spindle

The indicator A in Fig. 1 is actuated by the various fingers or stops which are shown mounted on the turret head, and the operator has previously so adjusted these stops that when the carriage is advanced far enough to cause the hand of the dial indicator to point to zero, the cutting tool has advanced to exactly the correct position, so that the operation is performed without the use of any measuring tools.

The second indicator A, Fig. 2, is mounted on a stationary portion of the carriage and its finger protrudes into the path of an adjustable stop which is mounted on the cross-slide of the lathe. The stop on the cross-slide is adjusted in such a manner that when the center line of any one of the tools in the turret exactly coincides with the center line of the spindle of the lathe, the hand of the indicator will point to zero. When such operations as drilling, reaming, centering or countersinking are being performed, the cross-slide is, of course, adjusted so as to cause the indicator to read zero. In such operations as rough- and finish-boring, the cross-slide may be set over so as to leave any specified amount on the diameter of the hole being bored, which will be accurately indicated by the indicator A, thus making it unnecessary to caliper or gage the hole being bored.

The operations on the drill press spindle consist in first drilling to the required depth, using the indicator for longitudinal work; second, rough-boring, leaving 0.015 inch on the diameter, and then finish-boring, leaving 0.003 inch for reaming, in this case using the cross-slide indicator; third, reaming, using the cross-slide indicator to centralize the turret; fourth, shaving, leaving the turret on center and gaging longitudinally by the longitudinal indicator (this being the operation illustrated in Fig. 1); fifth, rounding inside edge of countersunk hole, using the cross-slide indicator to show when the full radius is secured; sixth, facing end and chamfering with a combination tool, using the cross-slide indicator to show when the correct amount of chamfer is secured.

The longitudinal stop or finger B, Fig. 1, for the drilling position is arranged in a different manner from those in the shaving, boring and reaming positions. This finger is an integral part of the drill-holder; thus the drill, with the holder and finger, may be removed from the machine while another operation is being performed. When it is necessary to machine more of the parts, this drill and the other tools so equipped may be simply slipped into the turret without adjusting the fingers. This is not so with the fingers attached to the turret, as they must be adjusted at every set-up. These attachments are applied to an ordinary engine lathe with a turret toolpost, in use in the factory of W. H. Nichols, Waltham, Mass. V. B.

THE DETAIL ENGINEER

SIMPLIFIED DESIGN AND A SHOP SYSTEM WHICH RESULTED IN INCREASED PROFITS

BY GEORGE P. PEARCE*

NOT long ago the president of a well established manufacturing company called upon his manager to give a reason for the decrease in the profits of the business which had been noticeable for some time. In taking up the matter with the manager, the president stated that although the management seemed both thorough and systematic and although efficiency methods had been installed throughout the factory, yet the returns on the investment had only been about 3 per cent for the past year. Naturally, the situation was somewhat serious as it is evident that no factory could continue to do business for any length of time with a profit as small as this.

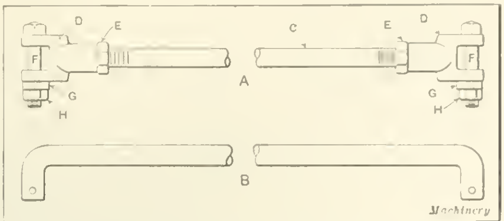


Fig. 1. (A) Old Design of Connecting-rod. (B) Improved Design

In reply to the inquiries, the manager stated that a number of things were responsible for this condition, and further remarked that the company should be satisfied that any dividends at all were forthcoming, as the competition was very strong; and he further argued that if the greatest care had not been exercised to hold the expenditures down as low as possible, there would not have been any profit at all. The manager complained that it was very difficult to get men who would take an interest in their work; and in confirmation of this he stated that twice during the past year he had instituted a general house cleaning, during which he had eliminated practically all the undesirable workmen and replaced them by new men. Even under these conditions, however, he stated that he had found it very nearly impossible to get the right kind of men to stay in the town. The president said that he could not see how it was that some of his competitors had made a profit of 15 per cent in the past year. The manager thought the reason this other firm had been so successful was that it had accumulated an organization which worked together to good advantage so that everything went along smoothly. He stated further that the other firm had been in business ten years to five of the company with which he was connected. However, the president seemed to think that it was the manager's business to see to the cooperation of the various heads of departments and made this statement very plain. The manager finally said that the president would complain if men of this kind were employed because their salaries would be so high that the company could not stand the strain.

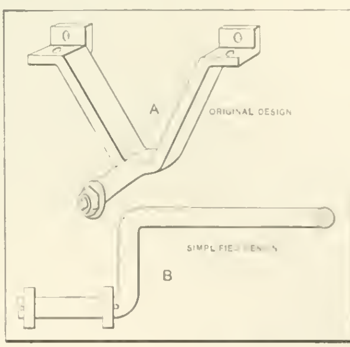


Fig. 2. (A) Old Design of Bracket Forging. (B) Simplified Design substituted by Detail Engineer

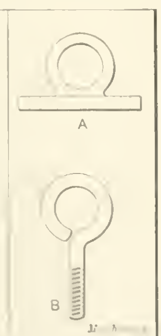


Fig. 3. (A) Original Eye Forging. (B) Standard substituted

The president then stated that he believed the methods themselves were at fault, and that although he believed the manager was conscientiously doing his duty, there must be something radically wrong with the methods used. It had been determined at a meeting of the stockholders that there were too many efficiency schemes, geometric decreasing premium plans, task systems, charge plans for the tool-room and many other intricate methods of doing things, which had been largely responsible for the decreased profits of the organization. A decision had therefore been reached at the meeting to call in a well-known detail engineer and have him look over the situation and endeavor to determine the trouble. The manager at first demurred at the proposed innovation, and stated that he would resign so long as the work which he had done was unsatisfactory, even after he had done his utmost to make a success of the undertaking, but he was finally persuaded to reconsider and remain to see what the effect of the detail engineer's work might be on the organization. After he had consented to this arrangement rather grudgingly, he said that he hoped the detail engineer would be able to devise some system that would cut costs closer than he had been able to; that he knew that the wages could not be reduced another cent without the men going out on strike; that he did not see how it would be possible to make the men work any harder, for they were obliged at present to exert themselves to the utmost in order to make living wages; and finally he didn't see how a stranger could come into an organization and expect to know more about it in a few weeks than men who had been connected with it for years.

The Detail Engineer Appears

About a week after this talk between the president and the manager, a quiet medium sized man appeared at the office and presented a card which simply stated that he was William Steelworth, detail engineer. The president had a talk with him and outlined the situation fully; after which Mr. Steelworth asked, without any comment on the situation, if he might have permission to roam around the plant and make his own observations for a few days, which of course, was immediately granted. After a week had been spent in inspecting the plant in its various departments, Mr. Steelworth once more appeared at the president's office and asked to be placed in full charge of the entire plant with authority to make any changes he desired. Although this was somewhat more than the president had bargained for, he finally concluded that the engineer knew his business and that things could at any rate not be much worse than they were at present; therefore, the desired permission was granted.

Shortly after this, remarkable things began to happen in the factory. One of the first of these was the removal of the innumerable notices, rules and regulations which had been distributed all over the factory; then a meeting of the men was called by the detail engineer at which they were told that the charge plan of issuing tools would be discontinued and that all tools could thereafter be obtained from the tool-room on checks; he also said that the premium plan and task systems would be abandoned and for a short time the work would be on the day work basis, every one being paid wages which were a little better than the average paid in the town. He stated fur-

* Address: 533 Tenth Ave., Moline, Ill.

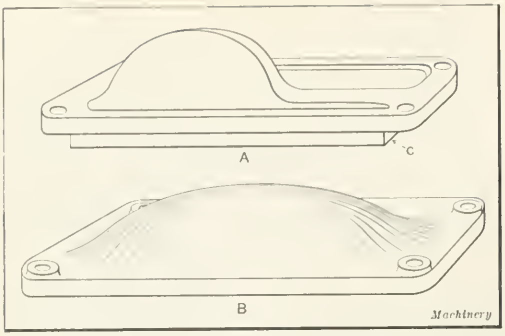


Fig. 4. (A) Gear-case Cover requiring Some Machining. (B) Improved Design finished on Disk Grinder except for Drilled Holes

ther that a little later a simple piece-work plan would be installed that would undoubtedly be satisfactory to all concerned. The new arrangement seemed to please everyone for the reason that by the old system it had been quite difficult to earn on an average as much as the minimum wages in the town.

For several months after this, great activity was apparent in the drafting-room and new models of various lines were developed. Shortly after this, a new piece-rate plan was established, and the men were informed that these rates would be maintained for the next two years at least, but that the right was reserved to readjust them if some newer or quicker way of doing any operation could be developed. He also said that in a short time the men should be able under the new system, to increase their wages from 30 to 40 per cent. It was remarkable to see the way in which the stock and parts were kept moving through the shop shortly after this system had been established, and while there was no particular show of great activity, there seemed to be a determined expression on each man's face that indicated the interest with which he was doing his accomplished task and thinking and planning out every move in advance so as to produce the work to the best advantage.

The Manager Makes a Few Remarks

During all these activities, the manager had been keeping his eyes open and his mouth shut and now felt that a climax must soon arrive. When he checked over the payroll for the current week, he was sure that the time had come without a question. Gathering up the data which he had accumulated, together with the payroll, he hastily entered the president's office without the formality of knocking. In his statements to the president, the manager made it evident that he considered that the firm was on the brink of ruin and that the sooner the detail engineer's practices were stopped the better it would be for the company. He gave as a reason for this belief, the evidence of the payroll, which he stated, showed about 25 per cent more being paid in wages for practically the same number of hours of work, and he was very sure that the men could not do 25 per cent more work or even 10 per cent more, for these matters had been thoroughly tested on many different jobs and the old premium system had been set a small amount ahead of the quitting effort of the man. In addition to this, the manager stated that everything had been changed all over the shop and new designs had been installed, new tools, jigs and fixtures had been made, and as a matter of fact, he was sure that instead of reducing expenses, the detail engineer had systematically increased them until it was at present costing about 30 per cent more to run the shop than it had six months before. He stated as a reason for his bringing up the matter at this time that he thought a 3 per cent dividend was greatly to be preferred to a 27 per cent loss.

In answer to this, the president stated that he had not paid very much attention to the details of what the detail engineer had been doing, but that he knew of the wonderful reputation which he possessed for making a losing job pay dividends, so that he had deemed it best to let him alone to straighten things out as best he might. The manager, however, was fully convinced that a fine mixup had been made of everything and he thought it doubtful whether things would ever be put on a paying basis again. He was also pretty sure that the men would all quit when they were put back on their old schedule as would, of course, be necessary after the detail engineer had finished his work. The president concluded that there might be something in what the manager said, and therefore thought it wise to send for Mr. Steelworth.

The detail engineer did not seem greatly worried over the discoveries of the manager, nor did he appear to mind the apparent losses to which he was subjecting the company by his changes of methods. In defence of his attitude, he stated that it was true that the men were being paid more for the same hours of work, but that the manager was somewhat mistaken in estimating the cost at 30 per cent more than it had been formerly, the actual amount being 36 per cent. He also admitted having changed the design of a number of parts, which therefore required the making of new jigs and fixtures. Going a step or two further, however, he stated that at the present time the material cost of the product had been decreased 22 per cent and the labor cost 45 per cent, or a total decrease in the cost of the product of 67 per cent.

Neither the manager nor the president could quite understand just how the statements of the detail engineer could be reconciled with what they thought they knew themselves about the changes and the extra cost incurred. The detail

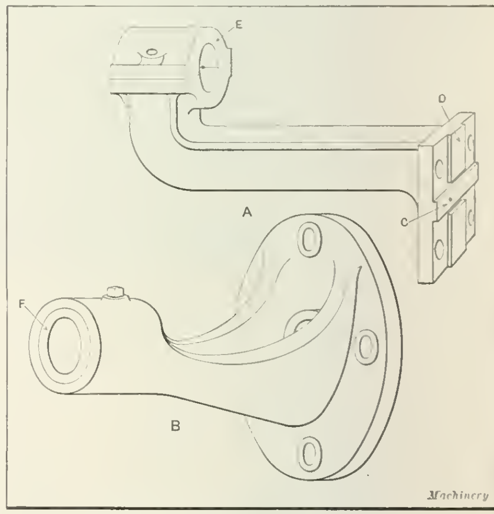


Fig. 5. (A) Original and Expensive Design of Bracket. (B) Improved Design of Much Cheaper Construction

engineer said that it could be very easily explained, and the answer to the question was simply that the output had been increased over 400 per cent. The manager wanted to know what was being done with the machines that were being produced, as they had previously had trouble in selling the smaller quantity which they made and the sales had been decreasing year by year. It seemed that the detail engineer had not overlooked this point, and he had taken a trip to the various agencies and had offered them a 10 per cent extra discount if they would make a year's contract. The result of this had been that they took the extra 10 per cent with avidity which increased the year's demand 250 per cent; it seemed also that orders had been placed with some new firms so that the requirements for the coming year had been brought up to over 500 per cent more than last year. The detail engineer pointed out the fact that after allowing for the extra 10 per cent discount, a handsome dividend would be assured for some time to come.

The manager seemed somewhat doubtful about the matter, but the president of the concern was very much interested and anxious to know what steps had been taken by the detail engineer in order to produce the results which he claimed. Furthermore, he did not see just how it was possible to cut the cost of production by increasing wages, but his inquiry of the detail engineer gave the following data which may make the matter clear.

The Detail Engineer's Report

In the detail engineer's statement of conditions as he found them when he first undertook the work, he cited a number of facts which were unknown to the president of the concern. In the first place, he found that every man in the factory was driven to the limit, and had the feeling that the only way he could hold his job was by making a great display of energy with the result that there was plenty of noise and racket and a great deal of rushing and hustling about. There was no place in the factory for the quiet worker who never made an unnecessary move and he was soon made to feel that he was out of place and either had to make a showing of some kind or get out. The detail engineer seemed to think that considerable credit was due to the men for the work they managed to do under these very trying and adverse conditions, but his idea was that the proper way to judge a man's work is by the amount of it that he turns out and its quality, and that all the activity which was apparent on every side did not necessarily mean industry. In looking over the manufacturer's product to see why such a tremendous effort was required to manufacture such a simple machine, it became apparent that the machines were designed for construction along lines which were unfavorable to quantity production. A few of the instances that he found and improved are noted herewith.

Fig. 1 shows a connecting-rod *A* which was used on one of the machines and is composed of the following parts: one 0.30 carbon steel rod *C*, threaded at both ends; two malleable iron forked ends *D*, threaded, faced and drilled; two lock-nuts *E*; two turned bolts *F*; two lock-washers *G*; two hexagon nuts *H*; making a total of eleven parts altogether. Attention was called to the fact that this rod had very little work to do and that there was no need for adjustment, providing the center to center distances were made commercially accurate. For this reason, the detail engineer entirely eliminated the rod in the new design and in place of it made one up like that shown at *B*. The improved design was made from a simple piece of cold-rolled steel bent over at the ends as shown, and held in place by two cotter-pins. This form required no machine work at all and there were only two holes to drill, so that the saving is very obvious; also the piece performed its function better than the original design because its construction makes it impossible to loosen as the old one did occasionally in the threaded portion.

The bracket forging on another machine, shown at *A* in Fig. 2, was made to carry the idle reversing gear. It will be noticed that this was a very bad forging to make and required a number of special dies and equipment, even in its rough state; and after it was made it was expensive to machine. In order to reduce the cost of construction on this work, a few changes were made in the design of the machine which permitted both sides of the frame to be used as supporting members so that the final result was that the bracket could be made up from cold-rolled steel as shown at *B* in Fig. 2. It can readily be seen that this is a very inexpensive piece to make, requiring only a bending operation and the drilling of two holes, as indicated. It has since proved to be of ample strength for the work for which it was designed.

A number of other changes were made in the forgings and no point was considered too small to be taken up by the detail engineer. The little eye-forging which held a small counterweight on one of the machines and which is shown at *A* in Fig. 3, was replaced by the standard formed wire eye shown at *B*. It would not have been possible to do this had it not been for the fact that in redesigning the machine on which this piece was used, suitable changes were made to permit it. In the original design, the piece was bolted onto a box section, while in the new design it was simply screwed into place. The difference in cost was such that fifty pieces of the new design cost about the same as one of the old style pieces.

Forgings were not the only parts that were changed, as some of the castings were redesigned to good advantage also. Referring to Fig. 4, which shows a cover *A* for the gears on one of the machines, the improved design *B* was made larger so that the clearance for the large gear was ample and it was unnecessary to machine the lip *C* on the under side, as the piece could be located by cap-screws closely enough for all practical purposes, as indicated. In the new design the machining was done on a disk grinder in about thirty seconds, and both covers are alike so that there is no right and left hand as formerly. Either end can be placed at the front with equally good results.

Another instance of an improvement is in the bracket *A*, Fig. 5, which formerly was used to locate and hold the extension shaft for the pinion gear drive on one of the machines. As originally made, this had solid cross keys *C* and *D* on the foot to locate it accurately, which made a very expensive machining job requiring a number of accurately gaged operations together with careful inspection, and even with these precautions some of the machines were being shipped with noisy gears, due to imperfect alignment. In changing this piece over, a few alterations were made in the frame of the machine and a hole was bored and faced so that a casting machined like the one shown at *B* could be bolted on. This casting is simply drilled first and then faced and flanged on a mandrel, both these operations being cheaply and rapidly done.

At this point in the detail engineer's report, the president wished to know how a certain key was placed in the pinion which was mounted on this bracket. In the original design the pinion had been placed on the shaft and keyed in position, after which the cap *E* was placed on the bearing; but in the new design the same result was accomplished by leaving out the bronze bushing *F* and pushing the pinion into position through the hole and holding it there while the shaft was pushed in from the front, a Woodruff key being in the shaft. As the key has less projection than the thickness of the bushing wall, no difficulty was experienced in slipping it through the hole, after which it could be driven in place and the bushing put in and fastened by the set-screw shown.

Another important change which was instituted is shown in Fig. 6. There were four of these spring tension rocking arms *A* on one of the machines, and these were bored, keywayed and set-screwed as indicated. A piece of 1-inch square stock was used in place of the 1-inch diameter shaft, and the rocker arms were cast with a square cored hole in them as indicated at *B*. The hubs of the rocker arm were made $^3/_4$ inch longer than formerly so that the hubs of the four rocker arms just about filled the space between the bearings on the machine; and it was thus unnecessary to put in any set-screws. In providing for the bearings themselves, the corners of the square shafts were ground slightly

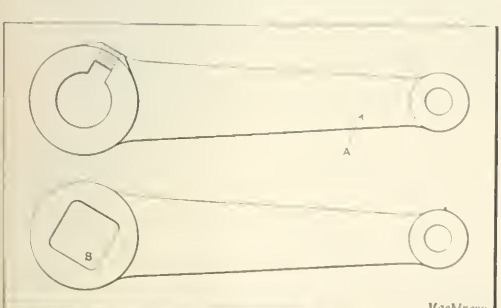


Fig. 6. (A) Original Design of Rocker Lever. (B) Improved Design requiring Less Machining

so that the shafts could be run through the bearing and rocker arm, and a couple of washers with square holes in them were slipped onto the projecting end, after which two cotter-pins were put through the shaft.

Many other changes were made by the detail engineer, each of which tended to eliminate unnecessary labor and simplify the general design of the machine. A great saving was possible through the care used in this redesigning, but the greatest improvement was obtained through the energetic and loyal organization of the men which was gained by eliminating the complicated systems and getting rid of the idea that every man must be on the jump every minute of the day. The new piece rates were so proportioned that good wages could be made, so that at present the men are fairly well contented and happy, with the result that everything is running smoothly and with over 400 per cent greater output, all of which is sold for the next eighteen months in advance.

About this time the general manager came back into the office and stated that things had been found in the factory as represented by the detail engineer. He furthermore remarked that he was as yet unable to understand how it was possible to have produced results such as those indicated, which he confessed seemed more or less of a mystery to him, but he was perfectly willing to give full credit to the detail engineer for the results which had been accomplished.

In talking over the matter, the detail engineer brought out a few points which are worthy of mention. He stated that about three-fourths of the credit was due to the men in the shops and drafting-room, and that their willingness made all the difference between a successful organization and failure. He laid considerable stress upon the fact that the men should be treated as partners in a commercial enterprise, and not as mere wage earners; and it was his belief that the devising and installing of complete task systems and other methods which are based upon the old and erroneous idea of driving men, were great mistakes, and that it had been found to be much easier to lead men than to drive them. After this explanation had been given, Mr. Steelworth said that he reached the conclusion that there was no further need of his services at that factory, as everything was now running along smoothly, and he expressed the hope that it would continue to do so. A number of lessons can be learned from these experiences, and while all the points may not be applicable to every variety of mechanical work, there are few manufacturing plants in which great savings cannot be accomplished by careful attention to details, both in the factory under working conditions and in the design of machines themselves. Furthermore, it should be remembered that in order to obtain the greatest efficiency in any manufacturing establishment, not only the mechanical features but the human factors must be carefully considered. Contented workmen are prominent factors in producing work of good quality with minimum expenditure.

* * *

According to G. F. Eberhard, in *The Metal Industry*, the first watches were made in the year 1500, in Nuremberg, Germany. They were made completely of iron, even the dials. Brass was substituted in 1530, and in 1550 watches began to come into vogue. In 1570, odd-shaped watches, hexagon and octagon shape, began to be fashioned. It was not until 1587 that the watch industry began in Switzerland. The fuzee chain was invented by a Swiss by the name of Gruet in 1590. Up to this time a catgut cord was used. Watch crystals of glass were first made in 1615. Enameled dials were first made in 1635. The balance spring (known as the hair spring) was first made in 1676. It is said that this was made from hog bristles, and that is how the name "hair spring" originated. The minute-hand device was first made in 1687, with its hour and minute wheels and cannon pinion which carries the minute hand. The first keyless watches were made in 1700. The compensating balance was invented in 1749. The duplex escapement was first made in 1750. The lever escapement was invented in the year 1776. Second hands were first used in 1780. Thin watches were first made in 1776. All important inventions for making watches were made in Europe.

NOTES ON TOOLMAKING

BY WILLIAM YOUNG*

There are a number of processes of sufficient interest to be especially noted in connection with accurate tool work, although they are incidental to the regular occupation of toolmaking and for this reason have been little touched upon in books or articles on toolmaking methods. In the following notes on lapping, filing and die work, there are many suggestions that may be of value to those who have not had much experience in this class of work.

Lapping

It is quite important in preparing to lap a piece of work, to select an abrasive that will produce the work within a minimum amount of time and at the same time leave a finish which will be of the required degree of fineness. It may be stated that it is inadvisable to use coarse emery when a polished surface is desired, and as a matter of fact coarse emery should not be used even for the preliminary cutting down unless a considerable amount of surface is to be removed, because it is likely to leave scratches so deep that they cannot be removed by the finer abrasive used subsequently. The abrasive used for this purpose can be mixed with oil or its equivalent, but gasoline is considered the best lubricant for operations of this kind because it evaporates and permits the abrasive to take hold and cut faster than if plain oil were used. In lapping out a hole in rough work, the cheapest method is to use a piece of split wood with emery cloth inserted and twisted around until it nearly fits the hole. In bronze or brass work a mixture of crocus and Vienna lime can be used to advantage; and unslacked Vienna lime, freshly crushed, can be used with a hard wood or lead lap and will continue to cut for a long while, but is very slow in its action.

It is well to remember that there are distinct substances and grades for different kinds of work and that the material used in lapping is largely governed by the kind of metal to be lapped and the speed of the operation. One of the best abrasives to use for small holes is diamond dust which has been charged into a copper, brass or bessemer rod, but caution must be used not to crowd this style of lap because it will "strip" easily. It must be remembered that diamond dust is expensive and should therefore be used sparingly. If a particularly high finish is desired on a piece of work, a piece of boxwood charged with diamond dust will give the finest results. No. 1 diamond dust is the best grade.

Lapping Cylindrical Work

For cylindrical work a copper or cast-iron lap is commonly used. The lap should always be long enough to extend entirely through the hole with a generous margin and should be made a running fit so as to lap the highest parts. A reciprocating motion should always be imparted to the lap in order to avoid lumping the emery and scratching or cutting grooves in the work. Care must also be taken to keep the laps parallel to the work in order to avoid having an irregular hole or one which is more or less bell-mouthed. In plug and ring gage work, care must be taken to cool the ring gage thoroughly in benzine and clean it carefully before testing the plug. Whenever it is possible to do so, a shoulder should be left around the end surface of a hole so that if made slightly bell-mouthed, the error can be easily corrected by grinding off the shoulder.

Lapping Flat Work

In lapping parallel work or other work of a similar kind, a cast-iron plate will be found the best. A steel plate should not be used. A plate having scored grooves is the best for flat surfaces and will give more satisfactory results than a plain surface plate. On work of this kind it is well to use a straightedge from time to time in order to note the progress of the work, and in this connection it should be remembered that no matter whether the work is cylindrical or flat, it should never be lapped continuously in one place

* Address: 282 Mountain Grove St., Bridgeport, Conn.

but should be kept moving about, and the pressure should be as nearly uniform as possible in order to secure the best results. When the work is of such a form that it cannot be reached with an emery wheel, a copper or bessemer rod can be formed to the shape desired, charged with emery, and used as a lap to finish the surface. An important point in connection with lapping is to see that the lap is thoroughly clean before being used and that it is cleaned after use.

Notes on Filing

There are a few points of interest in connection with filing, some of which will undoubtedly be familiar to the majority of toolmakers. It is well to heat the tang of the file and burn it into a handle rather than to drive it in. It will hold its position much better set in this way and there is little possibility of splitting the handle. It is fully as important to select the proper grade and shape of file for a piece of work as it is to file it properly after the file has been selected. A good toolmaker carries his file straight across the work without rocking and is careful to see that it is kept clean and free from filings and chips. A file that is filled with dirt and chips cannot be expected to cut rapidly nor produce good work.

In producing a nice finish on a piece of work, the file may be rubbed with chalk, or oil may be applied to produce a smoother finish than if filed dry. On certain kinds of work a file that has been in use for some time may be desirable, but never one that has been abused. If a file has been glazed it is practically ruined and will burnish or harden the material being filed without having much cutting effect. A point worth remembering in connection with filing is that the file may be charged with emery and used for stoning a tool in case of necessity. Finally after the files have been used up so that there is no more cutting action left, the temper can be drawn and they can be ground so that they will make excellent parallels.

Notes on Punch and Die Making

There are a number of points of interest in connection with punch and die making. In making up a set of punches and dies for any particular job, one of the first things to be considered is the material from which the work is to be produced. When blanking dies are to be made for thin metals, the punches must fit tightly, while the clearance should be proportionately larger when the section to be punched is thicker. An allowance should always be made of at least the thickness of the stock to be blanked between the nearest edge of the blank and the cut, this allowance being necessary in order to support the stock. In laying out work, an economy of stock can sometimes be effected by laying the blanks out at an angle, and it is always well to figure on using the nearest width of material in stock when laying out the dies. The kind of steel that should be used in making the punches and dies varies according to the work to be done and the kind of metal to be punched. The hardening and tempering operations should be determined by the quality of the metal to be worked.

Templets

In making a templet, it is a good plan to solder a rod to it so as to prevent the wrong side being inserted through the bottom of the die. When making a pair of templets, the greatest care should be exercised to make them as accurate as the punch and die to be made, as the templets are used as masters from which to form the punch and die. Pilots and piercing holes should be located by using the templet.

General Remarks

In connection with punches it is well to note that when shearing punches in the die, oil should be used and the work should be done a little at a time. When they are to be tempered they should be drawn from the back or shank, and when piercing punches are drawn, care should be taken to draw them evenly throughout their entire length. Tension buttons can be used in the gage plate or stripper when the stock to be cut varies in width. Too much clearance on a die is unnecessary and undesirable, as the greater the clearance beyond a certain point, the shorter the life of the die will be, as it will require more frequent regrinding. In order to provide a surface on which to work when laying out a blank or sample on brass, the material can be sprinkled over with cast-iron or steel chips and then rubbed with vitriol to give a good finish on which the scriber lines or other markings can be distinctly seen.

In laying out the dies themselves, they can be blued over a flame to permit the marking to show more distinctly. It is important that all pilots and the blanking points should be made to size so that the article which has been blanked will be perfectly accurate; hardened steel bushings should always be placed in the stripper plate when small piercings are required. When planing up the steel pieces from which the parts are to be made, sufficient stock should always be removed to get below the scale, as this reduces the likelihood of trouble in hardening. After the die is hardened it should be ground all over and the dowel pin holes lapped. The stripper is then laid on the die and the dowel pin holes are transferred. The dowel pins should be hardened and ground to a tight fit in the stripper and a push fit in the die. The screw holes are transferred through to the stripper and the stripper plate is removed. The die is now swung upon the faceplate of a lathe and one of the piercing holes indicated, after which the stripper is screwed on and centered and a hole smaller than the piercing hole is drilled. This hole is then bored to the outside diameter of the bushing and the stripper is once more removed. This procedure is repeated for the various piercing holes. The bushings for the stripper should be made after the stripper bushing holes are bored and the blanking punch hole is filed out. The bushings should be left about 0.005 inch larger on the outside and about 0.002 inch smaller on the inside than required. They should be hardened and drawn and the holes should be lapped to a close fit on the piercing punch; then they should be put on an arbor and the outside ground to a driving fit in the stripper holes.

An important point in die work is the file finishing of the die, as unless particular attention is psid to seeing that the work is filed to a polish before it is hardened, there is likely to be subsequent trouble due to the work becoming stuck. In order to give good results, the die must be absolutely free from any ridged or irregular surface; the turret angle or arm should be the same and the punch should always be made long enough to pass entirely through the die. Any piercing holes which are to be bored should always be formed in the lathe. After a die has been completed it should be ground, together with its points, before it is tried out, yet it should never be allowed to lie around several days when it is glass-hard, but should be drawn to the proper temper as soon as possible.

A number of the points which are given herewith are not new, and some of those mentioned may seem obvious to the more advanced readers. However, these readers must remember that in their own experience there must have been a time at which information of this kind might have proved of considerable service. Therefore those to whom the material is not of great interest can pass it on to those less fortunate ones to whom the writer hopes it will be of service.

* * *

A comparatively new business is the repairing of motor cars and motor trucks in shops specially equipped with machinery for the work and having a corps of expert workmen thoroughly familiar with the intricacies of the various makes of cars. These establishments can give service incomparably superior to the ordinary garage, as they have machine tools that enable them to make repair parts quickly when not in stock. Not all the work is of an emergency nature, and in a large shop, overhauling from the ground up can be done economically by switching the men to hurry-up jobs as required. In some places manufacturing on a small scale enables the equipment to be profitably employed in slack time.

ACCELERATING FORCE OF RECIPROCATING PARTS*

DIAGRAM FOR DETERMINING INERTIA FORCE FOR VARIOUS PISTON POSITIONS—ERROR DUE TO USE OF CHART

BY HUBERT L. WATSON†

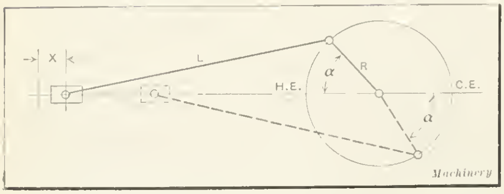


Fig. 1. Diagram illustrating Quantities in Formulas

CERTAIN calculations in the design of parts of a reciprocating engine, such as the flywheel, require a knowledge of the accelerating force or inertia of the reciprocating parts. The accurate determination of a diagram which will show the effect of this inertia is a tedious mathematical process. An expression by which this force may be obtained for any position of the piston is, for the forward stroke:

$$P_1 = -\frac{WV^2}{gR}\left(\cos\alpha + \frac{R}{L}\cos 2\alpha\right) \qquad (1)$$

For the return stroke, the value of this force is:

$$P_2 = +\frac{WV^2}{gR}\left(\cos\alpha - \frac{R}{L}\cos 2\alpha\right) \qquad (2)$$

where W = total weight of reciprocating parts, usually considered as combined weight of piston, piston rod, wrist-pin, and from 45 to 55 per cent of connecting-rod weight;

V = velocity of crankpin in feet per second;

R = radius of crankpin circle in feet;

g = acceleration due to gravity, or 32.2 feet per second per second;

L = length of connecting-rod in feet;

α = crank angle, measured from head-end dead center on outward stroke, and from crank-end dead center on return stroke;

P_1 = the accelerating force during the forward stroke;

P_2 = the accelerating force during the return stroke.

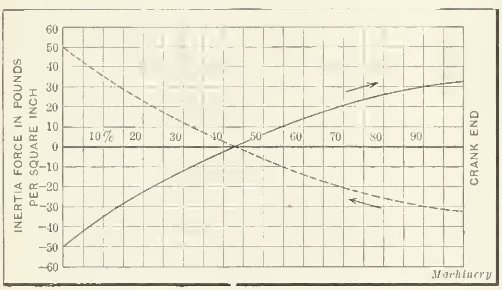


Fig. 2. Diagram showing Inertia Force in Pounds per Square Inch for Various Piston Positions

The derivation of these expressions may be found in numerous design books, such as Levin's "Modern Gas Engine and Gas Producer," page 472; Güldner's (Diederichs') "Internal Combustion Engine," page 156; and in a slightly different form in Unwin's "Elements of Machine Design," Part II, page 68.

It is evident that at the beginning of the stroke the weights of the parts retard the motion, while at the end of the stroke they aid the motion. If it is desired to determine the inertia force at the head-end position, α becomes 0 degrees and $\cos\alpha = 1$. Also $\cos 2\alpha = 1$, and Equation (1), simplified, is:

$$P_1 = -\frac{WV^2}{gR}\left(1 + \frac{R}{L}\right) \qquad (3)$$

At the crank-end position, $\alpha = 180$ degrees. Therefore, $\cos\alpha = -1$ and $\cos 2\alpha = +1$.

$$P_2 = +\frac{WV^2}{gR}\left(1 - \frac{R}{L}\right) \qquad (4)$$

For intermediate positions it will be found necessary to use Equations (1) and (2).

VALUES USED IN PLOTTING DIAGRAM SHOWN IN FIG. 2

Crank Angle, Degrees	Stroke, Inches	Stroke, Per Cent	Inertia Force, Pounds
0	0.00	0.0	50.6
15	0.44	1.7	47.9
30	1.78	6.8	40.1
45	3.89	14.9	28.6
60	6.90	26.5	15.2
75	11.15	42.9	1.7
90	14.61	56.2	—10.1
105	17.88	68.8	—19.3
120	19.90	76.5	—25.3
135	22.27	85.7	—28.6
150	24.63	94.8	—30.0
165	25.79	99.1	—30.3
180	26.00	100.0	—30.4

Machinery

For purposes of comparison it is customary to use $\frac{W}{A}$ or the weight of the reciprocating parts per square inch of piston face, where A = the area of the piston face in square inches. Thus the inertia force will be found in pounds per square inch of piston face. This is convenient, for the mean effective pressure and other pressures are so expressed. At the point where the velocity of the moving parts is changing from accelerating to retarding, the inertia force will be zero. This occurs when the connecting-rod and the crank are at an angle of 90 degrees to each other, or when $\tan\alpha = \frac{L}{R}$. The position of the wrist-pin, or the amount of travel from its head-end position, corresponding to any given crank angle, may be determined from the expression:

$$X = R\left(1 - \cos\alpha + \frac{R}{2L}\sin^2\alpha\right) \qquad (5)$$

Let us take an 18- by 26-inch engine running at 200 revolutions per minute, where the ratio of $\frac{R}{L} = \frac{1}{4}$, and the weight of the reciprocating parts is 700 pounds.

The area of the piston face will be:

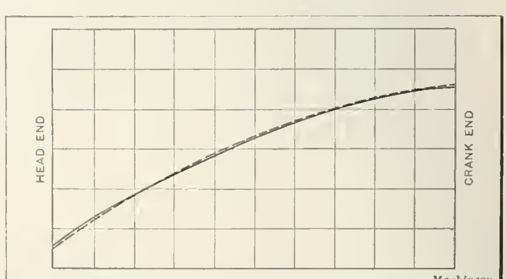


Fig. 3. Diagram showing Difference in Results obtained mathematically (Fig. 2) and by Use of Chart (Fig. 4)

* For additional information on this subject published in MACHINERY, see "Inertia of Reciprocating Parts," November, 1913; "Light Weight Reciprocating Parts for Motors," July, 1913; and "The Inertia of the Reciprocating Parts of a Steam Engine," September, 1900.

† Address: Department of Machine Design, Purdue University, Lafayette, Ind.

$$A = \frac{\pi D^2}{4} = \frac{\pi \times 18^2}{4} = 254.5 \text{ square inches.}$$

$$\frac{W}{A} = 2.75 \text{ pounds per square inch.}$$

The crankpin velocity is $2\pi RN = \dfrac{2\pi \times 13 \times 200}{12 \times 60}$ 22.68 feet per second.

Calculating the inertia force for different crank angles, the values are obtained which are shown in the table. Then by plotting the inertia force upon the piston stroke as a base line, we obtain the full line curve in Fig. 2. During the return stroke the values are numerically the same except in the sign, and hence may be readily drawn, as shown by the broken line. The foregoing has involved lengthy and monotonous calculations, which has led the writer to express this inertia force by a graphic chart, Fig. 4, instead of an equation, saving greatly in time and also giving much less opportunity for error. The best explanation of the use of the chart is, possibly, to follow out upon it the problem which has already been solved above. It is necessary to know the following: the weight of the reciprocating parts per square inch of piston face, the length of the stroke, the revolutions per minute and the ratio $\frac{R}{L}$. In the diagram D, Fig. 4, note the point on the lower horizontal line representing a 26-inch stroke, pass vertically upward to the oblique line of 200 R. P. M., and immediately to the right will be found the velocity of the crankpin in feet per second, which is 22.6. Similarly, from the diagram E, we find that with a ratio of $\frac{R}{L}$ the point where the inertia force is zero is at 44 per cent of the stroke from the head-end dead-center position.

Now in section A of the chart proper, upon the ordinate corresponding to $\frac{W}{A} = 2.75$ pounds, move upward to the oblique line of the stroke of 26 inches, in this case interpolated between the 24- and 28-inch lines. From this point move horizontally to the left until intersecting the oblique line in section B representing a crankpin velocity of 22.6 feet per second, and then vertically downward into section C. Here there are two sets of oblique lines corresponding to the various values of $\frac{R}{L}$, the upper set being for the crank-end position, and the lower set for the head-end position. Thus the intersection of the vertical line with the oblique line of $\frac{R}{L} = \frac{1}{4}$ in the upper set, gives us on the scale to the right, 30.8 pounds per square inch of piston face, as the inertia force at the crank-end position. Following on down to the intersection of the vertical line with the proper line in the lower set, we find the inertia force at the head-end position to be 51 pounds per square inch.

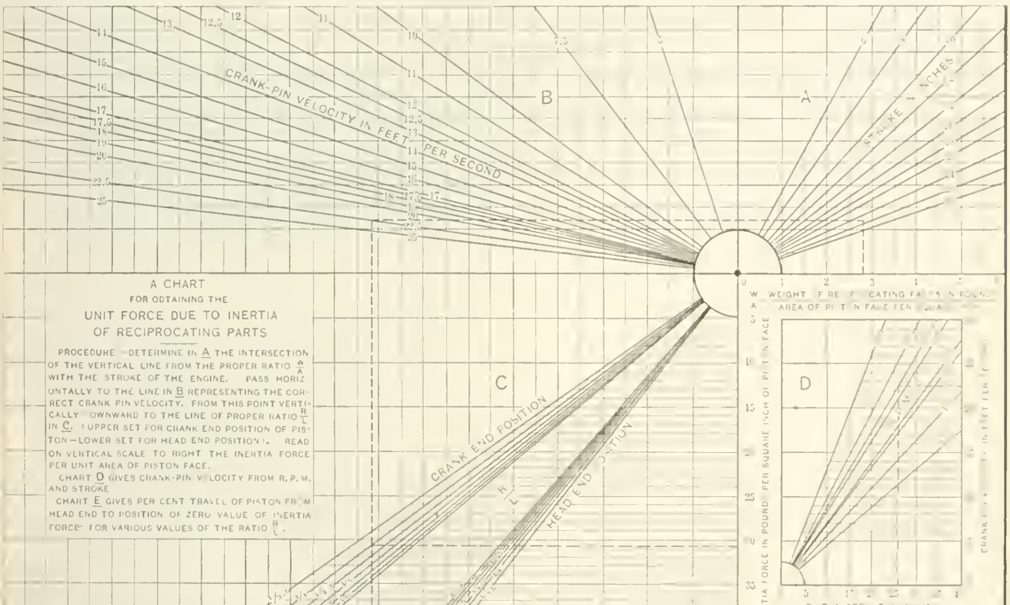


Fig. 4. Chart for Use in obtaining Unit Force due to Inertia of Reciprocating Parts of an Engine

We have thus quickly determined three points through which the inertia curve will pass. If an arc of a circle be drawn through these points we shall have a curve which very closely approximates the true inertia curve. In Fig. 3 the inertia curve has been replotted, and superimposed on it is the arc of a circle drawn through the points as determined by the diagram, showing the small error introduced by the use of the chart and a compass instead of the more laborious, though, of course, more accurate mathematical solution. If the value of $\frac{W}{A}$ is greater than the maximum shown on the chart, divide the actual value by some number, say 2, proceed as usual, and then multiply the results obtained by the same number, for the inertia is in direct proportion to the weight of the reciprocating parts.

Electric Spot Welding

by Douglas T. Hamilton*

THE resistance method of electric welding is divided into many processes, among which might be mentioned butt, spot, point, ridge, button, seam, etc. In all cases the principle is the same, being based on the resistance offered by the metals being welded to the flow of a low-voltage current. Electric spot-welding refers to the practice employed in forcing sheet metals together by means of copper electrodes and heating the metal through the same medium. There is a limit to the thickness of sheet metal that can be satisfactorily spot-welded. First, the copper rods used for the electrodes will only carry a certain amount of current without excessive heating, and when the current required to accomplish the weld exceeds the capacity of the electrodes, the latter will soften and wear away rapidly. Second, to produce a satisfactory spot-weld it is necessary to have the two pieces of sheet metal touch each other at the point where the weld is to be made. When the pressure required to bring the opposing sheets of metal into contact exceeds the compressive strength of the electrodes, the ordinary spot-welding machine cannot be used. For work of this kind other processes, which are given different names because of the variations in application, are used. One method is to enclose the copper electrodes in hardened steel bushings. The bushings and heating electrodes are operated by separate mechanisms, and to effect the weld the bushings are first operated to bring the sheets into contact, after which the current is turned on and the weld made.

Difference between Butt- and Spot-welding

Electric spot-welding differs from electric butt-welding in that the parts being welded do not necessarily need to be of the same cross-sectional area, and the parts can be welded at one point or at a series of points by forming contact points of the required area upon the faces of the upper and lower electrodes. In the butt-welding machine, the work is held in clamping jaws of varying shapes to suit the work, which are made from copper and serve as electrodes. In the spot-welding machine, round rods of copper are used for the electrodes, and as they are presented in a vertical plane with their contacting points opposing each other, they localize the current at the point where the weld is to be made. As is the case with butt-welding, a large volume of current at low voltage is made to pass through the electrodes, and when two pieces of sheet metal are placed between these points, and the current turned on, the metal instantly becomes hot at the point where the copper electrodes touch it. The hotter the metal becomes, the greater the resistance. The sheet metal between the electrodes is therefore brought to a welding temperature, and a slight pressure of a lever forces the molten metal together and forms a perfect weld at the point of application of pressure.

Electric Spot-welding Machine

An electric spot-welding machine consists essentially of a transformer for reducing the current from high to low voltage, a secondary circuit for conducting the current from the transformer to the welding electrodes, and the welding electrodes or copper contact points for localizing the current and applying the pressure. The constructional features of the various spot-welding machines, of course, differ to a considerable extent, depending upon the kind of work for which the machine is designed. However, the principle upon which these machines are constructed is the same. Fig. 1 shows a common type of spot-welding machine; it will be noticed that the main body of the machine is of the hollow column type to which an overhanging top arm is cast. Working in this arm is a slide which can be operated either by a toggle lever or foot-treadle, as desired. Fastened to the column is a lower arm or holder which carries the lower electrode. Connecting the electrode and the transformer is a series of laminated copper strips. These are attached to the electrode holders by bolts, and the upper laminated strips are so constructed as to permit of movement of the slide. The transformer proper is so constructed that the amount of current passing through the winding, and, likewise, the amount induced in the secondary circuit can be varied. On the column of the machine will be noticed two pointers. one working on the segment of a dial having two positions, "low" and "high," and the other covering a segment numbered from 1 to 5.

In setting a spot-welding machine, the upper regulator pointer should first be set to 1, and the lower regulator pointer to the left marked "low." The work is then placed between the copper electrodes, and these are brought down in contact with it; this forces the stock together and automatically turns on the current. If the stock does not heat rapidly enough, the upper regulator pointer is turned to 2, and this process continued until the pointer reaches 5. If there is still insufficient current to heat the work quickly enough, the upper regulator is turned back to 1 and the lower pointer placed at "high."

For information on electric welding previously published in MACHINERY, see "Welding High-speed Steel Blocks to Tool Steel Shanks," July, 1916, and articles there referred to.

* Associate Editor of MACHINERY.

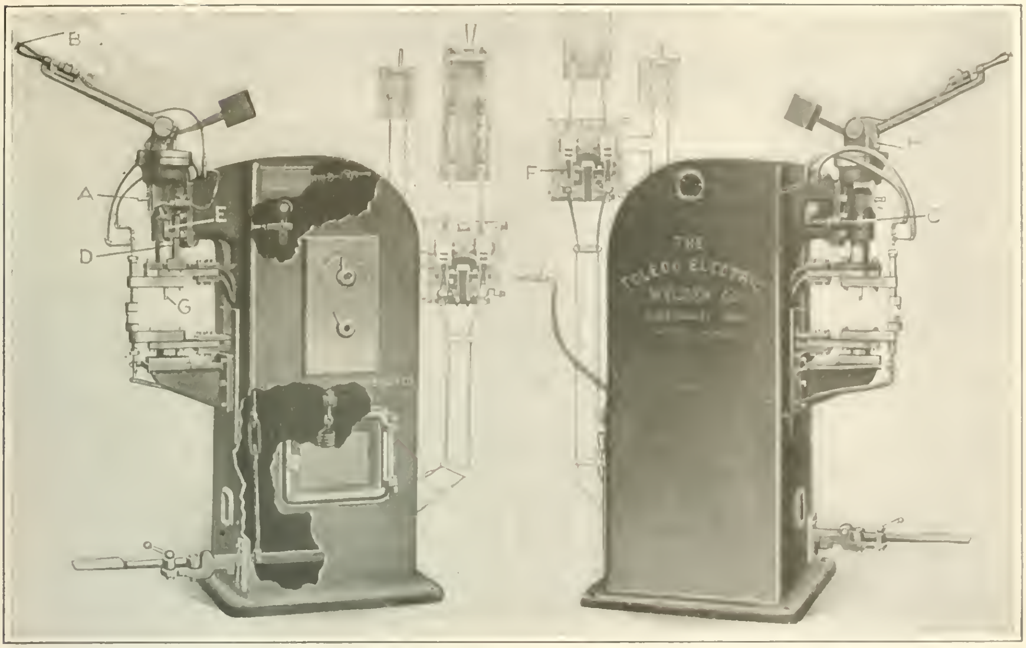


Fig. 1. Common Type of Electric Spot-welding Machine sectioned in Certain Places to show Constructional Features

The same procedure is then followed by moving the upper pointer from 1 to 5 until the proper temperature is obtained. The electrodes should be adjusted with two pieces of stock between them so that the toggle joint in the head of the machine stops just forward of the center in order to give the greatest amount of pressure on the stock.

In this particular machine the switch can be operated either automatically or by hand for turning on and off the current. When welding thick buckled stock, it is difficult to get a satisfactory weld by using the automatic switch, because of the variation in pressure required to force the opposing faces of the sheets together. When the stock is in a buckled condition, pin *A* is placed in the right-hand slot, which disconnects the automatic switch. To operate the machine, the lever or foot-treadle is moved as far as possible to bring the material into contact. The button *B* or control switch in the handle is then depressed and this turns on the current.

In using an electric spot-welding machine continuously, the copper electrodes become heated, and in order to increase their life a water cooling system is provided. The holders which carry the welding electrodes proper are made hollow, and through these a tube passes, allowing water to circulate close to the welding contact points. Each pair of electrodes is provided with a water supply and return pipe, and this is connected to the sewer.

Operation of an Electric Spot-welding Machine

The operation of an electric spot-welding machine differs from that of a butt-welding machine in that as a rule there is no clamping of the work necessary on the spot-welder. The two sheets to be joined are simply held in the hands in the correct position and in the proper location in relation to the copper electrode points. When this is done, the operator simply pulls down the lever or operates the foot-treadle. When the automatic switch is closed, this allows the current to pass through the contact points, and the material placed between them immediately becomes heated. When the proper temperature has been obtained, pressure is applied to effect a junction between the two sheets being welded. In order to get the correct pressure between the sheets, the electrodes should be adjusted. This can be done by loosening the clamps and raising or lowering them to the most convenient position. Before making any adjustment, the wall switch should be opened. The bolts fastening the copper leaves to the transformer and the copper electrode holders should be carefully tightened after the machine has been submitted to severe usage. The sliding head should be well oiled and the grooves kept clean. The movement of the electrodes or the up and down movement of the foot-treadle or hand-lever is adjusted by means of screw *C* located on the front of the machine, which comes in contact with a dog connecting the foot-treadle or hand operating mechanism.

Welding Processes accomplished on Electric Spot-welding Machines

The electric spot-welding machine, in addition to being used for spot-welding sheet metal, can also be used for a variety of other processes. In electric spot-welding practice, the copper electrodes are used to fuse the two sheets of metal together at localized points. The action which takes place is clearly indicated at *A* in Fig. 2. Here it will be noticed that before making the weld the two electrodes are brought into contact with the sheets. In making the weld, the upper pointed electrode is depressed into the upper sheet, as shown, and the two sheets welded together at the point indicated by the double cross-hatching.

At *B* is shown the method of welding known as point- or projection-welding, which differs from spot-welding in that the material must be provided with projections. These projections are brought into line with each other, and when the electric current is applied, the resistance, being greatest at the contact points, causes them to quickly reach a welding temperature, and upon the application of pressure the two sheets are welded at the contacting points.

At *C* is shown another application of the spot-welding machine. In this case it is being used for making what is known as a ridge-weld. This requires previous preparation of the material, and the material is disposed, as shown, between the electrodes with the ridges forming a cross. In this case, the electric current is also confined to the spot where the contact is made, and when the current is turned on and pressure applied, the metals are welded together.

Still another application of the spot-welding machine is indicated at *D*. This process is known as button-welding, because of the practice of using one or more "buttons" to localize

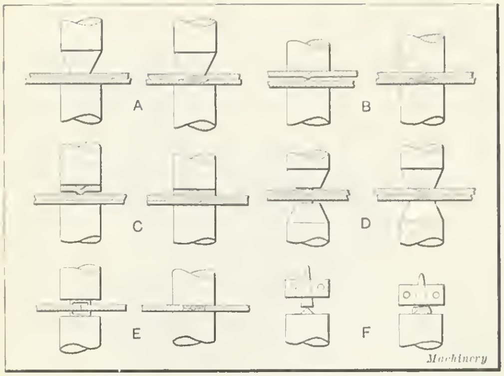


Fig. 2. Diagram illustrating Various Processes of Electric Welding accomplished on Electric Spot-welding Machines

the current. This is particularly advantageous for welding thick sheets that cannot be brought into intimate contact by the copper electrodes. In this case the buttons or disks of metal are interposed between the opposing faces of the electrodes and the pieces to be welded, and thus localize the current, causing the metal to quickly reach a welding temperature. Upon the application of pressure the highly heated buttons are pressed into the sheets and form a solid junction. There are many applications of this button method, some of which will be described later.

The process of welding shown at *E* is known as bridge- or tie-welding, because of the shape of the parts used to unite the two sheets. In a sense, this method could be called butt-welding, because the two sheets being welded are butted together, a junction being made between them by employing two channel-shaped pieces which overlap the ends of the sheets. When the electrodes are brought in contact with the work and the electric current turned on, these two pieces localize the current and offer sufficient resistance to cause them to heat; then upon the application of pressure they are forced into intimate contact and become one with the pieces to be welded.

Another process that is used quite extensively in the agricultural implement industry is shown at *F* in Fig. 2. This method is known as tee-welding, and is shown applied here to the manufacture of garden rakes. The same principle is employed as in the case of point-welding. The back or frame of the rake is made with a knife edge, and in this way localizes the current, so that sufficient resistance is offered to the flow of the electric current to fuse the metal and allow the prong to be forced over the back of the rake. and united with it. There are many different applications of the principles described in the foregoing, some of which will be illustrated later.

Materials that can be Satisfactorily Spot-welded

As the satisfactory welding of two pieces of metal depends upon their relative resistance to the flow of an electric current, such metals as copper, silver, aluminum, etc., are difficult to spot-weld. The reason for this is that they offer no more resistance to the flow of the electric current than the electrodes themselves, and hence difficulty is encountered in getting a welding heat. Pure aluminum cannot be commercially spot-welded, but by the addition of a small percentage of machinery steel, or 20 per cent of zinc, satisfactory welding is possible. Galvanized iron can be welded, although it will burn off the zinc at the spot where the weld is made, and this method is not recommended for welding very thin galvanized iron, as there is no body of metal to work on. By the time the zinc is burned off there is nothing left; 28-gage (0.0156 inch thick) galvanized iron and heavier can be welded without difficulty. When the galvanized iron sheets are very thin—below 0.015 inch—the button method of welding can be used to advantage.

Cast copper can be electrically welded to steel, brass, sheet copper, wrought iron and galvanized iron, but the process is limited almost exclusively to butt-welding. The surface of the cast copper becomes crystallized to a considerable extent when spot-welded, and therefore this method is commercially impractical for spot-welding. Sheet steel or brass cannot be commercially electrically welded to cast iron, because cast iron is usually very impure and the section at the weld becomes crystalline in structure. Tin can be welded to tin or to sheet iron, but the stock will be discolored at the weld. Sheet brass and bronze can be welded to sheet brass or to sheet steel. There is a little knack in this kind of work in knowing just what pressure and temperature is necessary, and the automatic switch must be very accurately set.

Practically all metals and alloys can be electrically welded, but the process is limited in many cases to butt-welding. Butt-welding is easily accomplished on all sorts of materials, copper and other good conductors of electric current being no exception. Spot-welding of copper is very difficult, owing to the small amount of metal that is actually brought into contact. In butt-welding, a large amount of metal can be used, and the fused metal thrown out into the burr. In spot-welding this is not possible. Copper must be welded very rapidly. It requires more current and less time.

Alloys containing tin are very difficult to spot-weld, brass to aluminum being particularly so. These metals are affected with what is known as "tin" disease. Brass welded to aluminum will hold together for a short while, but soon becomes disintegrated because of the tin composition. In fact, a weld can be successfully made in brass and aluminum, and shortly after the weld has been made the joint will be strong, but after lying exposed to the atmosphere for twenty-four hours or more, the metals can easily be pulled apart again. The theory is that the tin composition in the brass comes to the surface of the metal and acts as an oxidizer, preventing perfect union between the metals. After exposure to the air, the structure of the metal all around the weld becomes disintegrated.

German silver, monel metal, zinc, nickel and alloys of many kinds are easily welded. In some cases it requires a special preparation of the material, or various shapes of electrodes, and in some cases it is necessary to change the transformer in the machine, in order to get a heavy current over a short period of time. Malleable iron of good quality can be welded to sheet steel, but it will not stand as great a strain as rolled steel or iron. In welding heavy gages of sheet steel where the material is badly buckled, the adjacent surfaces cannot be made to contact by means of the electrodes. In cases of this kind the foot pressure used to force the uneven surfaces together would trip the switch before a weld could be made. To take care of this condition a hand-operated switch *B*, Fig. 1, is brought into use, as previously described. With this device it is possible to do work that could not be done with the regular automatic switch.

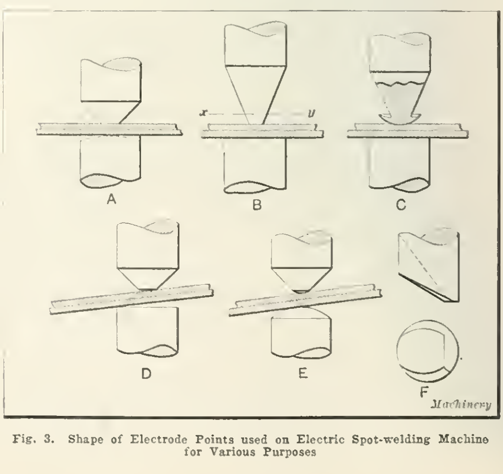


Fig. 3. Shape of Electrode Points used on Electric Spot-welding Machine for Various Purposes

Relation of Time to Current and Pressure in Spot-welding

There are four vital points that must be taken into consideration in making a satisfactory spot-weld. They are: (1) condition of stock, whether pickled, oxide-coated, coated with zinc, lead, etc.; (2) time required to make the weld; (3) pressure on the electrodes, which should bear a direct relation to the current used and the time taken to make the weld; and (4) amount of current passing through the secondary circuit. An increase in the pressure necessitates an increase in the amperage of the current; and the smaller or lower the amperage, the greater the length of time required to complete the weld, and *vice versa*. As the thickness of the stock increases, the pressure and current should be increased. Using a low current and heavy pressure will not give a perfect weld, and a heavy current and low pressure will burn the metal. For example, suppose the metal to be welded is 1/16 inch thick pickled sheet steel. The pressure should be 200 pounds, the current 10 kilowatts, and the time one second. This will give a perfect weld if the electrode points are properly shaped. In welding an oxide-coated stock, the usual practice is to increase the pressure over that required for welding pickled stock. In welding 16-gage mild steel, having a scaled or black hot-rolled surface, the pressure would be increased from 50 to 100 per cent, or from 300 to 400 pounds, the current 10 to 12 kilowatts, and the time one second. In welding a zinc, lead or aluminum-coated stock, the pressure and time should be decreased. For example, in welding 16-gage aluminum-coated steel, the pressure should be 100 to 150 pounds, current 10 kilowatts, and the time ¾ second. Pure aluminum, as previously stated, cannot be spot-welded.

Method of Determining Pressure Required

To determine the pressure required to make a satisfactory spot-weld, a regular platform scale is placed in front of the electric welding machine in such a position that a bar can be placed between the upper or movable member of the machine and the platform. Experiments are then made on small pieces of sheet metal of the same thickness as that to be welded until the required pressure, time and current have been determined. As has been previously mentioned, the amount of current can be controlled by moving the regulator pointers. The correct pressure, however, is a little more difficult to determine. To be certain that the welded joint is satisfactory, the metal should be sectioned and a microscopic examination made.

The way in which the necessary adjustments are made can be seen by referring to Fig. 1. For regulating the time that the current is on, screw *D* is adjusted. Turning this screw to the right shortens the time, and turning it to the left lengthens the time. This screw controls the position of automatic

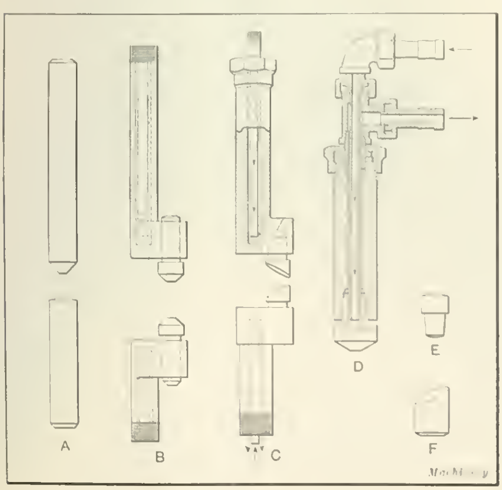


Fig. 4. Method of holding and cooling Electrode Points on Electric Spot-welding Machines

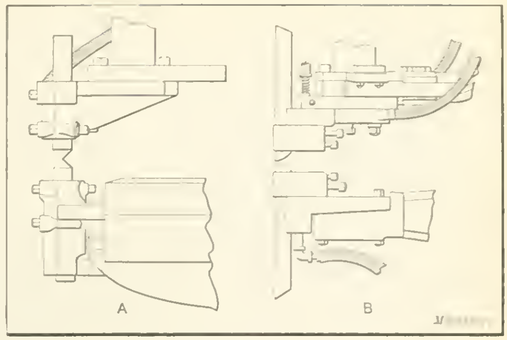


Fig. 5. Two Types of Electrode Holders

switch *E* which operates the solenoid switch *F*. To vary the pressure on the work, screw *G* is adjusted. This screw is loosened for light work, and tightened for heavy work. In addition to obtaining the proper adjustment for time, pressure and current, the electrode points should also receive attention. In the first place, the points should be properly shaped, the correct shape depending upon the material to be welded, as will be subsequently described. For welding pickled steel, the electrodes should be so set in the holders that when the two pieces of metal are placed between the contact points, the toggle joint *H* in the head of the machine stops just forward of the center. In welding brass, galvanized iron, tin, terne plate, German silver, aluminum, sherardized steel, and all coated materials, it is advisable to use less pressure between the electrode points. This can be done by setting toggle joint *H* forward to a more acute angle and loosening the tension on the compression spring by adjusting screw *G*.

Shape of Electrode Points

In spot-welding sheet metal, various shapes of electrode points are used. In most cases the shape is governed either by the kind of material being welded or the position in which the weld is being made. For welding sheet steel to sheet steel, the lower electrode point is generally left flat or slightly convex, as shown by the dotted line at *A* in Fig. 3, whereas the upper electrode point is pointed, the diameter of the point varying with the thickness of the sheet, as shown in the accompanying table. In welding tin, lead or zinc-coated stock, or galvanized iron, both upper and lower electrodes are pointed. The reason for this is that coated stock is more difficult to weld than uncoated material, and the aim is to confine the weld to as fine a point as possible to obviate burning. The shape of the electrode point should receive careful attention for several reasons. In the first place, an improperly shaped point will not last nearly as long as one that is properly shaped; and in the second place, an improperly shaped electrode will not produce a satisfactory weld.

Many machine operators make the point of the electrode too long. Reference to *A* and *B* in Fig. 3 will make this clear. Here the electrode at *A* is correctly shaped, lasting considerably longer and producing better welds than the point shown at *B*. The point shown at *A* has much more body and will stand up to greater pressure without upsetting than the point at *B*. The reason for this is that in using the point at *B*, the extreme end is made hotter than the portion just back of it on the line x–y, and when pressure is applied, an upsetting action takes place because of the lack of resistance, causing the point to upset and flare, as shown at *C*. When the point is upset as shown at *C*, it will produce an unsatisfactory weld.

The remarks just made apply more particularly to the upper electrode, which is generally pointed for welding all materials, but they also apply to the lower electrode when the latter is used for welding coated stock. When pickled sheet steel is being welded, the lower electrode is not pointed, but is generally made flat. When large articles are being spot-welded, it is better practice to make the lower electrode slightly convex instead of flat. The reason for this is that it is difficult

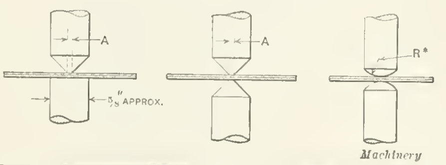
to hold large articles so that the surfaces contact perfectly with the flat face of the electrode. If the work is not properly located, as shown at *D* in Fig. 3, a scar will be produced on the lower surface of the work. This is caused by the work bearing on one edge of the lower electrode only, and the current, instead of flowing straight or following the axes of the electrodes, shoots off at an angle, and in most cases produces an unsatisfactory weld. The diagram at *E* shows what takes place when the lower electrode is slightly convex and the work held at an angle. It will be seen that although the work is not held correctly, it does not produce an imperfect weld, as a point instead of a "line" contact is secured.

The electrode point shown at *F* is used for getting in close to the edge of a box or corner. The point shown by the full lines will last much longer and make a better weld than the point indicated by the dotted line, because it will withstand a greater pressure without upsetting.

Methods of Holding and Cooling Electrode Points

Electrodes for spot-welding machines are made as a rule from round bars of copper about 3/4 to 1 1/2 inch in diameter

DIAMETER OF ELECTRODE POINTS USED IN WELDING SHEET STOCK OF THE SAME THICKNESS



No. of Gage, U. S. Standard	Thickness, Inches	Decimal Equivalent	Wrought Iron or Sheet Steel	Galvanized Iron
			Diameter of Point A in Inches	
0	5/16	0.3125	7/16	....
1	9/32	0.2813	7/16	....
2	17/64	0.2656	7/16	....
3	1/4	0.2500	7/16	....
4	15/64	0.2344	3/8	....
5	7/32	0.2188	3/8	....
6	13/64	0.2031	3/8	....
7	3/16	0.1875	5/16	3/8
8	11/64	0.1719	5/16	3/8
9	5/32	0.1563	5/16	3/8
10	9/64	0.1406	1/4	1/4
11	1/8	0.1250	1/4	1/4
12	7/64	0.1094	1/4	1/4
14	5/64	0.0781	1/4	3/16
16	1/16	0.0625	3/16	3/16
18	1/20	0.0500	3/16	3/16
20	3/80	0.0375	3/16	1/8
22	1/32	0.0313	1/8	1/8
24	1/40	0.0250	1/8	....
26	3/160	0.0188	1/8	....
28	1/64	0.0156	1/8	....

* For electrodes 5/8 inch diameter, radius "R" varies from 5/8 to 1/2 inch.

when of the solid type, and smaller (5/8 inch diameter) when of the inserted type. As illustrated in Fig. 4, that shown at *A* is known as the solid type, and is held in water-cooled holders, whereas those shown at *B* are of the inserted type or tip construction, and are held in water-cooled holders by means of a tapered shank as illustrated. The holders carrying the electrodes are connected by a 1/2-inch water pipe and a flexible pipe to a water main which is sufficient to supply enough water to keep the electrode points fairly cool. The return pipe is then connected with the sewer.

The type of electrode holder shown at *C* in Fig. 4 illustrates how this connection is made. The inner pipe carries the water into the holder, and it returns through the space between the hole in the holder and the inner pipe. This type of holder does not carry the cooling effect direct to the electrode point, and therefore is not as effective as the holder shown at *D*. Here it will be noticed that the electrode tip is inserted directly into the holder and is drilled out for the insertion of the cooling pipe which can be brought almost to the end of

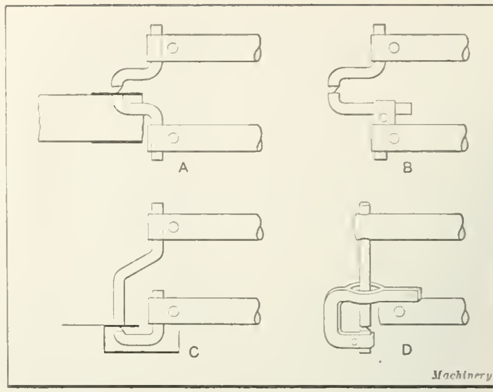


Fig. 6. Diagram illustrating Several Different Types of Electrode Horns

the electrode. The arrows indicate the direction in which the water flows. *E* and *F* show two types of electrode points. The one shown at *E* is used for welding average stock, whereas the one at *F* is used for getting into corners. There are many different types and shapes of electrode points in use, but those shown in the illustration represent some of the more common ones.

Construction of Electric Welding Machine Horns and Electrode Holders

The type of electrode holder or horn used on a spot-welding machine is governed almost entirely by the kind of work to be welded. There are, however, several standard types of holders which are capable of being applied to a large class of work. The holder shown at *A* in Fig. 5 is known as the heavy-duty machine type of holder. This, as will be seen, is rigidly constructed and is provided with a solid type of electrode, the cooling pipes being connected directly to the holders themselves.

Another type of standard holder is shown at *B* in Fig. 5. This type of holder is used for semi-heavy stock and is principally adapted for electric welding operations where it is necessary to get into a corner. It will be noticed here that the electrode points are so shaped that the welding can be done at the extreme edge. The construction of this holder does not differ materially from that shown at *A*, except that it is not as heavily and rigidly built.

Several forms of electric welding machine horns are shown in Fig. 6. The type of horn shown at *A*, which carries bent upper and lower electrode points, is used for such work as the welding of automobile muffler tubes, where it is necessary to carry the weld in at some little distance from the end of the tube. The type of electrode horn shown at *B* is of a somewhat similar construction, but is much more effective for constant use, as it is possible to bring the cooling pipes or water closer to the point where the welding is being accomplished. Where the welding machine is being used continually, this is a factor that must be considered.

The type of electric welding horn shown at *C* in Fig. 6 is

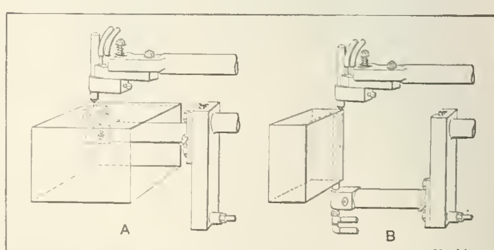


Fig. 7. Diagram illustrating Two Different Types of Electrode Horns for welding Boxes

of unusual construction, and it will be noticed that the lower electrode instead of the upper one is pointed. This horn is used for welding a plate onto a channel, as illustrated. The horn shown at *D* is of rather unusual construction and is chiefly employed where it is necessary to use a small electric welding machine for welding large, thin work. This greatly increases the capacity of the machine between the column and the electrode points, and welds the channel section shown at *C* in the reversed position.

Fig. 7 shows two applications of electric welding machine horns. At *A* is shown a type of horn which can be used for welding along the corner of a box, one of the electrode horns extending into the box and the other working on the top edge. The type shown at *B* is of slightly different construction, in that the welding, instead of being done in a position extending out from the machine, is done in a horizontal position in the machine, and makes necessary the use of an extended lower electrode holder. There are many other applications of electric welding machine horns, but the principal ones are illustrated here.

* * *

WELDING 13-FOOT TUBE SHEETS FOR SUGAR EVAPORATORS

An acetylene welding job that is decidedly out of the ordinary has just been completed by the Treadwell Engineering Co., Easton, Pa. This company makes, among other products, sugar evaporators, and the plates that were welded were to be used as tube sheets in this machinery. In a sugar evaporator, plates of this kind are used for supporting the copper tubes through which the sugar juice to be evaporated circulates. The tubes are, of course, expanded into the holes in the plates, and form steam-tight joints. The steam circulates on the outside of the tubes. Fig. 1 shows one of the completed tube sheets which is 13 feet in diameter. The thickness of the plate is 3/4 inch and the material is ingot iron, having a low carbon content and non-corrosive qualities. In each plate, there are 2618 1 3/4-inch holes. These plates are made in halves on account of the size, as it is impracticable to secure one rolled piece 13 feet in diameter. The welding consisted in joining these halves.

The welding was done with a Davis-Bournonville welding torch, as shown in Fig. 2. One factor that had to be taken into consideration was the expansion of the plates from the heat. Preparatory to welding, the halves of the plate were placed in contact at one edge, but an opening of three inches was left at the opposite side. The welding was started with the plate in this position, but as the operation progressed the heat caused the sheet to expand and the joint to "creep" together. An experienced operator was required for welding these plates and when the operation was started, it was necessary to keep the welding continuous, without interruption, until completion. The time required for making the weld in one tube sheet was six hours.

C. L. L.

Fig. 2. Welding One of the Tube Sheets

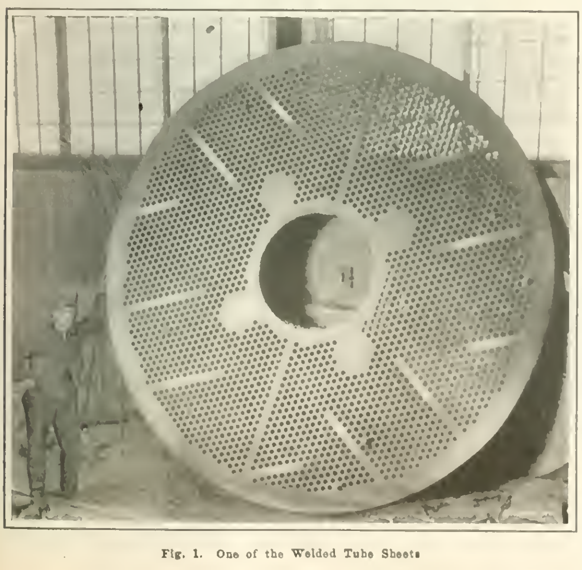


Fig. 1. One of the Welded Tube Sheets

* * *

USE OF INDIA INK IN FOUNTAIN PENS

BY W. F. SCHAPHORST*

Despite a somewhat general belief to the contrary, it is quite possible to use India ink successfully in fountain pens; and the ink will not clog, even if it is left in the pen for a long period of time. The principal precaution to be observed is not to allow the pen to dry at the point; keep it working or moist all the time, and plug the holes in the cap to exclude air while the pen is not in use. In putting the pen away, care must also be taken to see that the cap is on tight. These precautions are necessary in order to prevent evaporation, which would cause the ink to become thick and clog the pen. It is well to dip the pen point in water before putting it away, allowing as much water as possible to cling to the point. This additional moisture will effectually prevent the ink from drying on the point of the pen, because the cap is tightly sealed. In filling a fountain pen with India ink, it is important not to take ink from the bottom of an old bottle that has been left open, as such ink is often very thick and would be likely to clog the pen. Use only fresh ink and take it from the top of the bottle. If these instructions are carefully observed, no difficulty will be experienced in using black India ink in an ordinary fountain pen.

* * *

The common plan of setting lathes parallel with the lineshaft and using countershafts is being generally discarded with lathes having individual motor drives or single-step pulley belt drives. With either of these drives the lathes may be advantageously set at right angles to the bays of the shop, as more can be accommodated and better service can be rendered in taking work to and from the machines. Quarter-turn belts running from the lineshaft pulleys to the single-step pulleys on the belt-driven lathes run satisfactorily. There is less overhead works and less light obstructed. The lineshafts should, of course, be broken into short sections, each driven by a motor.

* Address: Woolworth Bldg., New York City.

DESIGN OF AUTOMATIC MACHINERY

BY JOSEPH W. WUNSCH*

It is not the purpose of this article to discuss the subject of how to design a machine, as this is adequately treated in many text-books; the object of the following is, rather, to formulate the technical routine of procedure in designing. I do not claim that the following elementary outline is not open to individual modification, but that in its fundamental elements it is the only logical way to proceed. Especially is this true of the class of machinery to which I have particular reference, namely, special automatic machinery.

Following are eight successive steps in the design of a machine, many of which are essential to every design, others being dependent on the complexity of the machine: (1) preliminary diagram; (2) preliminary lay-out; (3) final diagram; (4) design; (5) detail drawings; (6) partial assembly drawings; (7) unit assembly drawings; (8) general assembly drawings.

Preliminary Diagram.—Fig. 1 illustrates a preliminary diagram, which is nothing more than a graphical illustration of the problem. This drawing is usually essential in designing special machinery, and should illustrate the prime movements required of the machine. The time of one cycle of the machine (360 degrees or more) is the abscissae, and the magnitudes of the movements are the ordinates.

Preliminary Lay-out.—This drawing should be an approximate plan of the machine, embodying the essential mechanisms for the movements outlined on the preliminary diagram. It should be a skeleton of the ultimate design, as an architect's model is of the final construction. From this lay-out the patent draftsman should be able to prepare patent office drawings to accompany the specification, and it should be sufficiently clear to enable an engineer to render an opinion as to the merits of the machine.

No machine designer can be entirely familiar with all the materials which his machines may be called upon to handle. It is therefore highly essential, before involving much expense in the design of a new machine, for an expert opinion to be obtained as to the workability of the material under the given conditions. Thorough experimentation is often necessary, and is, of course, more certain than an expert's opinion. We are all familiar with the fact that every substance has its individual characteristics under different conditions, and many a machine, the mechanical functions of which were properly designed, has landed in the junk-shop, due to lack of understanding of the substance in hand.

In this type of drawing, symbols and center lines often suffice to indicate commercial stock and standard parts. Here in the early stage of the design, the advantages of a system of substitutible elements are evident. In fact, although I am not confident that the stage in machine construction will ever be reached when it will be possible to build machines without drawings, yet if such a stage is ever approached, it will only be through the universal employment of substitutible machine elements.

Final Diagram.—Fig. 2 illustrates a final diagram. This is distinguished from the preliminary diagram, inasmuch as it must be accurate and final, and it may readily be differentiated by the variations in movement and timing that have been introduced. It should embody all changes that have been suggested by discussion, and with it a competent designer should be able to design the machine. In many cases, of course, a second diagram will not be necessary.

Design.—At this stage, the designer should, of course, be thoroughly familiar with each function of the machine. With the aid of the final diagram, he has a graphical picture of the timing and magnitude of every prime movement, and he can proceed to design the machine. Standard parts, standard screws, bolts, nuts, stock gears, and standard drop-forgings should, of course, be used whenever possible. The design should always be full size and accurately scaled. Stock parts need not be drawn out in detail, but should be clearly indicated to the detail draftsman. Necessary views should be shown and principal dimensions indicated.

Detail Drawings.—It would be difficult to overestimate the importance of proper execution of detail drawings. They should be full size whenever possible. A full size drawing is very helpful to the patternmaker. All necessary views should be shown and no more. Proper finish, material, and number required should be clearly noted, and all dimensions plainly indicated so that no figures will have to be indirectly obtained by the patternmaker or machinist. In complicated castings, it is often desirable to make a separate detail drawing for the patternmaker. This facilitates the reading of both drawings, inasmuch as the dimensions in which the patternmaker only is interested are not on the machinist's drawing and *vice versa*. This is often the means of saving costly mistakes in the shop.

Partial Assembly Drawings.—These are of service where size or complication does not permit of adequate checking of details and clearances on the general assembly drawing. They show neighboring parts and units without relation to their functions.

Unit Assembly Drawings.—Unit assembly drawings represent assembled independent units. By an "independent unit" is meant all parts belonging to a particular function. Besides being an excellent means of checking for clearances and correct fits, they are a great help in the shop when assembling.

General Assembly Drawings.—These show parts and units in their relative positions. They are useful as a means for checking for clearances and as a general guide in the shop. All details should be identified by numbers. Principal dimensions and center to center distances should be indicated. Invisible parts, if they are explanatory, should be shown in dotted lines, and then only in their essential outlines. A list of parts with corresponding drawing numbers should accompany every set of drawings. This is as essential as an index to a text-book.

* Address: 1581 Lincoln Place, Brooklyn, N. Y.

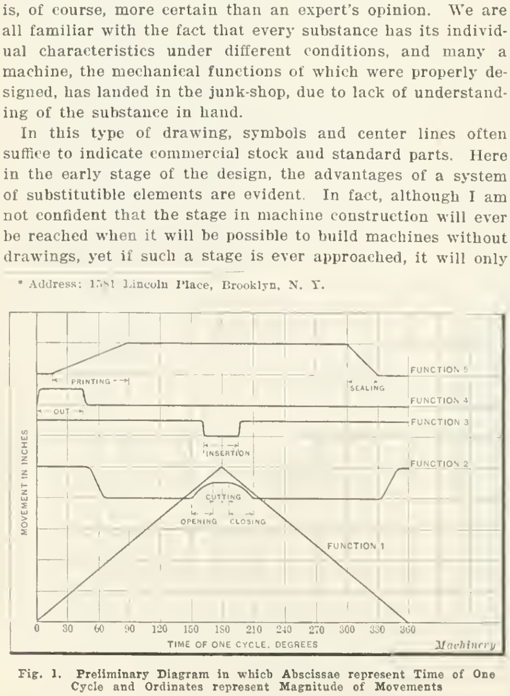


Fig. 1. Preliminary Diagram in which Abscissae represent Time of One Cycle and Ordinates represent Magnitude of Movements

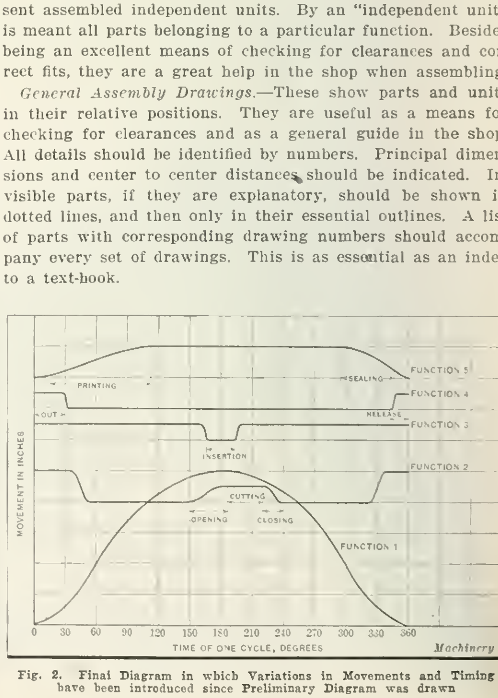


Fig. 2. Final Diagram in which Variations in Movements and Timing have been introduced since Preliminary Diagram was drawn

PRESS TOOLS FOR MAKING SHEET STEEL CORSET STAYS

The Taylor-Shantz Co. of Rochester, N. Y., has recently completed for one of its customers a set of press tools for

Fig. 1. Section of Finished Corset Stay

manufacturing sheet metal corset stays in continuous strips, a section of which is shown in Fig. 1. The stock is fed through a press where the slotting is done, and the finished perforated strip is coiled on the opposite side of the press, as illustrated in Fig. 2. The steel ribbon on which the work is performed comes in various widths and thicknesses, that of the sample shown being 9/16 inch wide and 0.034 inch thick. It will be noticed from Fig. 1 that the perforating consists in punching out slots alternately from a point 1/16 inch from each edge of the strip and punching across to the opposite edge. The result is an extremely flexible piece of ribbon steel that may be bent freely in any direction. The steel strip is afterward hardened by a special process that gives it still greater flexibility and at the same time a long life. The perforated slots are 0.035 inch wide and they are spaced 1/16 inch apart.

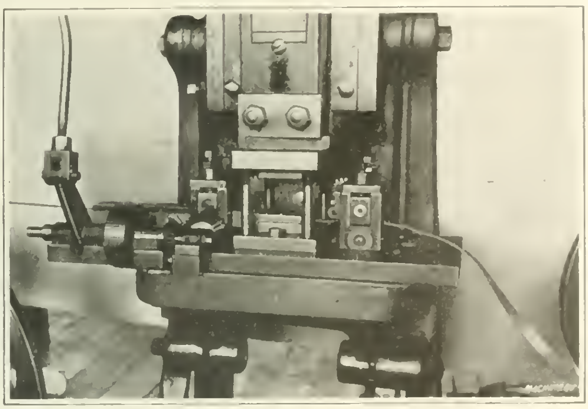


Fig. 2. Press equipped with Tools

Referring now to Fig. 2, where the tools are shown in position in the press, it will be noticed that the punching is performed by piercing eight perforations at each stroke of the press, which covers a section of the strip seven-eighths inch long. After one section has been punched the next operation of the press brings the stock forward another seven-eighths inch and the strip is held stationary while another eight slots are punched. The feeding and holding of the stock are accomplished through the roll feed on one side of the press that advances the strip and the receiving rolls on the opposite side that guide the strip as it emerges from the dies. These two pairs of rolls are geared together, and both are operated through a crank feed from the end of the crankshaft of the press as shown in the illustration. The crank feed rotates a pair of bevel gears that transmit motion to the stock feeding rolls and thence to the receiving rolls by the spur gears that are shown behind the die in Fig. 2. A friction clutch on the bevel gear shaft permits the use of this intermittent type of feed and obviates all backlash. This is an important feature, as any variations in the feed would produce an irregularly punched strip. Fig. 3 shows the die in section and end elevation and also shows a plan of the punches in operation. The die is of the sub-press type.

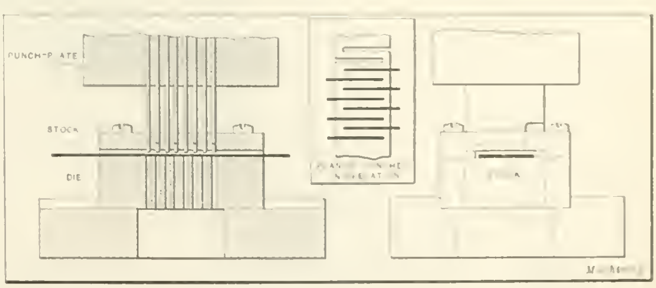


Fig. 3. Die in Section and End Elevation

As any die designer will appreciate, the chief trouble experienced in tooling up for this job was to prevent the punches breaking. The fact that the slots run out at the edges of the stock on one end and remain in the stock on the other end means that there is considerable side thrust on the punches. The stock is approximately located by the stripper and the punches are well supported in the stripper, but the punches are so delicate that they will break under a slight side strain. To counteract this thrust, the ends of the punches are shaped as shown by the end elevation in Fig. 3. The projections on the punches are for the purpose of guiding the stock on the sides and centering it between the punches. As four of the punches tend to thrust to one side and the alternate four to the opposite side, the tendency for lateral thrust is thus counteracted, with the result that very few punches break on the job. The projections on the punches are also a strengthening feature inasmuch as they extend well within the slots in the die before any cutting action takes place, and in this way each punch is well supported on the side against which the thrust would come.

The press operates at a speed of one hundred and twenty-five revolutions per minute and automatically produces the finished strip at a rate of nine feet per minute. No operator is needed except for starting a new coil of stock. C. L. L.

* * *

FIRST CHINESE TYPEWRITER

The first Chinese typewriter has just been designed by Hou Kun Chow, a graduate of the Massachusetts Institute of Technology. It is operated by placing a pointer opposite a character printed on the flat indicator at the front of the machine and then pushing in a plunger with the thumb. The movement of the pointer operates a cylinder, about 6 inches in diameter and 18 inches long, that carries 4000 zinc Chinese characters, and places the desired character into the proper position for printing. Pushing the plunger causes a hammer to strike the paper against the type with sufficient force to produce several carbon copies. The pulling in and out of the rack to which the pointer is attached rotates the cylinder, and pushing it back and forth moves the carriage. The striking mechanism is operated by the same impulse that moves the hammer. While it is not possible to obtain great speed with this machine as now made, Mr. Chow thinks it will become popular in Chinese offices where copies of Chinese documents must be made; also among Chinese in foreign countries where it is difficult or impossible to secure skilled Chinese writers. The present machine weighs 40 pounds, but improvements now being made will probably result in reducing the weight of the machine to 20 pounds.

TABLE I. SPECIFICATIONS AND RESULTS OF TESTS OF COMMERCIAL BRONZE AND BRASS CASTINGS

Nos. of Alloy	Name of Alloy	Composition								Tensile Test					Hardness		Compression Test	
		Copper, Per Cent	Tin, Per Cent	Zinc, Per Cent	Lead, Per Cent	Aluminum, Per Cent	Iron, Per Cent	Manganese, Per Cent	Phosphorus, Per Cent	Yield Points§	Elastic Limits§	Ultimate Strength§	Elongation in 2 In.	Reduction of Area	Brinell	Scleroscope	Elastic Limits§	Compressed Height, Percentage‖
1	Bronze	80	20						tr.						136			3.1
2	Grade "A" bridge bronze	80	20						1 (*)								25–40	6–10
3	Special phosphor-bronze	80	20						0.2 (†)								24 (†)	
4	Grade "B" bridge bronze	85	15						1 (*)								19–23	12–25
5	Special phosphor-bronze	99							1 (*)								19–23	12–16
6	Hard bronze	82.5–83.5	13.8–14.2	1.1–2.9	0.8–1.2						15–19	23–27	tr.–4	tr.–4		20–24		
7	Gear bronze	85	13	2						23–25		37–39	2–3	1–4				
8	Phosphor-bronze	79.5	12		7.5				1			30–34	1–2		74–80			
9	Tough bearing bronze	85.5–86.5	10.5–12	1.5–3.5	1 (*)		0.25 (*)	0.15 (*)			15–20	24–32	2–15	2–15		15–22		
10	Stone's English gear bronze	89	11							22–25		35–40	6–10	7–9	80		15.5–16.5	25–27
11	Gear bronze	89	10.5						0.5			31–35	6–10		72–77			
12	Cast gun metal, "G," U. S. N.	87–89	9–11	1–3	0.2 (*)		0.06 (*)			15 (†)		30 (†)	15 (†)					
13	Tough bronze	85.7–89.3	9–11	1.5–2.5	0.3–0.8						12–16	26–34	10–22	9–21		14–18		
14	Gun metal bronze	86–89	8–11	1–3								33 (†)	14 (†)					
15	Bronze	88	10	2								32–38	14–18		70–74			
16	Grade "D" bridge bronze	88	10	2					0.25 (*)			33	14				14 (†)	
17	Gun metal	88	10	2						19–23		32–38	14–18	12–15	70–75		14.5–15	27–29
18	Bronze 2, U. S. N.	87–91	8 (†)	4 (*)	1 (*)		0.5 (*)		0.5 (*)			30 (†)	15 (†)					
19	Cast phosphor-bronze, Pc. Grade 1, U. S. N.	85–90	6–11	Remainder	0.2 (*)		0.06 (*)		0.3 (*)	25 (†)		50 (†)	25 (†)					
20	Bronze	90	10							22–24		35–40	15–18	15–20	65–70		15.5–16	28–29
21	Bronze	90	10						tr.			32–36	10–14		67–70			
22	Bronze‡	89.5	10					(Included in Copper)									15	
23	Bronze	89	10		1							22					22	
24	Bronze	88	10		2					19–23		30–35	15–20	18–26	65–70		15	28–29
25	Cast phosphor-bronze, Pc. Grade 2, U. S. N.	78–81	9–13	Remainder	8–11				0.7–1	20 (†)		35 (†)	18 (†)					
26	Bronze	79.7	9–11		8–11				0.7–1								15–20	
27	Phosphor-bronze	80	10		10					20		30	6					
28	Phosphor-bronze	79.75	10		10				0.25			28–32	5–7		65–70			
29	Grade "C" bridge bronze	80	10		10				0.7–1								15–20	
30	Bronze	80	10		10				0.8								18	
31	Phosphor-bronze	80	10		10					19–21		28–32	5–7	6–10	55–60		11.5–12	33–35
32	Bronze	80	9.2		10				0.8								27	6.25
33	Bronze	84	9.5		6.3				0.2			29–33	8–10		59–61			
34	Bronze	88	8	2	2							31–37	16–20		57–59			
35	Free-machining bronze	87.8–89.8	7–7.8	0.4–3.4	1.5–2.3						11.5–15.5	21–31	11–15	7–13		8–12		
36	Bronze	81	7	3	9					19–20		30–35	15–18	22–24	50–55		12.5–13	34–35
37	Bronze	78	7		15					17–18		28–31	12–18	17–23	48		11–12	38–39
38	Bronze	90	6.5	2	1.5							34–40	25–33		54–57			
39	Bronze	90	6.5	2	1.5					18–22		34–40	25–33	26–34	50–60		12.5–13	33–34
40	Bronze	85	5	5	5							27–33	16–20		59–63			
41	Red composition, ounce metal	85	5	5	5					15–19		27–33	16–20	15–20	50–60		11.5–12	36
42	Bronze	89	5	3	3					16		34	26–31	29	40–45		11.5	34–35
43	Red brass	83	4	7	6					14–16		28–33	15–20	20–26	55–60		9.5–10	37–39
44	Red brass	85	3	9	3							23–25	16–18					
45	Red brass	83	2	5	10					10–11		19–23	7–13	11–17	34		7–8	46–47
46	Bronze, 3, U. S. N.	60–70	3 (*)	25–37	1 (*)		0.5 (*)					25 (†)	15 (†)					
47	Natural color brass	74.5–77.5	0.8–1.2	21–23.3	0.3–1.2		0.2 (*)				7–11	22–28	23–33	15–25		6.5–9.5		
48	Yellow brass	70	1	27	2					10–11		28–31	22–28	27–31	50–55		6	40
49	Yellow brass	69	1	30								28–32	22–28		57–59			
50	Bronze, 1, U. S. N.	55–62	1.5 (*)	Remainder	0.4 (*)	1.5 (*)	0.5–2	0.5–3.5				60 (†)	15 (†)					
51	Cast manganese bronze, Mn-C, U. S. N.	56–58	1 (*)	40–42	0.2 (*)	0.5 (*)	1 (*)	0.3 (*)		30 (†)		65 (†)	20 (†)					
52	Manganese bronze	57.75–58.25	0.2–0.5	38.5–39.5	tr.–0.2	0.5 (*)	1.05–1.35	tr.–0.25			26–34	56–72	18–30	22–30		17–23		
53	Manganese bronze	56	0.75	41.5		0.5	1	0.25				72–84	22–35		109–119			
54	Manganese bronze	57	1	40		0.75	1	0.1			37 (†)	75	18	22				
55	Manganese bronze	56	1	41		0.5	1	0.5		33		70	22–35	25	104–119		27.5–28.5	10–11
56	Manganese bronze	56–57	1	38–40			1.5										35–40	
57	Manganese bronze	53–62		36–45	0.15 (*)	0.05–0.5						70 (†)	20 (†)					
58	Manganese bronze	60		40						30		60	20					
59	Yellow brass	55		45								39–45	9–13		80–93			
60	Vanadium bronze, Vn-C, U. S. N.	61 (†)	1 (*)	38 (*)						22.5 (†)		55 (†)	25 (†)					
61	Tensilite	64	0.2	29		3.1	1.2	2.5		30		98	16	17	130			
62	Tensilite	67		24		4.4		3.8	0.01								60	1.33
63	Titanium aluminum bronze	90				10				22–26		70	20	21	90–100		19–20	11.1
64	Aluminum bronze	90				9.9				25		71	21					
65	Titanium aluminum bronze¶	89				10	1			24–30		70	24.5	27.3	92–96		18–20	13–15
66	Cast monel metal, Mo-C, U. S. N.	Remainder			0.0	0.5	6.5 (*)	60 (†)		32.5 (†)		65 (†)	25 (†)					
67	Monel metal	27					6	67		37		78	38					

* Maximum limit. † Minimum limit. Compiled from sixteen different sources, but in each case the physical and chemical data came from the same authority. ‡ 0.5 per cent antimony. ¶ Nickel. § In thousands of lbs. per sq. in. ‖ Per cent of height remaining after loading to 100,000 lbs. per sq. in.

BRONZE ALLOYS FOR AUTOMOBILE CONSTRUCTION*

In a paper abstracted in the following, the authors point out the need for more concrete information concerning the physical properties of bronze alloys and present an extensive table covering the results of actual tests on a large range of cast bronze alloys. The influence of the method of making the test specimens is also discussed.

Experience in the bronze casting business has demonstrated the need of information on the physical and chemical properties of alloys. Tables showing such properties determined from actual practice, which may be termed "experience tables," are rare; some data exist, but they are usually in the private files of individuals or companies. The Bureau of Standards at Washington frequently receives requests for such information, and states that there is great difficulty in obtaining such data. With this need in mind, the committee on non-ferrous alloys of the American Society for Testing Materials discussed at a recent meeting the advisability of publishing such data as might be compiled from existing "experience" tables. On account of the fact that publication of data by that society is made in a formal manner, usually as specifications, it was thought best to delay action, so as to allow the tables to be checked by further work. The need was fully realized, however, and it is with that idea in mind that the accompanying tables were compiled.

Test Bars

One very important point should be emphasized in connection with the use of the tables mentioned. Most tests are made on standard test bars either attached to castings or cast separately. Test bars cut from castings, where this procedure is possible, show conclusively that a variation exists between results on standard test bars and the metal in the castings themselves. Castings may show higher or lower results, depending on the design and size of the casting itself. The results are usually lower, on account of the fact that the average size of castings exceeds the test bar size. It has been proved conclusively that the rate of cooling and the shape of the casting affect the results markedly. Alloys of high shrinkage are much more likely to show internal strains due to practical inability to feed the shrinkage properly, so that the net strength is the difference between the true value for the metal and the internal strains caused by this shrinkage. Manganese bronze, for example, normally shows an average ultimate tensile strength of from 65,000 to 75,000 pounds per square inch. It is not uncommon to find this lowered to 30,000 or 40,000 pounds per square inch in actual castings. Copper tin alloys, such as phosphor-bronzes, do not exhibit high shrinkage, but show the same proportional discrepancy in strength, on account of large crystal growth and the formation of a coarse network of the high tin eutectoid, which is very hard and brittle. Thurston, for instance, in his work on alloys, quotes from Major Wade's report of 1856 on "Experiments on Metals for Cannon," in regard to gun bronze containing 10 per cent tin, that eighty-three test bars from gun head castings averaged about 30,000 pounds per square inch in tensile strength, while thirty-two small bars averaged about 42,000. The average of twelve gun heads was one-half (in strength) of that obtained from small sample bars cast with the guns. The area of the cross-section of the casting, as well as its design, therefore, has a very important bearing on the subject and should always be taken into account in engineering work.

Improper foundry practice affects the tests of any alloy to a marked extent, so that two metals of the same chemical analysis may show very different results when handled by different foundries. The latter statement is self-evident, but many engineers do not realize the effect of small amounts of impurities, some of which are acquired during the melting process, on the final result.

Materials for Bearings

Specific statements or recommendations about materials for bearings have been avoided, because it is difficult to predict

* Abstract of paper by W. M. Corse and G. F. Comstock presented before the Society of Automobile Engineers convention, June 15, 1916.

TABLE II. USES OR APPLICATIONS OF ALLOYS GIVEN IN TABLE I

No. of Alloy	Uses, Remarks, Etc.
1	Dies, bells, bearings, etc.
2	In bridges, for contact with hard steel under pressure above 1500 pounds per square inch
3	Disks for draw bridges
4	In bridges, for contact with soft steel at pressure below 1500 pounds per square inch
5	Trunnion bearings
6	Bearings and bushings
7	Gears
8	Bushings and bearings not subjected to shock
9	Bearings, gears, etc.
10	Gears and worm-wheels
11	Worm, spur and bevel gears
12	Valves, gears, etc., and where strength and incorrodibility are desired
13	Durable castings
14	(American Society for Testing Materials tentative specifications)
15	Hard bearings, hydraulic work, valves, machine parts, etc.
16	Gears, worm-wheels, nuts, etc.
17	Bearings for heavy pressures and high speeds, thrust collars, steam fittings, hydraulic work
18	Water-tightness and bearing qualities in thin sections
19	Castings for strength and incorrodibility
20	To resist acid, and for thrust collars and disks under high pressure
21	Pumps, collars, bearings, and to resist corrosion
22	Worm-wheel rims (copper content includes manganese)
23	Worm-gearing, safe working stress: 7000 pounds per square inch
24	Gears under moderate service, easily "machineable"
25	Gun fittings
26	Bushings and shaft bearings
27	(Society of Automobile Engineers specifications)
28	Bearings for high speeds and heavy pressures
29	Ordinary machinery bearings
30	Bridge bearings
31	Standard for high speeds, heavy pressures, shock and vibration
32	Miscellaneous
33	Slide valves, bearings, and for resisting acids
34	Bearings, small valves, steam fittings
35	Gears and pump castings
36	Inexpensive bearings
37	Bearings for medium pressure and high speed
38	Bearings, steam fittings, and for incorrodibility
39	Small automobile bearings, or for high speed and heavy pressure, and steam fittings
40	Valves and bearings
41	Pump bodies, valves, steam fittings, and bearings
42	Valves, steam fittings and metal patterns
43	Valves and pipe fittings
44	Oil and water pumps, and trolley fittings
45	Inexpensive bearings for low pressure and no shocks, valves, fittings, etc.
46	Miscellaneous fittings, not subjected to friction, corrosion or pressure
47	Oil feed, cylinder top cover, etc., for automobiles
48	Light castings and ornamental work not requiring strength
49	Ornamental work
50	For strength in heavy work, substitute for steel in intricate designs, resistance to corrosion
51	Castings requiring great strength
52	Strong castings
53	Propellers, engine brass, and all strong castings
54	Strong castings
55	Propellers, valve stems, engine framing, and castings requiring strength and toughness
56	Miscellaneous
57	Ingots for castings (American Society for Testing Materials specifications)
58	(Society of Automobile Engineers specifications)
59	Low-grade bearings
60	(Tin content includes all other impurities)
61	(Single test)
62	Railroad turntable
63	For work in which strength, toughness, and especially incorrodibility are necessary
64	(Eighth report to Alloys Research Committee, British Institute of Mechanical Engineers)
65	For strength and resistance to wear, pressure, or repeated shocks
66	Fittings, etc., and castings that require great strength
67	Miscellaneous

Machinery

the result with several other variables undetermined. For instance, the hardness of the steel shaft and its finish are as much a factor in the selection of the bronze as the properties of the bronze itself. Moreover, the quality of the surface finish needed on the bronze bearing is also determined by the ability of the bronze to conform to the steel. It is evident that as the bearing pressure increases, the hardness also must increase to avoid flowing. In order to have a satisfactory hard bearing it is necessary to have a finely machine-finished surface on both bearing and shaft, because they will not conform as will softer metals.

Inasmuch as there are many different bearing conditions of pressure and speed, no one bronze can fill all the needs of the automobile engineer. In a general way tin and zinc harden bronze, and lead softens it. The use of zinc in small proportions is principally for deoxidizing purposes, but it has a detrimental effect on the wearing properties. When conditions require hard bronze bearings, the tin content must be relatively high. It sometimes reaches 15 per cent in automobile work. Lead may reach 30 or even 40 per cent for special work, such as in racing cars, but its effect should be considered in relation to the tin content as well as by itself. It is a good lubricant in bronze. Present practice frequently calls for a combination bearing with a relatively hard back and a soft lining of babbitt metal. The selection of babbitt should be determined by the thickness of the lining, and pure tin can be used if the lining is very thin.

Summary

In order to aid engineers in choosing the right alloy, the following points are especially emphasized: Results obtained from standard test bars do not necessarily represent the material in the casting. When possible, tests should be made on pieces cut from the castings themselves. Competent foundry work is necessary, as the chemical analysis of the alloy does not alone insure the best results. The microscope is as important in determining the properties of a bronze as it is in the metallurgy of steel. Endurance or fatigue tests are important in determining the qualities of a bronze. The proper composition of an alloy depends on the service required; a high percentage of tin is required for hardness, and a high percentage of lead for conformability. Authentic information on the subject of non-ferrous alloys is somewhat meager, and additional reliable information would be a distinct gain to engineering literature.

* * *

One of the noticeable changes in motor car engine design during the past six years is the decrease in cylinder bore diameters. Since 1910 when the average cylinder diameter was 5 inches, the diameter has decreased until in 1916 the average is about 3¼ inches. A curve showing the changes in average cylinder diameters was published recently in the house organ of the Burd Compression Ring Co., which showed that the diminution of diameter continued steadily from 1910 to 1912, when it was slightly more than 4 inches. The average diameter continued fairly constant at this figure until 1914, when it again dropped steadily from 4 inches to 3¼ inches.

CHART FOR DETERMINING ENGINE FRAME LOADS

BY ERNEST A. ANDREWS*

It is the purpose of this article to explain the use of a chart for finding the loads on the following members of an engine: (1) main bearings; (2) crankpins and crosshead pins; (3) crosshead guides. The horizontal line *AB* represents various values of the total load on the piston in pounds; the vertical line *CD* indicates the projected area of the main bearings in square inches; vertical line *AE* represents the projected area of the crankpins and crosshead pins in square inches; and the horizontal line *EF* shows the projected area of the crosshead bearing surface in square inches.

To illustrate the use of this chart, let us assume a case in which the total load on the piston is 24,000 pounds. This value is located on line *AB*, and assuming that it is required to find the size of the main bearings, we follow the 24,000 pound line vertically to the radial lines indicating allowable main bearing pressures. It will be seen that these lines cover a range of from 140 to 200 pounds per square inch, and assuming that we decide to use a value of 150 pounds per square inch, the radial line corresponding to this value is located, after which the horizontal line is followed across the chart to the vertical line *CD*. Here we find that the required area for the main bearings is 159 square inches. Following the same method in determining the areas for the crankpins and crosshead pins, the required values may be quickly determined from the chart, taking care to use the proper section of the chart in each case.

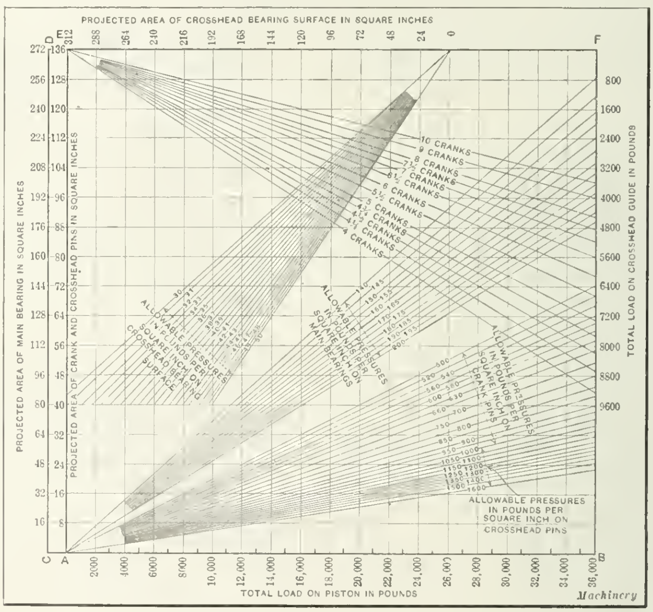


Chart for Use in rapidly determining Loads on Important Engine Frame Members

To determine the proper area for the crosshead bearing surface, it is necessary to know the ratio of the length of the connecting-rod to the radius of the crank circle, and assuming that for the case under consideration the value of this ratio is 5 to 1, or "five cranks," we follow the 24,000 pound piston load line until it crosses the radial line marked 5 cranks; from this point of intersection, move across the chart to the left to the radial line of allowable crosshead bearing surface pressure. Assuming that the value used is 40 pounds per square inch, we follow up the vertical line to *EF* at the top of the chart, and find that 123 square inches is the proper area for the crosshead bearing surface.

The total load on the crosshead guide is represented on line *BF* at the right-hand margin of the chart, and is found by moving across the chart to the right from the point of intersection of the piston load line and the radial line representing the ratio of connecting length to crank radius.

* * *

None of us today really believe that men are created equal, but we do believe that they are entitled to an equal opportunity. Moreover, developments seem to indicate that the more nearly we can accord men equal opportunities for advancement, the more prosperous will be the individual and the country as a whole.—*H. L. Gantt, in Industrial Leadership.*

* Address: 1308 Franklin Ave., Bond Hill, Cincinnati, Ohio.

ALBERT BALL'S MAGAZINE RIFLE OF 1863

A CHAPTER ON MACHINE TOOL DEVELOPMENT AND RIFLE MANUFACTURE

BY GUY HUBBARD*

THE machine tool business in the United States is unusually prosperous at present, due to the impetus it has received, both directly and indirectly, by the European war. The direct result of the war is shown in the boom in the manufacture of munitions, while the great increase in the production of machine tools, which are required in quantities by the munition makers in this country and abroad, may be called the indirect result. The conditions at present existing in these lines are considered unparalleled, and in certain particulars they are, but in many respects the same conditions existed in the North, especially in the New England states, during the Civil War. At that time the war was upon home ground, and production was hastened by a general desire for self-preservation and perhaps by patriotic motives; yet in those days, as now, fortunes were made in the mechanical industries. The town of Windsor, Vt., furnishes in its machine tool industry of today and that of fifty years or more ago a comparison of these two periods, and it is with the earlier of these that this article is mainly concerned.

Some years prior to the Civil War a gun shop was started at a point where the water power was abundant and about which Windsor, like many other New England towns, grew up. The organization of this gun shop gradually brought together a considerable company of skilled workmen, among whom were certain men having more than the usual amount of inventive genius. Through the efforts of these men the products of the concern became widely and favorably known at a time when more than a local reputation was rare. The extent of the reputation is shown by the fact that the Windsor rifle was a favorite among Kentucky hunters and it also armed the soldiers of Texas at the time when, as the "Lone Star Republic," she fought the whole of Mexico.

A famous product of the old concern was known as the "100-to-the-pound" rifle, the small-bore gun of its day and a general favorite among sportsmen and pioneers in the '30s. This rifle had a barrel of extraordinary length and shot a round bullet, one hundred of which weighed a pound, making it 0.36 inch caliber. A short man must have had some difficulty in ramming a charge into the long barrel, but it utilized the expansive energy of the powder to such a high degree that a light charge served to drive the bullet at high velocity, as the space for acceleration was great.

A system of rifling called the increased twist was applied to the rifle mentioned, this system being afterward discarded by gunsmiths as being a needless refinement. The greatest care was taken in the manufacture of the barrels for these rifles, and before they were passed by the inspector, each one was held toward a window in order to determine by the distortion of the reflection in the polished interior whether the barrel was suitable for use or not. The writer has heard it stated that "Dave" Crockett was carrying one of these particular rifles when the coon came down, but does not wish to vouch for the truth of this. In these early days of gun manufacture, a great deal of the work was hand work, or, at the least, work which was partially done by hand, as, for example, chipping and filing, and the turning of metals in slow-running speed lathes with hand tools, while threads were frequently cut by hand chasing, the accuracy depending upon the skill of the workman in the initial guiding of the chaser along the rest. It was not long, however, before this gun shop began to design and build machines to do its work, many of these machines being of novel design which afterward proved very successful. By good authority, credit is given to these designers for the introduction of the shaper or crank planer (as it was then called), milling machines and profilers, disk grinder, and most important of all, the turret lathe. So successful was their machinery that other armories and machine shops both here and abroad began to buy it. For example, when the well-known firm of Enfield in England began to manufacture rifles, the entire outfit of machinery was built at Windsor, Vt.

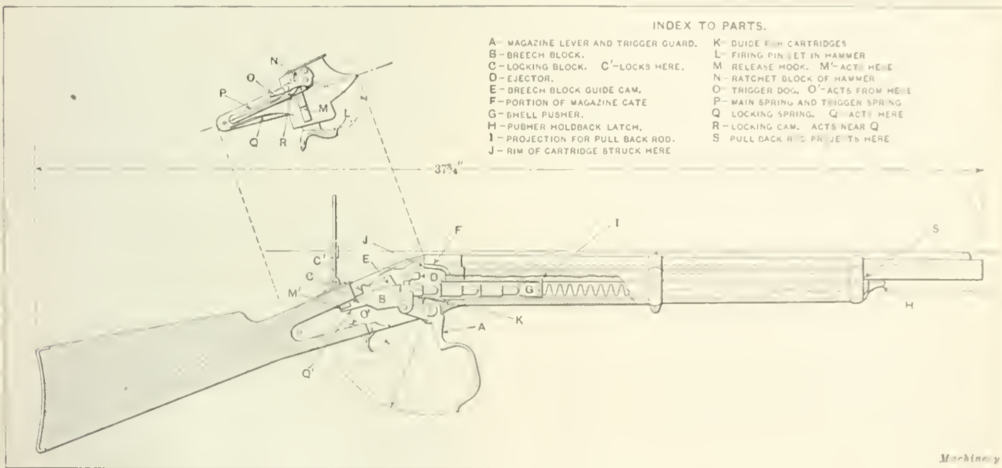


Fig. 1. Diagram showing Mechanism of Ball's Magazine Rifle

Thus it was that parallel to the gun business there grew up at Windsor a machine tool business which was destined to outlive its parallel and to come down to our own time as a leader in the field opened by the introduction of the turret lathe. The original Windsor concern was the root from which grew an extraordinary network of newer machine companies, some of which are now among the largest and best known in the United States. The influence of the industry at this point has been very thoroughly investigated by Prof. Roe of the Sheffield Scientific School.

The name by which one of the factories was known at that time was Robbins & Lawrence. Many inventions were made and developed by this concern, one of which was a five-shot pistol, patented in 1849. A description of this pistol was published in MACHINERY, May, 1912. At about this time Robbins & Lawrence built the Windsor Armory which was a large brick

* Address: Windsor, Vt.

structure; this is still in a fine state of preservation and is now used as a power station, where the first "Stumpf Uniflow" engine to be installed in New England is in operation. While the armory was still under construction large contracts for army muskets were received from the United States government, with the result that the new shop became a very busy place. These muskets were smooth-bore guns of large caliber not unlike cylinder bored shot guns, though having heavy barrels designed to shoot solid balls, and one phase of their manufacture that may be of interest was the making of the barrels.

A musket barrel was made at that time of flat stock, somewhat thicker than the walls of the finished gun, this stock being forged up about a rod and its edges welded lengthwise along the barrel, just as old-fashioned wrought iron pipe was made. It is apparent that this weld needed to be perfect or the gun would tear open when fired; there were few men in the country who were expert enough to be trusted on this work, and there was just one man with this company who could do it. For this reason this particular workman received the then unheard of wages of $10 per day. He was also experienced in making the so-called "stub and twist" barrels used on the superfine sporting and target guns made up on special orders. The stock for these barrels was forged in a narrow strip from high-grade scrap (horse-shoe nails in particular), then wound spirally about a rod and the edges welded. When finished, these barrels presented a handsome mottled appearance, and because of the direction of the fibers were unlikely to burst.

A short time previous to the outbreak of the Civil War, Robbins & Lawrence became associated with a concern making the Sharpe rifle. This company met with business reverses of such magnitude that both concerns failed completely, which was a rather common occurrence at that critical period. When the Windsor Armory with its full equipment and power was put up for sale, E. G. Lamson of the Lamson & Goodnow Cutlery Co. purchased the entire outfit at a ridiculously low figure, the price that he paid for the machinery being its scrap value only. At this time the Civil War broke out and Mr. Lamson immediately discovered that he had purchased a veritable gold mine, for not only did he own a plant in readiness to manufacture the guns for which there was a prodigious demand, but he possessed also an excess of gun making machinery. From this excess machinery he cleared $83,000 in one year, which was more than the initial cost of the whole plant. $10,000 of this was realized from the bayonet room alone. He also set the armory in operation after having received heavy orders from the government, and after gas was installed for lighting, ran night and day shifts, employing nearly five hundred men.

At this time the standard army gun was being manufactured at a large profit, $17 apiece being paid for them in quantity; yet Mr. Lamson looked about for something better than the muzzle loading gun. This possibly incited Alfred Ball, a young mechanic in Mr. Lamson's employ, to bring forward his magazine rifle, which, viewed from a modern standpoint and in the light of future developments, was plainly an invention far ahead of its time. Mr. Ball obtained basic patents on his gun in 1863, the third year of the war, and steps were immediately taken by Mr. Lamson to manufacture it on a large scale.

The construction of this rifle is shown in Fig. 1. Primarily it is a lever-action, breech-loading repeating rifle, using metallic cartridges carried in a tubular magazine beneath the barrel, and resembling quite closely the present-day repeating rifle in many of its features. It must be remembered that at this time the ready-made brass shell, the magazine principle of handling the shell, and the breech method of loading were all innovations, so that there were three improvements of prime importance in the Ball rifle. These guns were made in two types, one a heavy infantry rifle, 0.50 inch caliber, and the other a short and comparatively light rifled carbine, 0.38 inch caliber, designed for cavalry service. This latter model, while it was never put on the market, was preferred, I understand, by the designer. It was the good fortune of the writer to be able to borrow from Mr. Gridley one of the carbines, although specimens of both models are now somewhat rare; the following description is therefore confined to this type, the essential principles being identical in both models.

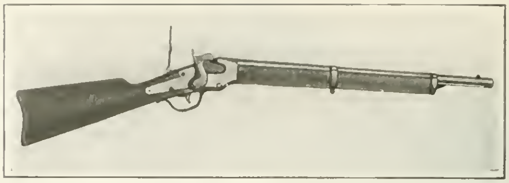


Fig. 2. Ball's Magazine Rifle assembled

The Ball carbine shown in the illustrations accompanying this article has an over-all length of $37\frac{3}{4}$ inches and weighs 8 pounds. Nine of the rather chunky rim-fire cartridges may be carried in the magazine, which consists of a brass tube 16 inches long and $\frac{3}{4}$ inch in diameter, located below the barrel. This tube contains a pusher G to feed the shells, the pressure being exerted by a long coiled spring of steel wire. The spring was made from No. 22 wire (Birmingham gage used at that time), and when free is 28 inches in length, but compresses on full magazine into a space of 3 inches, so that considerable force is exerted in the range of movement of the pusher. In order to facilitate the loading of the magazine a pull-back rod projects like a ram rod beside the barrel and engages a projection on the pusher. This works in an L-shaped track soldered over a slot in the magazine, the pusher projection I traveling in this slot. When the pusher is drawn back, it is caught by a latch H at the end of the magazine and held so that the rod may be pushed in out of the way, and after the magazine is loaded the pusher is released by pressure on this latch. The brass rim-fire shells used in the Ball rifle were among the first prepared cartridges of the type now in use. They were similar to those used in the old Smith & Wesson 0.38 inch caliber revolver, and the writer believes the original cartridges were made by this company. Upon experiment it was found that dry ammunition gave trouble in the gun, so Mr. Ball designed a cartridge greasing machine which is used today in all cartridge factories, and this overcame the difficulty. The shells were loaded with 20 grains of black rifle powder and a round nose lead bullet of 150 grains, this combination having considerable stopping power at moderate ranges. The primer was composed of fulminate of mercury spun out into the rim of the shell.

The barrel of the carbine tapers from 1 to $\frac{3}{4}$ inch at the muzzle, making it amply heavy at the breech. It is bored to 0.38 inch caliber and has five grooves broached through it, these grooves having a uniform lead of 30 inches to the helix. The barrel was made from a steel forging and the breech frame was shrunk onto it. This frame is a drop-forging of intricate pattern, its interior being milled out to contain and guide the loading mechanism, and its wearing surfaces bushed with hardened tool steel. The wooden parts, stock and magazine cover are of black walnut and were turned to shape in a gun stock lathe; the recesses in them were cut by fast running end-mills or burrs. Fig. 2 shows the general appearance of

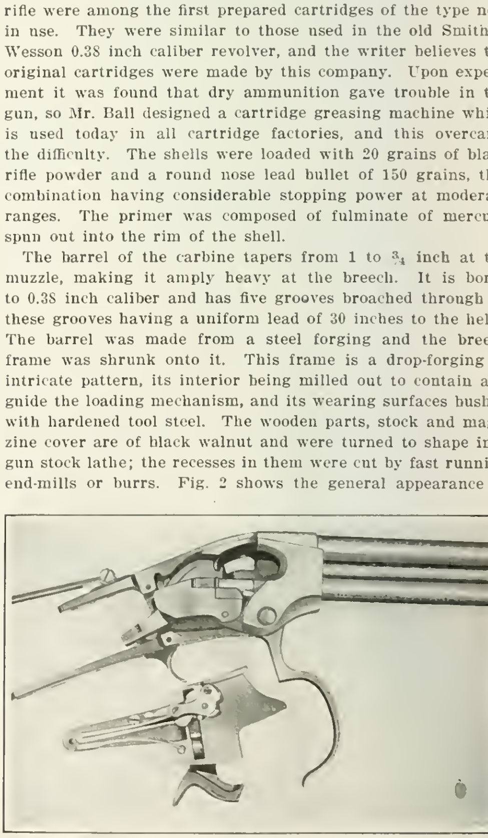


Fig. 3. Action of Ball's Rifle at End of Operation 1

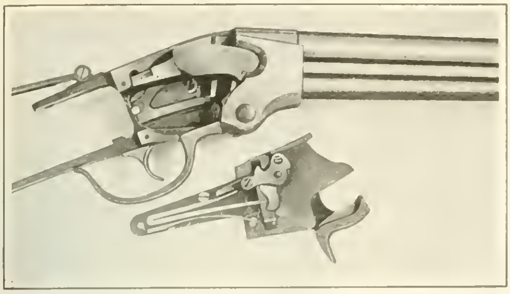


Fig. 4. Action of Ball's Rifle at Beginning of Operation 5

the assembled Ball carbine. In order to indicate as clearly as possible the internal mechanism of the gun, the sectional assembly drawing shown at the upper left-hand portion of Fig. 1 is revolved upward through an angle of 180 degrees, so that the projection shows it bottom side up and inside out in order to show its position in relation to the loading mechanism. In order to explain the working of the Ball gun, the process for a complete cycle of operations is indicated herewith, reference being made to the illustrations accompanying the article.

Details of Rifle Manipulation

1. Gun empty, full cock, and magazine open. Pull back magazine spring by rod projecting at end of magazine (not shown) until pusher is caught by latch. Then push rod back, drop cartridges into magazine through gate, bullets facing front. When full, release spring by pressing latch, which causes first shell to be pushed out of magazine, whence it is guided by the trough into the breech-block, where it is held in place by the forward and downward pressure of the ejector upon it. See Fig. 3.

2. Magazine lever is started upward. Front end of breech-block begins to swing upward, being pivoted to short arm of magazine lever, while rear end is guided upward and forward by flat cam on frame. Ejector forced back by pressure of shell against curved arm; locking block pushed upward against frame by flat spring on lock plate. Guide trough pivoted to under side of short arm of magazine lever, tips up, holds back second shell, and slides beneath mouth of magazine.

3. Movement of magazine lever is completed. Ejector is pushed completely back and nose of bullet enters chamber of barrel. Locking block drops into place behind shoulder and is held in place by spring, thus locking breech. Breech-block is now part of chamber and covers magazine gate. Shell is locked on chamber with small part of rim exposed to blow from firing pin on edge of hammer face.

4. Trigger is pulled. Heel of trigger bears upward against long lever arm on pivoted dog on lock plate. Edge of short arm of dog slips out of notch in ratchet block integral with hammer, and ratchet block is revolved about 30 degrees by opening of double flat spring connected to it off center by link. This causes hammer to fall, exploding cartridge, while at the same time locking cam fastened to ratchet block is thrown up beneath locking block, causing positive locking of breech at instant of explosion. Release hook on breech spring slide, operated by turning of ratchet block, also snaps above locking block. Fig. 4 shows position of receiver mechanism at this stage in cycle.

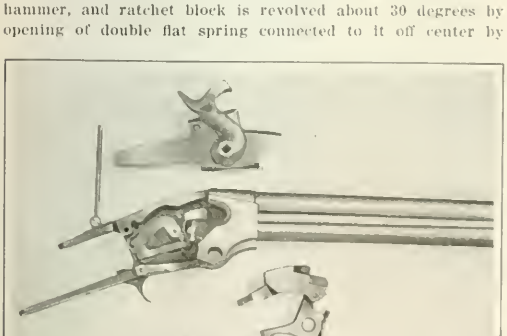


Fig. 5. Loading Mechanism of Ball's Rifle partly disassembled

5. Gun is cocked. Ratchet block turns back and edge of dog drops into notches, first that for half cocking, then that for full cocking, where it is held. At the same time locking cam is withdrawn and release hook pulled down locking block, unlocking loading mechanism.

6. Magazine lever is thrown down. As breech-block recedes, shell is withdrawn from chamber and magazine gate opens. Ejector suddenly slips off corner of breech-block and snaps empty shell out through gate. As breech-block comes back to starting point, guide trough is drawn into place and second shell moves into position. This completes the cycle.

Although this cycle of operations takes some time to describe, it is quickly done, and the gun may be fired as fast as the lever can be worked and the trigger pulled, the 0.50 inch caliber barrel sometimes becoming too hot to hold, while the effect upon the shoulder of the operator is like the pound of a pneumatic hammer. The action of the Ball gun must also have been somewhat disconcerting to the men at the other end who were armed with single-shot muzzle loaders at this time. When it was desired, this rifle could be used as a single-shot breech loader, by inserting the magazine cut-off, a pin set across the mouth of the magazine to hold back the shells, and putting the cartridges directly into the breech-block.

After tests had been carried out upon the Ball gun and its practicability as a service arm demonstrated, the Federal government became interested and preparations for its manufacture in quantities were hastened. The tests as conducted by government officials stationed at the armory were, to say the least, somewhat rigorous, the test of barrels in particular being very severe. Before the guns were assembled, a long row of barrels, loaded with double charges of powder and balls, was set in a rack in a sort of "bomb-proof" room, the muzzles directed toward a sand bank. All the charges were then fired at once by a train of powder touched off from outside, the resulting roar being heard all over the town. The barrels which survived this test were again tested by regular loads to reveal any weaknesses developed by the first trial. The inside of the bomb-proof room was well studded with pieces of burst barrels after many of these tests had been made.

A further test was occasionally given by selecting a sample from among the finished guns, this being buried in a mixture of salt, iron-chips and wet earth, to be exhumed later and tested to determine whether it was still in working order. In those days an ordinary gun consisted of "lock, stock and barrel," so that it is not surprising that experts were rather skeptical in regard to the complicated Ball repeater. As the interchangeable system of manufacture was in force at this time at the Windsor Armory, a great deal of special machinery, as well as expensive jigs and fixtures, was required before the new rifle could be made in any numbers. All these operations required both time and money, and when all was in readiness, $25,000 had been spent on special machinery and the year 1864 was nearly over. A contract was made with the Federal government as indicated by the nameplate on the gun. The wording on this plate reads: "E. G. Lamson & Co., Windsor, Vt., U. S., Ball's Patent, June 23, 1863."

Some of the special machines that were built for this rifle were deep drilling machines for boring barrels, rifling machines, drop-forging hammers and dies, gun stock lathes, and profile milling machines. It is known that some of these rifling machines are still in service at the factory of a well-known maker of revolvers. The output of the armory was sufficiently great so that the Ball rifle might easily have proved to be a deciding factor in favor of the North, and, in fact, hundreds of these repeating rifles had already been made and they were just coming into use when the war came to an end. Thus it was that the whole thing went flat at this time and no more guns were wanted. Hence, cases of modern magazine rifles sold at $\frac{1}{2}$ cent per pound, and many a Vermont

hunter in the late '60s carried a gun like those in use by the hunters of the present generation. At the same time hunters in other sections of the country were still using "muzzle loaders" with the powder, ball, and percussion caps.

It now remained for Prussia with her "needle gun" to demonstrate in 1866 and 1871 what could be accomplished by the use of single-shot breech-loading rifles in warfare. The Ball repeater as an invention lay dormant for many years, but finally came to the front again as the Winchester repeater, and as such has a wide reputation. After the crash, the special gun making machinery all went into storage and finally was sold as junk, marking the end of the munition business at Windsor, Vt. The machine tool industry, however, did not die out in 1865, but after passing through many precarious years as the old Windsor Machine Co., the idea of the turret lathe bore fruit, and the concern now flourishes in a large and growing modern plant as the manufacturer of the "Gridley" automatic screw machine. The munition idea still persists in the minds of some people who recollect the past, and only a short time ago an old gentleman who was being shown through the shop looked over a single-spindle "Gridley" automatic and inquired which end of the spindle the shot was fired from, while another person asked, in regard to the multiple-spindle machine, how the four-barrel cannon was moved about on the field of battle.

Albert Ball, who invented the magazine rifle, has reached

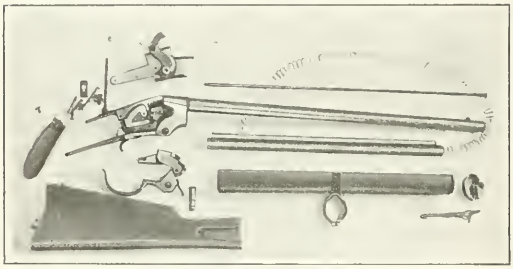


Fig. 6. Details of Ball's Rifle

nearly the allotted "four score years and ten," and is still an active designer with the Sullivan Machine Co., at Claremont, N. H., and has been for many years the mechanical engineer of this concern. In addition to the magazine rifle, Mr. Ball has to his credit numerous important inventions in mining machinery, steam engines, air compressors, and allied machines. There is little doubt that he is one of the last of the Civil War period inventors worthy of note, and has more than held his own beside those of another generation. He is a living example of the truth of a statement made by an old-time designer of machinery: "We of those days" (this man said, in reference to mechanics of years gone by) "were just as intelligent as you of to-day. We had little behind us, and built up, step by step, those things upon which you have learned unconsciously to depend. Without the foundation laid by us you could not build the intricate machines of the present day, but would yourselves be forced to lay foundations instead of building upon them."

The writer is indebted for much of the material contained in this article to G. W. Hubbard, who was a draftsman at the armory in 1853; G. O. Gridley of the National-Acme Mfg. Co., inventor of the "Gridley" automatic screw machine; Mack Mower, Frank Hall and M. Harrington, who have been connected with the Windsor shops for many years.

* * *

EXTENSION MILLING ATTACHMENT

There are two bearing bosses used to confine the reverse idler shaft in the transmission case of the Maxwell automobile which are so situated on the interior of the case that it is difficult to machine them quickly and accurately. This was one of the problems confronting the manufacturing department of the Maxwell Motor Co., New Castle, Ind., and after trying a double facing tool in a drill press and, later, end-milling, the milling fixture and extension milling attachment shown in Figs. 1 and 2 were designed.

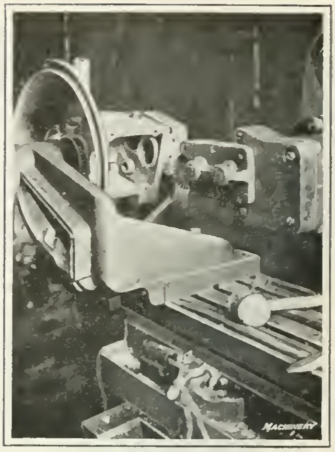


Fig. 1. Extension Milling Attachment, with Work in Place in Fixture

The milling fixture is of simple construction, consisting of two fixed locating plugs on one end and a movable locating plug on the other end which is run in and out by a handwheel and screw. The extension milling attachment consists of a rigid casting which is attached to the column of the milling machine by screws. On an extended portion of this casting, and so situated as to be able to reach into the transmission case a sufficient distance, are located two side mills which are driven by a train of gears from the main driving spindle of the milling machine. The distance between the bosses in the transmission case which is to be milled is 1 15/16 inch, and the two side mills are placed just this distance apart, so that it is only necessary to run the mills between the two bosses to accomplish the operation.

With the previous methods of milling, it was impossible to machine any two bosses exactly alike, and the best production was 125 cases in ten hours. By the use of this milling attachment and fixture, it is possible to mill any number with an error not exceeding 0.003 inch, and with a production of 250 cases per day with one machine and one operator.

It is apparent that this fixture paid for itself very soon, and the greater degree of accuracy secured through its use was, of course, an advantage. The attachment is shown being used on a No. 1½ Cincinnati milling machine. V. B.

* * *

NON-CLIMBABLE FENCES

Two knights of the road of the yeggmen type sauntered by a munitions plant surrounded by a high woven wire fence. The fence was surmounted by three strands of vicious barbed wire set to overhang each side. The makers sign, "Hicks Non-climbable Fence," roused the slimmer yeggman's ire.

"Say, dat fella *is* a 'hick'—his fence is easy. If I wants to get in, do you know what, bo? I gets a few burlap bags and makes me a cushion, see, to trow over de hooks so, and over I goes slick and easy. When I makes me getaway de cushion is de Johnny again. Dese fellas dat tink dey can keep tings under lock and key makes me tired."

From which we learn that barriers are not as effectual to the ingenious as they appear to simple, law-abiding souls to whom a Yale lock or "No Admittance" means "keep out."

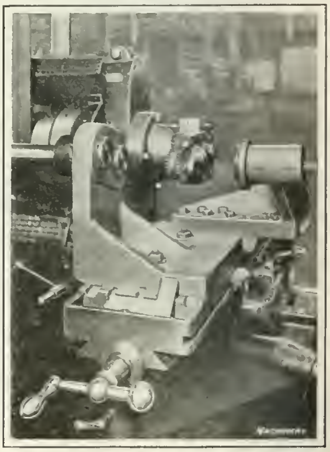


Fig. 2. Fixture shown Empty, with Locating Plugs exposed

RECENT LEGAL DECISIONS INVOLVING MACHINERY

State Regulation of Sales

(Virginia) The Supreme Court of Virginia recently handed down an opinion holding that the business of a foreign corporation in bringing its machines into the state before selling them, in maintaining a stock of machines for exhibition and trial and selling them after their transportation in interstate commerce has ended and they have become mingled with the general mass of property in the state, in renting such machines and collecting rents therefor, in buying and exchanging machines for those of other make, and selling the machines received in exchange at will, in employing a mechanic in the state and entering into yearly contracts for repairing machines, and in keeping on hand in the state parts of machines which are frequently sold in the state, constitute intrastate commerce, in the transaction of which the company is subject to state regulation.

The Dalton Machine Co. was fined $1000 for having failed to pay the state corporation license tax. The company's defense was that it was not subject to regulation by the state, as it was engaged only in interstate commerce. The evidence established the fact that the defendant, though engaged in the interstate sale of machines, maintained a salesroom and sales agency in Virginia, employed salesmen, clerks, and repairmen whose duty was performed wholly within the state of Virginia. In holding the company subject to the license tax on the ground that it was engaged in intrastate commerce, the court said:

> Nobody may, by any device or by any ways or means whatsoever, avoid local license taxes for doing intrastate business contrary to the laws of this state. That this method of transacting business by the Dalton Machine Co. is a mere device for the purpose of avoiding the state statutes is apparent when the contention is made that, even in case of a cash transaction, when a machine previously in the possession of the purchaser is sold by a local agent to that purchaser for cash, strictly in accordance with the previous instructions given to the local agent, such a transaction needs confirmation by the company at its home office. The price is fixed, the property delivered, the terms complied with, and nothing is left of such a transaction except for the local agent to send the check or the currency to the selling company. Inasmuch as the purchaser has complied with every substantial term of the contract, it is not believed that the selling company could refuse to accept the purchase price, notwithstanding the device referred to. It can only be resorted to in case of such a cash transaction for the purpose of attempting to convert "into a form resembling interstate commerce that which in its intrinsic substance is local business subject to state control. We think it perfectly apparent that in these particulars the business of the company in this state is not "commerce among the states," the freedom of which is guaranteed by the United States Constitution, but that such business, in every essential particular, is business which has been transacted by the company in this state in violation of the statutes referred to. *(Dalton Machine Co. v. Commonwealth, 88 S. E. 170.)*

Only Reasonably Safe Appliances can be Required

(Pennsylvania) In an action for injuries to a servant while unloading freight from cars, where the negligence alleged was the failure to supply appliances for unloading the cars instead of iron straps for sliding the freight to the ground, but it did not appear that the method employed was dangerous or unusual, though that suggested might have been safer, it was an error to submit the case to the jury, and a verdict should have been directed for defendant.

The Pennsylvania Supreme Court came to the foregoing conclusion in Miller v. Republic Chemical Co. The Republic Chemical Co. owns and operates a plant for the manufacture of chemicals. In the course of the construction and operation of its plant, it received from time to time, on board cars, certain heavy pieces of machinery, varying in weight from one to two tons each. This machinery was generally skidded from the car into the building, though it was a known fact that it could have been handled better had it been moved with a crane. Plaintiff was injured while unloading some such machinery. He brought this suit basing his case on the theory that defendant had not used the most practical method in unloading the machinery; that had a crane been provided for use, no injury would have occurred.

The Supreme Court, in reviewing the case, reversed a judgment of the trial court in favor of plaintiff. In its opinion the court said, in part:

> The plaintiff admits that as an employe of the defendant he had been engaged in exactly the same work, using the same device, for a period of six months prior to the accident complained of. He mentions not a single mishap during this period.
>
> What duty owing to the plaintiff in the choice of method did the defendant neglect to observe? When the employer furnishes his employe the tools and appliances which, though not the best possible, may by ordinary care be used without danger, he has discharged his duty, and is not responsible for accidents.
>
> If the machinery be of an ordinary character, and such as can, with reasonable care, be used without danger to the employe, it is all that can be required from the employer—this is the limit of his responsibility, and the sum total of his duty.

Even were it admitted that the evidence was sufficient to warrant the conclusion that the crane method was the safer, it comes far short of showing a disregard of any duty on the part of the defendant in not adopting it. A plaintiff can only prove negligence in such case as this by showing that the appliance used was not reasonably safe. Even though it be made to appear that it was not in ordinary use, such fact would not warrant an inference of negligence. *(Miller v. Republic Chemical Co., 97 A. 73.)*

Operation of Machinery

(Pennsylvania) An employe cannot recover for personal injuries sustained in stopping machinery by grasping a flywheel, thereby bringing his hands into contact with a bracket which had just been put into place, intended to hold a guard, of which the employe knew, when there were several other wheels by which he might have stopped the machinery more safely. *(Hoffman v. Brentmore Knitting Mills, 97 A. 474.)*

Proper Protection Must be Provided

(Federal) Plaintiff, a machinist's helper, was holding by an iron bar a journal from turning on the axle, while the machinist was chipping therefrom with a chisel and hammer. On the machinist's order, he laid down the bar, helped to turn the box over, and without any further direction stooped down to pick up the bar. While doing so the machinist resumed chipping on the box, and a chip struck plaintiff's eye. There was no protection from the chips, nor warning that the machinist was about to resume chipping. There was evidence that chipping such boxes was particularly dangerous to bystanders, and that it was a good practice, and the general practice in that shop, to provide some barrier, such as a canvas, board, box or broom. Held, the plaintiff is entitled to recover for the employer's negligence in failing to supply protection from the chips. *(Siegesmund v. Chicago, M. & St. P. Ry. Co., 229 Fed. 956.)*

* * *

Bortz are obtainable in various sizes and qualities. For truing wheels up to 24 by 2 inches, the one carat stone answers very well and probably gives as much yield per dollar invested as larger stones of the same quality. When, however, wheels over 2 inches wide are to be trued, it has been our experience that the larger stones give greater service. This is doubtless due to the fact that the longer the contact of the diamond and wheel, the greater the heat generated. A copious supply of water should always be directed on the diamond during truing operations to carry away the heat generated. For truing wheels over 2 inches and up to 6 or 8 inches wide the advantage of using the larger stones is that they offer a greater mass to dissipate the heat, and as a result do not break down so quickly. The difficulty, however, is to secure stones of two or three carat size of the light brown variety which will be free from fractures or flaws. Perfect stones are more easily obtained in sizes ranging from 1/2 to 1 1/2 carat. It has therefore been our practice for the general run of grinding to select stones weighing approximately one carat.—*Grits and Grinds.*

BOARD DROP-HAMMERS

GENERAL CONSTRUCTION, OPERATION AND DESIGN OF IMPORTANT DETAILS OF DROP-HAMMERS BUILT BY WELL-KNOWN MANUFACTURERS

BY DIXIE

BOARD drop-hammers have been in practical use a little over sixty years for the production of drop-forgings, and owe their present high state of development to American designers. The crank drop-hammer or "Peck lift" was also largely used for drop-forging in the early days of the industry, but this type is now confined largely to stamping work and the silverware trade. The first patent containing the basic principle of the board drop-hammer was taken out by Goulding & Cheney in 1861, the patent covering a drop-hammer that was lifted by means of a belt or board placed between rolls running in opposite directions. Practical working drop-hammers were used as early as 1853, and they have since been built in two types. One is known as the board clamp type, the hammer being held at the top of its stroke by clamps or toggles gripping the board. The other is the latch or catch-up type which is now seldom used. With this construction, the hammer had a recess milled into one side to receive a latch or finger that was pivoted adjustably to one of the uprights and connected to the foot-treadle. As the hammer reached the top of its stroke, the latch dropped into the recess and held the hammer up. All modern board drop-hammers of whatever make are but a modification or combination of the early designs with certain changes which were needed to meet the severe service of modern requirements.

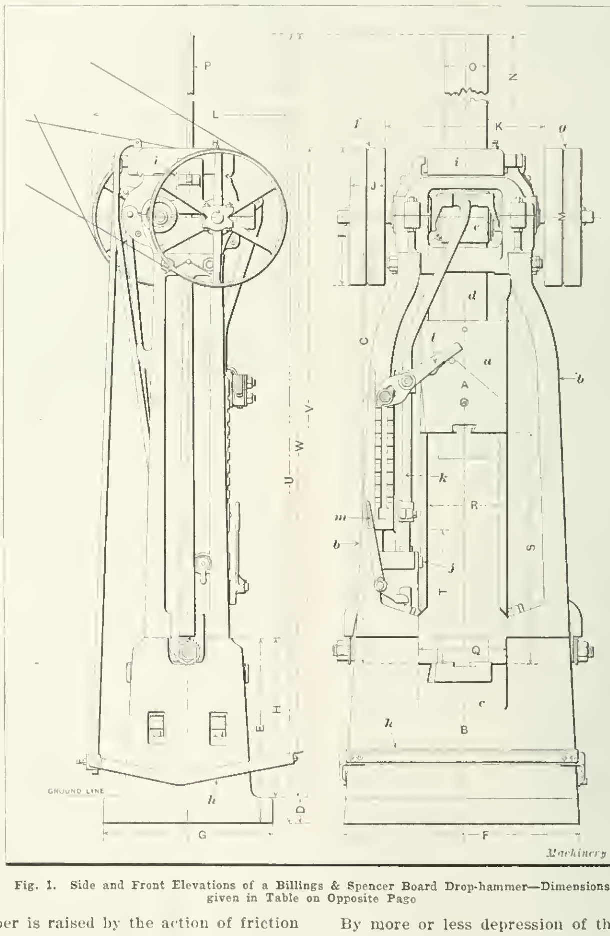


Fig. 1. Side and Front Elevations of a Billings & Spencer Board Drop-hammer—Dimensions given in Table on Opposite Page

General Construction of Board Drop-hammers

The board drop-hammer is so named because the hammer proper is raised by the action of friction rolls which bear against a board that is attached to the hammer. The design shown in Fig. 1 will serve to illustrate the most important constructional features and the principle governing the operation of drop-hammers generally. The hammer *a* to which the upper die is attached operates between two uprights *b*, and is held in position by V-shaped guides. These uprights are attached to the base *c*, which carries the lower die. A board *d* is attached to the hammer head *a*, and extends upward, passing between front and rear friction rolls at *e*. These rolls are revolved in opposite directions by open and crossed belts operating on pulleys *f* and *g*. One pulley drives the front roll and the other the rear roll.

The action of the hammer is controlled by a foot-treadle *h*, which is connected with board clamps enclosed at *i*. There are two of these clamps, one at the front and the other at the rear of the board, and they serve to hold the hammer in its upper position when the foot-treadle is released. When the foot-treadle is depressed, these board clamps are withdrawn, thus releasing the board and allowing the hammer to drop; the front elevating friction roll at *e* is previously withdrawn slightly, so that the hammer falls freely.

As the hammer approaches the bottom of its stroke an incline surface on the side engages a plunger or knock-off *j* which is forced back, thus allowing the friction bar or front rod *k* to drop. This downward movement of the friction bar *k* moves the eccentrically mounted friction roll *e* against the board so that the hammer is immediately elevated preparatory to making another stroke. As the hammer approaches the top of its stroke, a pin attached to the hammer comes into contact with the roll-releasing lever *l*, which raises the friction bar *k*, thus withdrawing the front friction roll from contact with the board and stopping further upward movement. As soon as the pressure of the friction driving roll is released the hammer will again fall and will continue to run automatically as long as the foot-treadle is held downward. When this treadle is released the board clamps at *i* grip the board as soon as it reaches the top of its stroke and start to move downward.

By more or less depression of the treadle, variation in the force of the blow may be obtained, regardless of the stroke or fall for which the hammer is adjusted. For instance, when the foot-treadle is pushed all the way down, the clamps are entirely released and the hammer drops freely, whereas if the treadle is only partly depressed there is more or less friction between the board and the clamp, and the fall of the hammer is retarded correspondingly. The hammer can also be stopped at any point when falling, without injury to the working part.

The stroke of the hammer, or the height to which it ascends before falling, is regulated by changing the vertical position of the roll-releasing lever *l*. Means are also provided for adjusting the friction-bar releasing mechanism at *j*, in accordance

with the thickness of the dies used. Thus, when using thick dies, the trip mechanism is set so that the friction bar k will drop sooner, thus causing the friction rolls to lift the hammer sooner. A lever m is provided for raising the friction bar by hand when necessary. The board d should preferably be of seasoned maple, as this has been found to give better service than any other kind of wood. Paper fiber has been tried with fairly good results, but as yet the cost of this material is prohibitive.

While all board drop-hammers operate on the same general principle as the one described in the foregoing, the details of the different designs vary considerably, and therefore the more important features embodied in the design of well-known makes of drop-hammers will be described and illustrated in detail.

Cross Adjustment for Alignment of Dies

With one or two exceptions, the builders of steam drop-hammers make no provision for cross adjustment of the dies, justing screw B bears against the upright, there is generally a tool steel plug inserted to prevent battering the upright.

To adjust the dies for alignment, first lower the hammer or ram until the faces of the dies are together; then loosen the upright base bolts F and the lock-nuts G on the adjusting screws and back off one screw in the direction toward which it is desired to move the top die, tightening the opposite screw a corresponding amount. The hammer or ram, acting as a distance piece between the guides, will move the entire superstructure. In locking the adjusting screws, care must be taken not to pinch the hammer between the guides. The uprights are kept in line by two guides C just outside the lug. In this construction, as well as in the design shown in Fig. 3, the upright base bolts are vertical and cushioned by leather washers H under the nuts. The bolt holes are cored, and they are elongated in the base to allow for a limited cross adjustment. It is essential that these bolts be kept tight or the

GENERAL DIMENSIONS OF A DROP-HAMMER—BILLINGS & SPENCER CO., MODEL D

Weight of Hammer	Weight of Base	Length of Uprights, Feet and Inches	Below the Ground Line, Inches	Height of Base, Inches	Length of Base, Inches	Width of Base, Inches	Above the Ground Line, Inches	Diam. of Pulleys, Inches	Face of Pulleys, Inches	Between Pulleys, Inches	Pulley Space, Inches	Revolutions Per Min.
A	B	C	D	E	F	G	H	I	J	K	L	M
400	6000	6-6	3½	41	42	27	37½	26	6	28	37	190
500	7500	6-6	3½	41	42	27	37½	26	6	28	37	190
600	9000	7	3½	41¼	49½	30	37¾	30	7	32	41	170
800	12000	7	10	47⅝	49½	30	37⅝	30	7	32	41	170
1000	15000	8	7½	43¾	57¾	40	36¼	32	8	38	45	130
1200	18000	8	12⅝	48⅞	58¼	40	36¼	36	8	38	49	115
1400	21000	8	17⅞	54⅛	58⅞	40	36¼	36	8	38	49	115
1600	24000	8	21	57¼	59¼	40	36¼	42	8	38	55	110
1800	27000	8-6	18½	52¾	65½	39½	34¼	48	9	43	61	105
2000	30000	8-6	23	57¼	65⅞	40	34¼	48	9	43	61	105
2500	37500	9-6	21½	56½	71	47	35	56	10	55	69	100
3000	45000	9-6	22¼	57¼	71	48	35	56	10	55	69	100

Weight of Hammer	Length of Board, Feet and Inches	Width of Board, Inches	Thickness of Board, Inches	Between Uprights Above Base, Inches	Between Ways on Uprights, Inches	Extreme Fall, Feet and Inches	Shortest Automatic Fall, Feet and Inches	Total Height of Machine, Feet and Inches	From Floor to Top of Pulleys, Feet and Inches	Height to Operate Machine, Feet and Inches	Length of Shoe—Front to Rear, Inches	Length of Hammer—Front to Rear, Inches	Horsepower
A	N	O	P	Q	R	S	T	U	V	W			
400	7-7	6	1¼	15	12	4-6	3-0	16-4	11-0	16-1	15½	9	5
500	7-7	6	1¼	15	12	4-4	2-10	16-4	11-0	16-1	15½	9	5
600	8-4	8	1¼	18	14	4-0	2-6	17-1	11-9	16-10	19½	10	5
800	8-4	8	1¼	18	14	3-9	2-3	17-1	11-9	16-10	19½	10	5
1000	8-9	10	1¼	21½	17	4-9	2-6	18-6	12-7	18-0	24	12	10
1200	8-9	10	1¼	21½	17	4-6	2-3	18-6	12-9	18-0	24	14	10
1400	8-9	10	1¼	21½	17	4-6	2-3	19-0	12-9	18-0	24	15	10
1600	8-9	10	1¼	21½	17	4-6	2-3	19-0	13-0	18-0	24	18	10
1800	8-10	12	1¼	25	20	4-0	2-3	19-0	13-9	17-6	27	18	15
2000	8-10	12	1¼	25	20	4-0	2-3	19-6	13-9	17-6	27	18	15
2500	10-5	16	1¼	27½	22	5-0	2-6	21-6	15-2	19-9	30	20	20
3000	10-5	16	1¼	29½	24	5-0	2-6	21-6	15-2	19-9	30	20	20

this being done by the use of shims, but the board drop-hammers of all makes have a cross adjustment; the uprights, together with the entire superstructure, are shifted laterally, the bottom die being keyed securely in the base or shoe. Fig. 2 shows the construction used by a number of builders. The anvil shoe D is keyed and doweled securely into the base, and the bottom die E is keyed to the shoe; both the die and shoe remain stationary so far as cross adjustment is concerned. There is a lug or ear A cast integral with the base, through which there is an adjusting screw. In the more modern hammers, this lug is not tapped, but a nut fits into a pocket at the front of the lug. The uprights are cored to clear this lug, and on some drop-hammers the clearance between the top of the lug and the pocket of the upright is great enough to allow the nut to be removed by hand. Where the point of the ad- blows of the ram will cause a movement of the uprights that will result in excessive wear of the guides. The uprights will also settle into the top of the base, owing to the peening or hammering action, and scale and dirt will enter between the top of the base and the bottom of the upright. To prevent the entrance of dirt, the upright seat is raised above the die seat on at least two well-known designs.

In the design shown in Fig. 3, the lug on the top of the base is dispensed with and an adjusting bracket A is hooked into the base, as shown by the front view. This bracket or plate is made thick enough to serve as a guide for the bottom of the upright. The top of the bracket carries the adjusting screw B, and there are nuts outside of the upright supported by a projection on the base. A flat plate pressing down a block of wood on top of the body of the adjusting screw

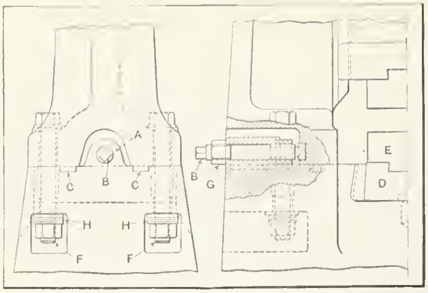


Fig. 2. One Type of Upright Adjusting Bolt

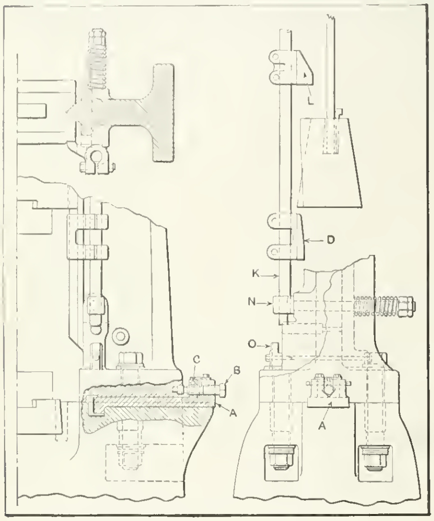


Fig. 3. Front and Side Views, showing Roll-releasing and Tripping Mechanism, and Upright Adjusting Bolt

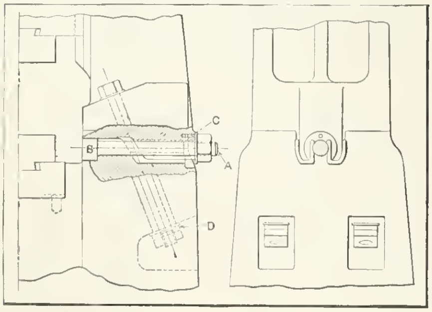


Fig. 4. Another Form of Upright Adjusting Bolt

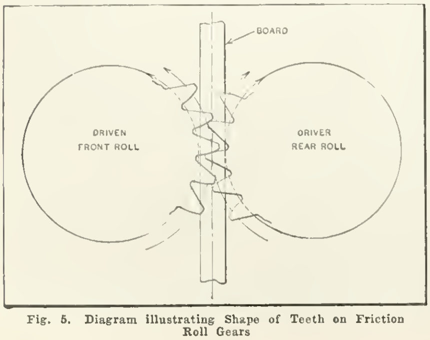


Fig. 5. Diagram illustrating Shape of Teeth on Friction Roll Gears

holds the latter in place. The inserted adjusting nut *C* is split and clamped for a lock-nut. The builder's claim for this construction is that the adjusting nut or screw can be replaced, if necessary, without removing the uprights from the base, which is necessary with the construction shown in Fig. 2 unless the lug is slotted and the upright cored higher. On at least one design, the slotted form of lug is employed.

Cross Adjustment by Bolts in Tension

Fig. 4 shows a method of making cross adjustment by a bolt in tension instead of in compression as in Figs. 2 and 3. The construction is such that in case of failure the old bolt can be replaced with a new one without moving the uprights. The bolt *A* has an eccentric head *B*, the lower portion of which pulls against the base and is resisted by the collar-nut on the outside of the upright. The body of the bolt is held in position by two ribs or supports, one cast on the base and the other on the upright, as shown by the end view. The collar-nut is locked by a horizontal locking pin *C* held out by a spring, and is slotted to receive the beveled point of the locking pin.

The bolts that hold the uprights to the anvil or base are set at approximately 20 degrees from the vertical, thus holding the uprights back against the adjusting collars. Rubber is used as a cushion under the nuts at *D* instead of leather.

It is important to have sufficient bearing surface on the top of the base and the bottom of the upright, as otherwise the weight of the uprights and superstructure will cause the former to "peen down" into the top of the base. In some of the older models of various makes, it is quite common to see the bottom of the uprights peened into the top of the base from 1/8 to 3/16 inch, in from eight to ten years of service.

With the cross adjustment shown in Fig. 6, there is a tension adjusting bolt, but no lugs or ears on either the upright or base. A wide, deep tongue on the bottom of the upright fits into the base for practically its full depth; through this tongue there is a drilled hole to support the body of the adjusting bolt *A*, the head *B* of which is T-shaped and extends across the groove in the base; the collar-nut on the outside of the upright takes all the side thrust. The bolt head is reinforced where it bridges across the guide, to take care of the bending moment. The collar-nut is locked by means of a vertical locking pin *C* and spring. The end of the locking pin is beveled and engages angular notches in the locking collar, thus automatically locking the nut in either direction without the necessity of raising the pin by hand. This construction gives a bearing over the entire top of the base upon which the uprights rest.

By removing the anvil shoe from the base, the frame adjusting bolts can be removed and replaced without raising the uprights. Heavy springs *D* under the nuts cushion the bolts and allow the uprights to be adjusted without loosening the nuts. The cored pocket in the base is of such a shape that in case a bolt fractures, with the long end in the base, it can be removed readily.

Automatic Knock-offs or Bottom Trips

The trip mechanism for automatically throwing the friction rolls into engagement with the board when the hammer is at the bottom of its stroke should be so designed as to take almost any thickness of dies and it should be readily adjustable, so that the rolls can be thrown into engagement with the board as the hammer rebounds from the bottom die. Tripping too soon cushions the blow, because the rolls engage the board and tend to lift the hammer before it strikes its blow. On the other hand, if the knock-off is set too late, the hammer rebounds and falls back before the rolls come into engagement with the board. This means picking up a dead load from rest, which wears the board even more rapidly than tripping too soon. The greatest amount of wear on the board takes place at the point of pick-up or where the rolls first come into engagement with the board.

In general principle, the trip mechanisms of the drop-hammers made by the E. W. Bliss Co., Chambersburg Engineering Co., Waterbury Farrel Foundry & Machine Co., and United Engineering Co. are all the same. The lower face of the hammer (see Figs. 3 and 9) is planed on an incline to correspond to the incline of the knock-off bracket *D*, which is clamped to the lower end of the friction bar *K*. As the hammer descends, the friction bar, which is attached to the front roll eccentric, is pushed off its seat. The falling of the bar throws the rolls into engagement with the board; the weight of the bar is sufficient to hold the rolls against the board with enough friction to lift the hammer to the top of its stroke, where the front roll is released, as will be described later. As the lower end of the friction bar is raised above its seat or shelf by the upward movement of the hammer, a spring-

operated guide N pulls the friction bar in on its seat, locking the roll in the release position, ready for another blow. So long as the board clamps are released by depressing the foot-treadle, the hammer will strike continuously.

Adjusting Automatic Trip for Different Dies

To adjust the knock-off D (Figs. 3 and 9) for different thicknesses of dies, so that the rolls will come into contact with the board as the hammer rebounds, it is simply necessary to shift the knock-off on the friction bar until the bar is timed to fall at the same instant that the hammer rebounds. In setting the knock-off it should not be forgotten that the hammer falls several feet and has considerable velocity when it passes the knock-off, whereas the friction bar starts from rest as it is tripped from its seat and falls about four inches. It can readily be seen that the location of the knock-off on the friction bar will vary not only for the thickness of the dies but also for any great variation in the stroke of the hammer, being set high for a long stroke or thick dies, and low for a short stroke or thin dies.

On the Billings & Spencer drop-hammer, a knock-off plug J, Fig. 7 (see also j, Fig. 1), is forced back by an incline on the hammer a distance x, when the stop-pin B is free to fall through the elongated hole in the knock-off plug, thus allowing friction bar K to fall until the stop-pin bracket C strikes the rubber cushion D. When the roll-releasing lever L raises the friction bar enough for the stop-pin B to clear the knock-off plug J, a spring S pushes the latter forward under the stop-pin. The adjustment for different thicknesses of dies is made by swinging the stop-pin bracket C in an arc and again locking it to the friction bar, thus increasing or decreasing the distance x that the plug J must be pushed back before the stop-pin can fall through.

Fig. 14 shows the Williams, White & Co.'s construction which was also used on the old Bausch drop-hammer with but slight modification. The knock-off A is clamped adjustably to a short vertical bar B behind the friction bar K and a "catch-up" C, fastened to the bottom of bar B, is given a rotary movement and is thus disengaged from a slot in the friction bar when the hammer descends. The time of release depends on the vertical location of the knock-off A. The thickness of the dies that can be used depends on the amount that the knock-off can be adjusted along this bar.

Bottom Stop for Friction Bar

After the hammer has fallen, the power required to start it upward depends upon the amount of rebound, which, in turn, is affected by the nature of the work and the solidity of the blows. The first few blows on the heated stock are accompanied by considerably less rebound than when the forging is about completed and the dies are close together, because in the latter case the upper die strikes more solidly. Evidently the full gripping effect of the rolls should be exerted on the lifting board later when there is considerable rebound in order to secure the advantage of the rebound. The final gripping of the rolls is retarded somewhat, when solid blows are being struck, by a slight rebound of the friction bar.

A bottom stop O (see Figs. 3 and 9) consisting of a small piece of steel is located below the friction bar so that the latter can only drop a predetermined distance, which, in any case, must be sufficient to give the rolls the required frictional grip upon the lifting board. Now when the hammer is striking soft heated stock, the friction bar, as it is tripped, does not fall with the same force as when the hammer is working "die to die" and is striking more solidly, because these solid blows result in a quicker downward movement of the bar; consequently the friction bar rebounds more and the rolls grip the board later when the hammer is striking solidly, so that the upward rebound is not checked but gives the hammer a start before the friction rolls grip the lifting board tightly. On the other hand, when the blows are upon soft and more plastic stock, the fall of the friction bar is not affected by the blows to the same extent, and as there is little rebound to the bar, the rolls grip the lifting board with full force at the same time that the bar reaches the end of its downward movement; hence, the full power of the rolls is obtained just when it is needed.

The bottom stop also serves another purpose in that it prevents the friction bar from falling a greater distance each time, thus wearing a deep groove across the board at the point of pick-up. As the bar and its attached parts must be heavy enough to give the required gripping pressure for lifting the hammer and die, this gripping effect would be excessive for light dies at the instant that the bar reached the lower end of its fall if there were no stop to arrest its downward movement, and a groove would soon be worn in the board. Leather

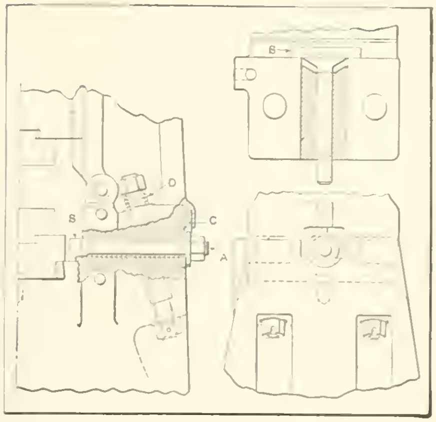


Fig. 6. Upright Adjusting Bolt of T-head Pattern

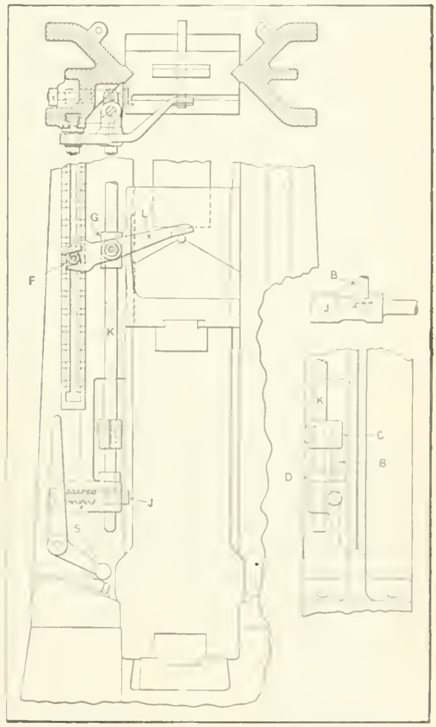


Fig. 7. Detail View of Releasing Lever and Automatic Trip of Drop-hammer shown in Fig. 1

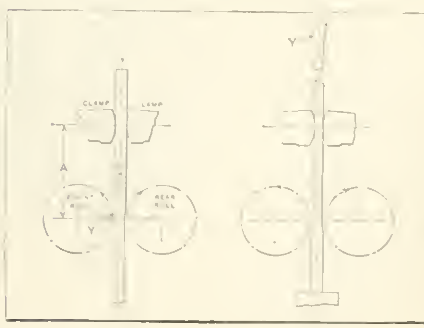


Fig. 8. Board Clamps located above Rolls

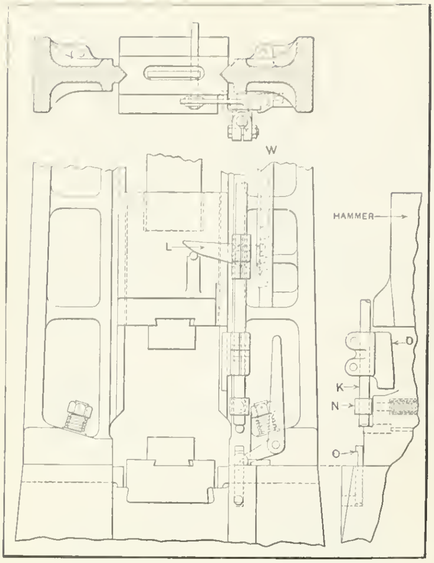


Fig. 9. Automatic Trip Mechanism—Rack and Segment Lever for Stroke Adjustment and Roll Release

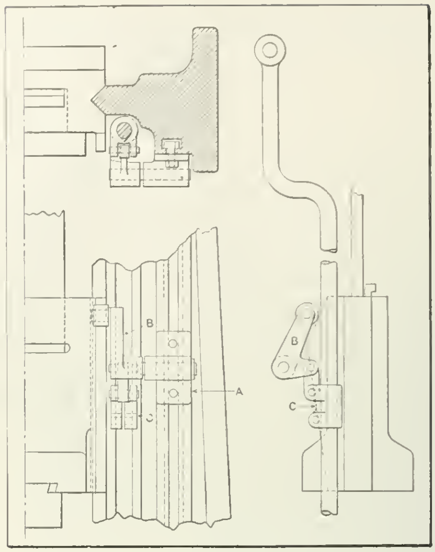


Fig. 10. Bellcrank Tripping Lever equipped with Roller

washers are placed under the bottom stop to cushion the fall of the friction bar.

It is evident from the foregoing that the first point of contact between the friction rolls and lifting board will vary with the variation of the rebound of the hammer, thus distributing the wear on the board. When a hammer is used continually upon a class of work that causes very little rebound, the wear is concentrated at one point, and the result is that the board does not last nearly as long as when a hammer is used for a more diversified line of work.

Roll-releasing Mechanisms

The general principle of the roll-releasing mechanism, which is the oldest and most common type, is illustrated in Fig. 3. It consists simply of a bracket *L*, which is clamped to the friction bar. This bracket has an extension that is engaged by the ascending hammer, thus raising the friction bar and releasing the rolls. This form of release is positive in action, but the mechanism is subjected to rather sudden shocks, owing to the fact that the heavy friction bar and attached parts are instantly started from rest and given the same upward velocity as that of the hammer.

With the construction shown in Fig. 10, the right-hand upright is cored for a T-slot to which an adjustable bracket *A* is clamped. This bracket carries a bellcrank or releasing lever *B*, the roller of which projects into the path of the hammer. There is an incline or cam path on the front of the hammer, the lower part of which operates the automatic knock-off, and the upper part, the roll release. As the hammer comes into contact with the roller on its upward stroke, the friction bar is raised at a much lower velocity than the hammer, the rate depending on the ratio of the arms and the angle of incline on the hammer. The adjustment for different lengths of stroke is made by changing the location of the lever bracket *A* in the T-slot and the friction-bar bracket *C* connected with the lever by a link.

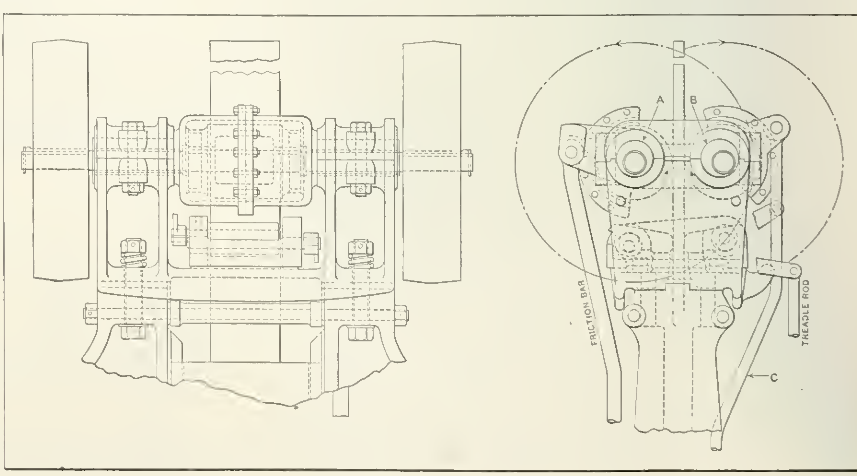


Fig. 11. Lifting Head having Eccentric Adjustment for Front and Rear Friction Rolls and Board Clamps

With the Billings & Spencer release mechanism shown in Fig. 7, a lever *L* is pivoted on an adjustable bracket *G*, clamped to the friction bar. The long end of the lever projects into the path of a wood or fiber hammer pin, and the short end slides on a block that is pivoted at *F* to a bracket engaging a notched rack. The upward velocity of the friction bar is lower than that of the hammer in proportion to the ratio of the two arms of lever *L*, which is usually about 3 to 1. Variation in stroke is obtained by adjusting the friction-bar bracket *G* and the bracket *F*. The latter, in addition to a bolt for clamping, has a tongue that fits into one of the slots on the upright so that the bracket cannot slip.

The friction bar of the roll-releasing mechanism shown in Fig. 9 is practically straight, and the roll-releasing lever *L* is located on the inside of the friction bar, or next to the upright. The releasing lever is also straight and the end is in the form of a segment with teeth that engage a shrouded steel rack bolted to the upright. The adjustment for variation in stroke is made by simply loosening the clamp bolts in the lever bracket, taking hold of one end of the lever, and sliding the bracket along the friction bar until the teeth of

the segment are out of engagement with the rack; the segment lever will then slide freely to any position desired, when the teeth of the segment are again engaged with the rack and the bracket bolts tightened. One of the advantages claimed for this design is that it gives a greater travel to the friction bar in releasing than a simple lever, because as soon as the hammer pin comes into contact with the lever *L*, the segment moves up along the rack, thus constantly changing the pivot point.

A novel form of key such as is shown at *W*, Fig. 9, is used on practically all drop-hammers to prevent the releasing-lever bracket from turning on the friction bar. The front of the friction bar is flattened and the bracket is slotted out to form a seat for a triangular key. Thus it can readily be seen that as the clamp bolts are tightened, the key will effectually prevent the bracket from turning.

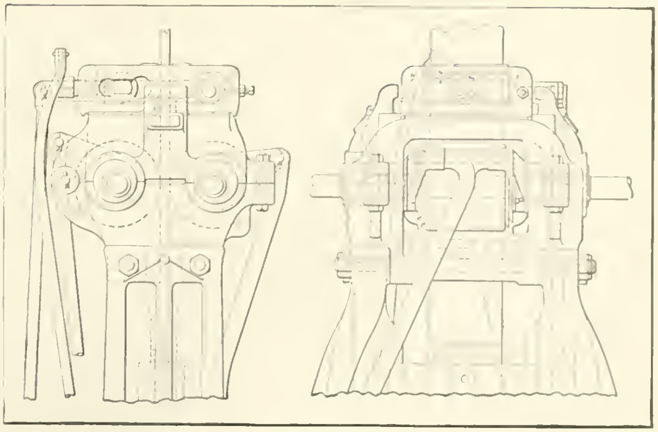


Fig. 13. Lifting Head having Eccentric Adjustment and Board Clamps above Friction Rolls

Head or Lifting Mechanisms

In all board drop-hammers, from the earliest types, the ram or hammer has been raised by rolls running in opposite directions, and the pressure is applied and released by one of the rolls (usually the front) which is mounted in or on an eccentric; the weight of the friction bar and its attached parts serves to hold the roll against the board, and the opposite roll is generally constructed so that it can be adjusted to compensate for wear of the board. Compressed air, steam and solenoid magnets have been used for operating the friction rolls. As early as 1907 the solenoid magnet received serious consideration, but at the time it seemed impossible to get a satisfactory magnet that would carry the necessary load and operate fast enough without heating and later crystallizing. Compressed air was used by one manufacturer of drop-hammers for a time, but the difficulty of keeping the joints tight was so great that the old friction bar construction was again employed.

Fig. 15 shows a side view of one design of head or lifting mechanism. This type of head is used with the latch or "catch-up hammer" previously referred to. The concern that builds this head also builds the board clamp type, but the roll and eccentric constructions are the same. The front roll is carried in two sliding boxes or bearings that are connected by links to a one-piece eccentric at the front. An arm keyed to one end of the eccentric is connected with an auxiliary wooden friction bar. The main friction bar is connected to the wooden bar by a bracket at the bottom. The roll release is in the form of a single bracket clamped to the friction bar, the arrangement being similar to that shown in Fig. 3. As the friction bar rises and falls, the front bearings approach toward and recede from the board on a straight line. The rear bearings are used to make adjustment for wear of the board, and are held in place by means of a set-screw and pull-back bolt behind each bearing.

Another design of lifting mechanism is shown in Fig. 19 The front roll eccentric is a one-piece steel casting. With this construction the roll and shaft have to be finished separately and the shaft is pressed into place by putting the roll in the hood and inserting the shaft through the ends of the eccentric. The bronze bushings are put in from the outside and pinned, and the walls are heavy enough to allow the key to pass through.

Front and Rear Eccentric Adjustment

The lifting mechanism shown in Fig. 11 is somewhat like the old Stiles head built in 1872 in that both the front and rear rolls and the board clamps are mounted in eccentrics; the front eccentric *A* is for operating and the rear eccentric *B* for adjustment. Both the rear roll and board clamp are connected to bars extending down the back of the uprights, so that adjustment for wear of the board can be made from the floor. The claim made for this construction is that the rolls and clamps are always in line. The roll eccentrics are hooded and are made in two pieces, and tongued and bolted in the center so that the roll and shaft can be finished together at one setting. The ends of the eccentrics can also be slipped over the ends of the shaft and roll and bolted in the center. The bronze bushings are fitted in the eccentrics from the inside before the eccentrics are bolted together. With this construction, new bushings can be put in without pressing the roll from the shaft The plan view shows how the front eccentric arm is offset so that practically a straight friction bar can be used

Another design of lifting mechanism with eccentric roll adjustment is shown in Fig. 13. The eccentric for adjusting the rear friction roll is a duplicate of the one used for engaging

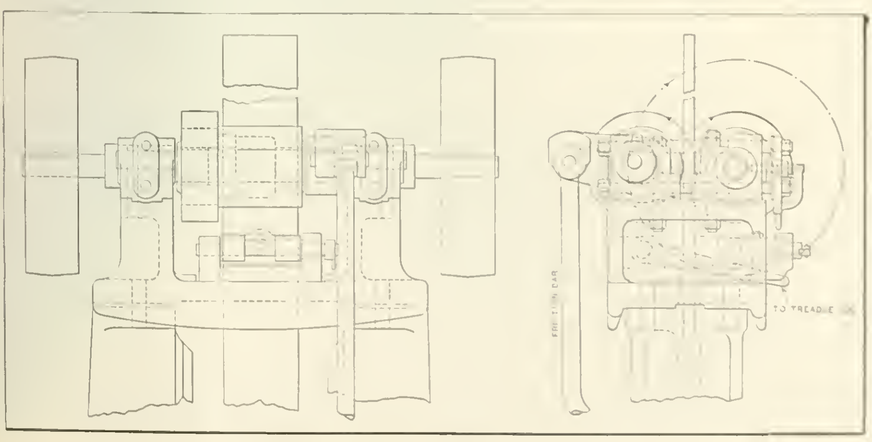


Fig. 12. Lifting Head equipped with Geared Friction Rolls

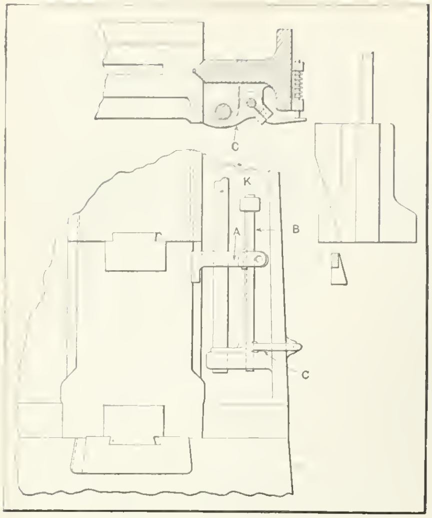


Fig. 14. Trip Mechanism of Swinging-latch Type

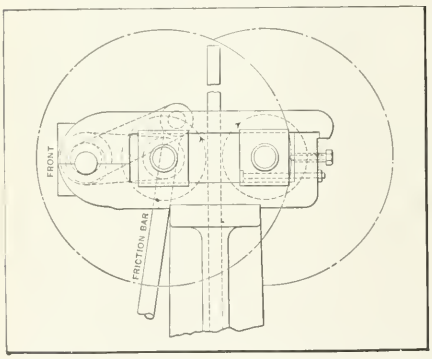


Fig. 15. Lifting Mechanism for Drop-hammer of Latch Type

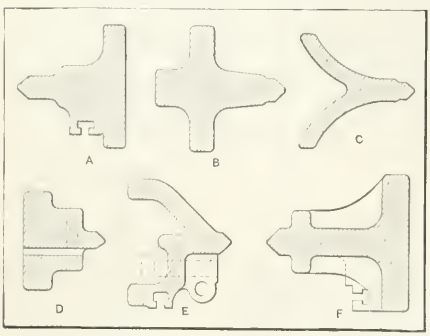


Fig. 16. Cross-sections of Drop-hammer Uprights. (A) Waterbury Farrel Foundry & Machine Co. (B) United Engineering Co. (C) E. W. Bliss Co. (D) Billings & Spencer Co.—Model B. (E) Billings & Spencer Co.—Models C and D. (F) Chambersburg Engineering Co.

the front friction roll. The adjustment of both the rear friction roll and of the rear board clamps is effected by means of bars extending down the rear sides of the upright to a point within easy reach of the operator, the same as in the design shown in Fig. 11. The lower ends of these rods pass through lugs and they are adjusted vertically by means of nuts above and below the lugs. The top of the head or lifter is cored out to form an oil reservoir, which is made large enough to hold several quarts of oil. Oil ducts with wicks lead down into the reservoir.

Geared Drive for Friction Rolls

The rolls of the lifting mechanism shown in Fig. 12 are geared together and both belt pulleys are mounted on one shaft instead of having a pulley on each shaft driven by open and crossed belts. The diagram Fig. 5 shows the shapes of the gear teeth. As the rolls always run in one direction, only one face of each tooth is an involute; the backs of the teeth are straight and coincide with a line drawn tangent to a circle somewhat smaller than the root circle and starting from a point so that the top of each tooth is approximately ¼ inch wide. When the rolls are geared (which is the arrangement on several well-known drop-hammers) the driving pulleys are both on the rear shaft, and the front roll runs free on an eccentric similar to the board clamp eccentric. The claims for this construction are that the belt pull is even on both bearings, a cross belt is avoided, and a constant velocity ratio is maintained between both rolls. The greatest bearing pressure, however, is due to the roll pressure against the board. The gearing is also subjected to considerable wear, as the teeth only bear on the points when the board is new, and the limit to the adjustment for board wear is the amount that the gears can be adjusted before the teeth bear at the bottom, which is usually about 5/16 inch. Instead of using geared friction rolls, both the front and rear rolls of several other well-known drop-hammers are driven by separate belts; one belt is open and the other crossed, if the drive is from one lineshaft.

The roll shaft bearings shown in Fig. 12 are separate from the main head casting, being tongued and bolted to the top. The pressure from the rolls in contact with the board is taken by tie-rods. The position of the front bearing is stationary, but the rear bearing is adjustable and the pressure is transferred from the adjusting stud through a nut to a plate or bar connecting the tie-rods and thus to the tie-rods themselves. The rear roll is keyed or otherwise fastened to the driving shaft and carries both driving pulleys. The front roll runs free on the eccentric shaft. The gears connecting the rolls are usually of steel castings and are screwed into the end of the cast-iron roll. The lifting mechanism is held in line with the uprights by a tongue or guide, and is attached to the top of the uprights by four through bolts. The bolts on the right-hand or friction-bar side are a tight fit, but those on the left-hand side have slotted holes to permit adjustment for wear of the hammer guides. Taking up for wear on the left-hand side only, keeps the friction bar perpendicular.

Oil Guards for Friction Rolls

Oil on the board has always been a bother to the hammer user because the friction rolls and board clamps cannot grip an oily board properly, and a certain amount of oil will work out of the bearings and get on the board in spite of all that can be done in the way of wipers, oil guards, etc. Fireclay or soft coal dust applied to the surface, usually crushed in from the face of the clamps, presents a good gripping surface but does not help the edge of the planing tools if the boards are replaned. The right- and left-hand V-threads shown on the ends of lifting roll *A* in Fig. 17 provide an effective oil guard for the rolls. The threads carry the oil back and away from the body of the roll. As the rear roll runs in the opposite direction, the threads are reversed. The oil guard shown at *B* consists of flanges inclining away from the body of the roll; this guard depends on centrifugal force to throw the oil off.

Control of Board Clamps

The board clamps act as toggles and hold the hammer or ram suspended by gripping the board. The front clamp is usually mounted on an eccentric and is connected to a foot-treadle by means of a lever and rod as shown in Fig. 1. As the foot-treadle *h* is depressed, the treadle rod and the treadle lever which is connected to the front clamp are raised. As the front eccentric is located above the center of rotation, the front clamp is drawn back from the board, thus releasing the hammer. To strike a hard blow, the treadle is fully depressed, completely releasing the clamps; to cushion or stroke a light blow, the treadle is only partially depressed so that the board drags through the clamps at the velocity desired. If a single blow is desired, the treadle is depressed until the hammer strikes its blow, when it is released. For a series of blows, the treadle is held down and then the hammer operates automatically until the treadle is released. Both clamps should be mounted on shafts free to lift and relieve themselves when the board is going up and the treadle has been released to lock the clamps. The instant the board starts downward the friction against the side or face of

the board clamps causes them to grip the board instantly, the weight of the hammer tightening the grip.

Floating Board Clamps

From the beginning of drop-hammer development, it was hard to keep a board true, and for this reason Stiles patented the floating board clamp in 1872. This type of clamp is free to move in any direction to allow for a warped board and thus prevent the board from bearing heavily against either roll, which would quickly heat the rolls and prevent the hammer from falling free. The board clamp eccentrics of some early designs are fitted directly into the main head casting instead of in a floating bracket; this construction was soon discarded for the floating clamp, as it was found that boards could not be used where they were warped or twisted to any extent.

The rear clamp is adjusted to compensate for wear of the board by means of set-screws and lock-nuts behind the rear clamp holder on several designs of drop-hammers, whereas eccentrics are utilized on other makes. In the design shown in Fig. 11, the front and rear clamp eccentrics are duplicates and the rear eccentric is used for adjustment only; a lever clamped to the end of the eccentric connects with a bar or rod that leads down the back of the left upright and is locked in position within easy reach of the operator, as previously mentioned. The adjustment of the rear clamp on another design is made by a taper wedge behind the clamp, which is connected to a bar extending down the back of an upright. An earlier model of the same make of hammer was equipped with a screw adjustment as shown in Fig. 13.

Location of Board Clamps

The board clamps are below the friction rolls on the lifting head shown in Fig. 11 and above the rolls on the design shown in Fig. 13. When the clamps are located above the rolls the oil from the roll bearing cannot reach the clamping surfaces and thus reduce the effectiveness of the grip on the board. Many drop-hammer manufacturers and users, however, contend that it is better to have the board clamps below the rolls for the following reasons: When the clamps are above the rolls as indicated by the diagram Fig. 8, they must grip the board on a surface that passes between the rolls at every stroke, as indicated by the right-hand view which shows the hammer in its upper position. If the same stroke is used for a long time the clamps make an impression in the board at the point where they constantly grip it; moreover, the boards on all makes of hammers wear more or less tapering from the point of pick-up to the point of release, which makes it more difficult for the clamp to secure a good grip. The result is that the board sometimes slips through the clamps until they engage the point of pick-up, leaving the hammer suspended at a height equal to the distance A, between the center line of the rolls and the center line of the board clamps.

That part of the board above the point of pick-up is never engaged by the roll, but must pass through the clamps before the hammer can strike its blow. The result is that when a board is badly worn, if the clamps are set tight enough to grip the board on the thin part, the force of the blow is cushioned or retarded when the thick part of the board passes between the clamps. Gripping the board on a surface that passes between the rolls also requires adjustment to compensate for the change in the thickness of the board. For cushioning the blow in drawing work, edging, etc., the location of the clamps above the rolls is an advantage, because when the treadle is lightly depressed the board slips through the clamps, until the thick part of the board above the point of pick-up is wedged between the clamps, thus arresting the movement of the hammer before the die strikes unless the treadle is further depressed. When the clamps are below the rolls, as indicated by the diagram Fig. 18, they grip the board when the hammer is at the top of its stroke at a point which never passes between the rolls; consequently this gripping surface is not worn except by the action of the clamps, and when the treadle is released there is no enlarged point of the board to interfere with the fall of the hammer.

On the other hand, it is claimed that if the clamps are designed with sufficient action or throw to the eccentric actuating them there is no more tendency for the board to slip through the clamps when they are above the rolls than when below the rolls. Moreover, if the clamps have a sufficient radius of action, it is contended that the force of the blows will not be cushioned or retarded by the thick part of the board above the point of pick-up, unless this cushioning effect is desired by the operator, in which case it is obtained by the foot-treadle control. While it is true that little or no adjustment for board wear is required when the clamps are below the friction rolls, the adjustment, in any case, can be made easily and quickly on drop-hammers having the extension rods at the rear of the uprights.

The manufacturers of the design of drop-hammer, the upper part of which is shown in Fig. 13, claim a safety feature in that if the board slips through the clamps owing to the jar of adjacent hammers in operation, the descent of the hammer will be stopped before the dies come together, because the thicker or unused portion of the board reaches the clamps

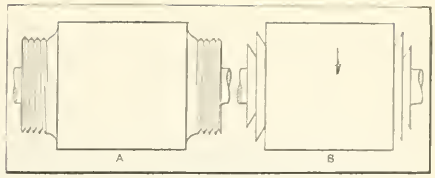


Fig. 17. Friction Rolls provided with Oil Guards of Different Types

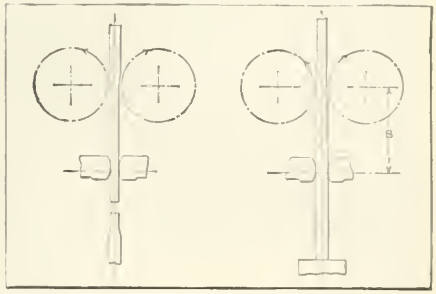


Fig. 18. Board Clamps located below Rolls

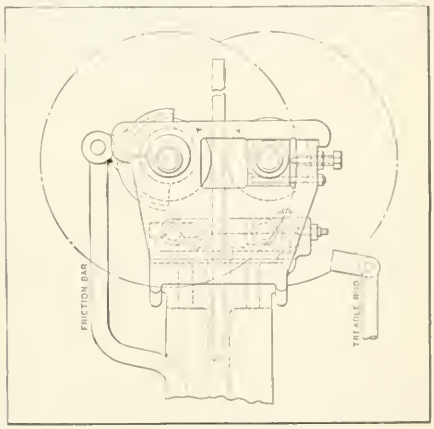


Fig. 19. Lifting Head having eccentrically mounted Front Roll and Bolt Adjustment for Rear Roll

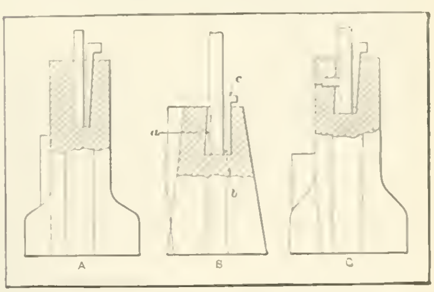


Fig. 20. Methods of holding Lifting Boards in Hammers. A) Billings & Spencer Co. B) E. W. Bliss Co. C) Chambersburg Engineering Co.

before the dies touch each other, so that there is a space between the dies of eight or ten inches. With the clamps below the rolls, they would not engage this thick part of the board above the point of pick-up, so that in case of slippage the fall of the hammer would not be retarded, but advocates of the latter design contend that the board is not so likely to slip when the clamps are placed below the rolls for the reason previously given.

In the production of drop-forgings it is desirable in most cases to strike a light final blow, especially where the forging is hot-trimmed, because the trimming operation often bends the forging slightly and the final blow is necessary to straighten it. This blow should preferably be a light one, as otherwise it will form another fin on the forging which must eventually be ground off. Furthermore, in making a great many forgings that are finally cold-trimmed, cutters are used on the hammer for cutting the forging from the bar, and it is desirable to use a light blow for this cutting-off operation. With the clamps above the rolls, this light blow may readily be obtained, owing to the cushioning effect of the enlarged part of the board, whereas when the clamps are below the rolls it is more difficult to secure the proper cushioning effect. The fact that the location of the clamps above the rolls keeps them free from oil is a feature recognized by the advocates of both designs.

Cross-sectional Shapes of Uprights

The cross-sectional shapes of the uprights on different makes of drop-hammers are shown in Fig. 16. There is a single V-shaped guide that is cast integral with each upright. The bolt holes at the upper and lower ends of the upright are elongated to allow for lateral adjustment in order to compensate for wear between the guides. As the V-shaped ways on the upright are longer than the average stroke of the hammer, they wear faster at the bottom than at the top, and for that reason the ways are planed open at the top, the amount depending somewhat upon the size of the drop-hammer. The manufacturers represented by the various uprights illustrated in Fig. 16 are as follows: *A*, Waterbury Farrel Foundry & Machine Co.; *B*, United Engineering Co.; *C*, E. W. Bliss Co.; *D*, Billings & Spencer Co., Model B; *E*, Billings & Spencer Co., Models D and C; *F*, Chambersburg Engineering Co.

Methods of Holding Boards in Hammers

Three methods of attaching boards to hammers are illustrated in Fig. 20. The method employed in the Billings & Spencer drop-hammer is shown at *A*. The mortise for receiving the board is comparatively deep in order to insure a good frictional grip, and the board is held in place by several wedges which bear against a thin plate placed between the wedges and the board.

The method used by the E. W. Bliss Co. for attaching the board to the drop-hammer is illustrated at *B*. Before placing the board in the hammer head, a sawtooth taper wedge *a* should be placed in position in the recess in the hammer, with the thick part down and the teeth bearing against the board, as the illustration indicates. After inserting the board in the mortise, the taper plate *b* should be set in back of it, with the thick part down, and three or four taper keys *c* then driven in. The inertia due to the falling hammer and the weight of the keys tends to drive them in, thus holding the board securely.

The method adopted by the Chambersburg Engineering Co. is illustrated at *C*. This is similar in principle to the arrangement just described, although the board grip differs somewhat in form. These holding plates or board grips are placed at the front of the ram and the board wedges are driven in from the rear, a few blows from the light sledge being sufficient. It is not necessary to nick the board for the board grips, as they readily seat themselves after a few blows. The under-cut or angle at the front of the hammer holds the grips in position, and they are further secured by means of pins which also prevent them from being removed with the board.

Relative Fields of Board and Steam Drop-hammers

Board drop-hammers can be used economically on small work that requires but little "breaking-down" or forging into shape, and the weight of the ram most commonly used is from 500 to 2000 pounds. Work requiring hammers much heavier than this generally needs considerable breaking-down and, with few exceptions, can be done to better advantage in a steam drop-hammer or forging machine. A properly designed modern board drop-hammer on light work that requires but little "edging" or breaking-down, will hold its own against the steam drop-hammer at two-thirds the upkeep cost. For work that requires more than a few blows to finish it, the steam drop-hammer will produce almost one-third more work per day, but the operating cost will be higher.

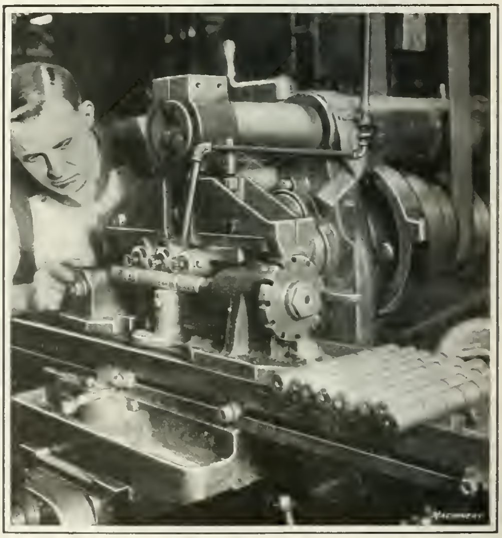
Most modern board drop-hammers run so fast on their minimum stroke that the operator has just time to change the work from the break-down to the finishing impression. The small steam drop-hammers usually run so fast that on small work it is necessary for the operator to work the treadle for each blow.

* * *

WOODRUFF KEYWAY MILLING ATTACHMENT

The milling attachment shown in the accompanying illustration is one of the numerous contrivances for increasing production in use at the plant of the Maxwell Motor Co., New Castle, Ind. This milling attachment consists of a casting, the upper portion of which is bored out to fit the over-arm of the milling machine, while the lower portion has three bearings attached to it for the three key cutter shafts to run in. The cutter shafts are driven by gears from the main driving spindle of the milling machine. The machine for which this attachment was designed is a plain Cincinnati No. 2 milling machine.

The magneto gear shaft which is mounted on the centers is made of nickel steel and has three Woodruff keyways cut in it, the sizes of which are Nos. 8, A and 5. The speed at which the cutters are run is 225 R. P. M. All three keyways are cut simultaneously. The magneto gear shaft is mounted on the centers as shown, and the table is raised on the vertical column until the desired depth of keyway is secured. The production from this operation is 450 shafts per ten-hour day, which is approximately three times as much as was secured when one keyway was milled at a time on a hand milling machine. V. B.



Milling Three Woodruff Keyways Simultaneously

AUTOMOBILE CUSHION SPRINGS*

METHODS OF JAPANNING AND MEANS OF CONVEYING PRODUCT

BY E. F. LAKE†

THE methods of manufacturing the springs used in upholstering the cushions of an automobile are rapidly being revolutionized. As none of the automobile companies have thought it advisable to manufacture their own cushion springs, owing to the fact that this business has been specialized by wire spring makers, the result has been that those making coil springs have increased their plants and enlarged their business to such an extent that special and automatic machines, as well as other labor-saving equipment, are now being sought to lower the cost of production.

The Jackson Cushion Spring Co., Jackson, Mich., decided to make some radical changes in its methods a few months ago, and to this end called upon the writer to study its manufacturing methods, gather data and make suggestions as to what might be done to lower the cost of production. The equipment illustrated and described in this article is the direct result of the suggestions made. After the equipment had been in operation four weeks, it proved so successful that the company ordered some five hundred feet of track added to the trolley system and a second japan dip tank installed with its hoisting apparatus. Since this time other additions have been made to the trolley track and spring carriers.

Description of Equipment

The complete equipment consists of 1800 feet of trolley tracking; a japan dip tank 10 feet long, 2½ feet wide and 6 feet deep; an electric hoisting apparatus over the dip tank; a drain board 25 feet long; a three-compartment japan baking oven 50 feet long; and a fuel oil plant to furnish heat to the oven. Fig. 1 shows a section of the trolley system from the middle of the shop looking north. Along the right side of this picture the springs may be seen hanging from the spring carriers and trolleys that are located on numerous side tracks. A somewhat better idea of the general arrangement of these may be obtained by an inspection of the plan view, Fig. 3, in which the sidings are shown at *A*. The letter *A* also denotes the same part in Figs. 1 and 2.

Construction of Spring Carriers

At this point the work is started by hanging the springs on spring carriers, several of which may be noted empty and hanging from different parts of the track. The details of construction are more clearly shown in Fig. 6. The body of the carrier is formed of a 2-inch gas pipe which has caps screwed on each end, the entire length being 8 feet, 4 inches. Six of these carriers just fill an oven compartment which is 50 feet, 2 inches long on the inside. The hooks on which the springs are hung are made by bending ⅜-inch strong steel rods to the desired shape and springing them along the gas pipe. It will be seen that they can be easily adjusted along the pipes by sliding, to allow for springs that differ in thickness. The bolts *H*, Fig. 5, pass through the gas pipe and into four-wheel roller bearing trolleys that roll inside the tracks. These ¾-inch bolts support the gas pipe carrier with its load of springs in such a way that it can be readily pushed to any part of the trolley system. It will be seen that the carriers are very simple and cheap in their construction. As soon as a carrier has been completely loaded, it is switched onto the main line track *B*, Fig. 1, from which it is rolled into the japanning room. At the left may be seen two side tracks *C* where springs can be switched and stored while waiting their turn to be dipped in the japan tank. Fig. 2 shows this trolley system looking south from the far end of Fig. 1. The curves and track that carry the work from both ends of the shop and switch it into the japanning room are shown at *D*. At *E* may be seen one of the spring assembly or inspector's benches where the springs are loaded on the carriers. The work is switched from bench sidings to the main line on one of the curves shown at *F*.

Referring once more to Fig. 3, the ten sidings at which the springs are loaded on the carriers by the inspectors can be seen at *A*; the curve *F* and the switches that turn the work into the main track are a part of these sidings. The plan view which shows the track in outline also gives a good idea of the layout of tracks leading into the japanning room; the japan dip tanks; the drain boards; the three-compartment japan baking oven; the room where the springs are crated; the doors through which these are loaded into the freight cars and the door through which the empty spring carriers are returned to the siding *A* to be reloaded. Four lines of track lead to the japan dip tank and three of these tracks converge at the tank, while the fourth comes from the opposite side

* For previous information on springs published in MACHINERY, see "Wire Springs" in March, 1915, and articles there referred to.
† Address: 352 Belvidere Ave., Detroit, Mich.

Fig. 2. Trolley System, looking South from North End

Fig. 1. Trolley System, looking North from Center

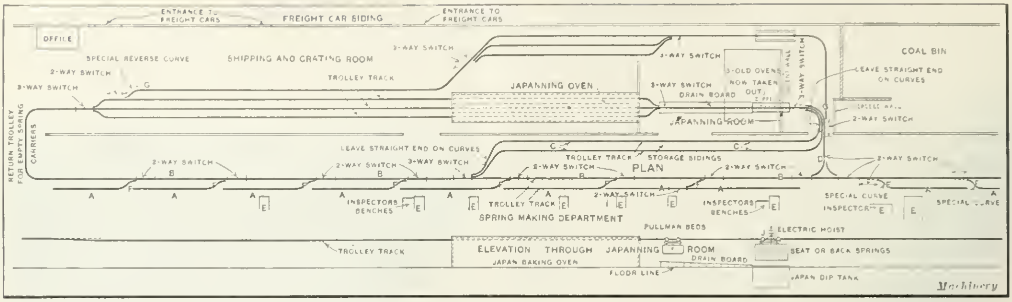


Fig. 3. Plan and Elevation of Trolley System for handling Cushion Springs

of the shop and is switched to one of these three in the other room. After running over the dip tank and drain board, the trolley system again branches out into three tracks, one of which goes to the center of each of the three compartments in the japan baking oven. Once more the three tracks converge into one where the empty spring carriers go through the door to return to the inspector's benches for reloading.

Prior to the installation of this trolley system, the work was loaded on floor trucks similar to those shown in Figs. 1 and 2. This method of handling caused considerable trouble, as the trucks would accumulate along the wall and it was a daily occurrence for this gangway to be so full of trucks that another one could not be pushed through without moving some of those already there. Assembled springs were frequently thrown to the floor while waiting for trucks to be extricated from the jam and emptied, all of which necessitated extra work in handling the springs and interrupted the steady movement of the work in one direction. It can easily be seen that a trolley system of this kind is a great labor saver by keeping the work moving in one direction in a continuous procession, the empty carriers coming back around the other end of the loop. The arrangement of the track is such that it would be impossible for the work to travel backward, as it would be blocked by the work that was coming forward. The illustrations Figs. 1 and 2 were taken at a time when the production of springs was at its height, and they plainly show how little chance there is for congestion. During January, when the old method of handling was in use, it was difficult to walk through this gangway on account of the number of floor trucks that were in the way. At the time when these photographs were taken, there were from 10 to 15 per cent more springs turned out than in January.

Types of Springs Handled

Fig. 4 shows a collection of springs of different sizes and shapes that are handled by the trolley system with equal quickness and saving of labor. The springs vary from the loose coiled springs sold by the gross to the full size assembled bed spring. The coil springs may be thrown into wire baskets which hang from the work carriers, or they can be tied up into bundles as shown at *Z* and hung on the carrier hooks. Band irons, to which three or four springs are fastened, form an assembly which is called a strip. These strips may be tied into bundles as shown at *Y* and hung on the carrier hooks or thrown loosely into wire baskets hung on the same hook. The individual seat springs *X* are hung from the carriers two and three deep, and a full load consists of from twenty-four to fifty-four springs, according to their thickness. Another type of spring is shown at *W*, this being a back spring for an individual automobile seat. A full carrier load of these springs, hung four deep, would be seventy-two springs. Springs of this type are sometimes used for the sides of rear automobile seats. The springs shown at *V* and *U* are, respectively, the types used for the backs and seats of automobile seats. From twelve to eighteen of these springs form a full load, as they hang but one deep. Springs *T* are used for the beds in the upper berths of Pullman cars.

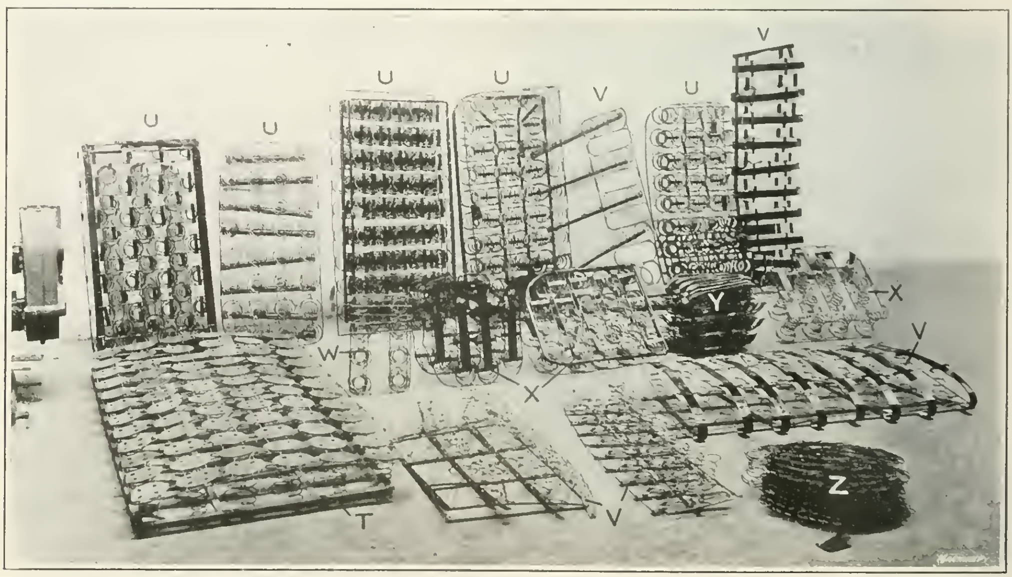


Fig. 4. Springs made by Jackson Cushion Spring Co., showing Variety handled by Trolley System

Arrangement for Japan Dip

Referring to Fig. 5 it will be seen that the four tracks come together to pass through the door into the japanning room and unite at the dipping tank. In the foreground at the upper part of the illustration can be plainly seen the carrier hooks on which the springs are hung. The load of springs *I* is just entering the loose piece of track over the dip tank to be lowered into the japan tank. It may be noted here that the trolley track, with its switches, curves, hangers, etc., is the product of the Richards-Wilcox Mfg. Co., Aurora, Ill. A very good view of the hoisting apparatus is shown in Fig. 6. The electric hoist itself is located in the dog-house overhead, and is therefore not apparent in the illustration. It is, however, a standard type of electric hoist made by the Detroit Hoist & Machine Co., which is geared to lower the cable at the rate of 50 feet per minute, at which speed it has a capacity of 1000 pounds, which is ample, as a load of springs never weighs more than 300 pounds. The two cables *K* are lowered simultaneously from the drum of the hoist, traveling over the sheave wheels *L*, and are leaded into the blocks *M*, which are bolted to the loose track *J*. When the track is lowered, the spring bars *N* push the blocks up into the track to prevent the wheels from rolling out and permitting the load to fall. As the load is raised to its position, the tapered ends of blocks *M* enter holes in the blocks *O* and guide the apparatus back to its correct position. The sheet metal forms *P* at each end of the gap, serve to guide the loose track *J* into correct alignment with the track at both ends.

Fig. 5. Four Trolley Tracks passing through Door to unite at Japan Dip Tank

The electric hoist is started by means of a switch when the spring load is ready to be lowered into the japan, and when the springs are within six inches of the bottom of the japan tank, the hoist automatically reverses and raises the load again to the track. When it reaches the top, another trip automatically stops the hoist when track *J* has reached its proper position and is in alignment with the track at both ends. The trip blocks are movable so that the upper and lower limits of the hoist travel can be set at any point desired. In connection with this japanning operation, a rather unusual procedure was introduced by putting sufficient water in the japan tank to reach within twenty-four inches of the top. Enough japan was then put in the tank to bring the level to within six inches of the top, and as the japan is lighter than water, it always remains on top. Therefore, when the springs are lowered into the bath, they are coated with japan before they reach the water, and as the water cannot wash the japan off, it cannot attack the steel to form rust. The amount of saving will be evident from the statement that approximately fifteen barrels of water and five barrels of japan are necessary to fill the tank to the desired level, so that it is evident that about fifteen barrels of japan are saved.

After the dipping operation has taken place, the casting *R* must be moved out of the way before the spring loads can travel forward once more. This casting acts as a buffer block against which the end of the gas pipe strikes when the springs are rolled onto track *J*, thus stopping the load in the right position to be lowered. This buffer projects from a sleeve which revolves on a casting fastened to the track. After the loose piece of track is raised into position, the slot *T* must be brought opposite the opening in the bottom of the track. The bolts *H* which support the carriers on the trolleys can then pass through and the work travels forward. The buffer is controlled by pulling the handle *S*, to which is attached a wire rope passing over the pulleys shown, the other end of which is fastened to the buffer projection *R*, swinging it back toward the brick wall. This hoisting apparatus is very simple and works much easier than the description might indicate. The springs are lowered into the japan and then hoisted back, carried over the drain board and then to the three compartments of the oven much faster than they can be baked. As each oven compartment is designed to hold six loads and does the baking in twenty minutes, it will be seen that the hoisting apparatus handles eighteen loads every twenty minutes, or fifty-four loads per hour. The capacity of the hoist is ample for the work, and arrangements have been made for a fourth oven compartment which can easily be taken care of by the hoist in case it should be required.

Fig. 6. Dipping Springs into Japan with Electric Hoisting Apparatus

Arrangement of Japanning Ovens

Fig. 7 shows the springs just after they have been dipped, as they are passing over the drain board and into the oven. It will be noticed that each oven door is furnished with a clock dial, and when the door is closed the hands of the dial are set at the time when the compartment was filled with springs. After twenty minutes has elapsed, during which time the japan is baked hard and dry, the operator pulls a wire that rings a bell located at the other end of the oven. This notifies the operator at the other end that one of the compartments has completed its bake, and by ringing the bell one, two or three times,

he is advised which oven is ready for discharge. The operator then pulls the springs out of this compartment and leaves it ready to be recharged. The thermometer shown on each door indicates the temperature in each compartment, and the oil burners can be regulated so that the temperature will be kept uniform at the desired degree.

Owing to the construction of the trolley system, the spring carriers can be easily moved. In fact, one man pulls the entire charge out of each compartment at one time, and as this consists of fifty feet of springs, or six carrier loads, it is evident that the work cannot be difficult since one man does it all day long. The same man also moves the springs to the part of the trolley system where the crating is done before shipping, at any desired point in the 100-foot length of the shipping room that the three tracks pass through.

Old Method of Handling

The old method of handling this work prior to the installation of the equipment mentioned consisted in the use of floor trucks, on which the springs were brought to the japan dip tank. They were then removed from the trucks one at a time and dipped in the japan, after which they were hung on a chain and moved over the drain board by turning a sprocket wheel with a crank. After this, they were removed from the chain and placed on iron trucks which were wheeled into the gas-fired japanning oven and baked. The baking frequently consumed an hour's time, and never less than forty minutes, to get the springs dry and hard enough to ship. After that, the trucks were trundled from the ovens to the shipping room, which usually required moving a number of other trucks (that had accumulated in the passageways) out of the way.

Four men were required on the day shift and four on the night shift to do this work, or a total of eight men for each working day. With the new equipment, one man keeps the springs moving to the electric hoist, another operates the hoist and fills the oven, and the third man pulls the springs out of the oven and delivers them to the shipping department to be crated. It is evident from this that the labor of five men was saved on this part of the work, and allowing for 300 working days per year, the amount saved in wages alone would be $3150. This saving would be increased considerably if the labor costs at the loading and crating end of the trolley system were also included.

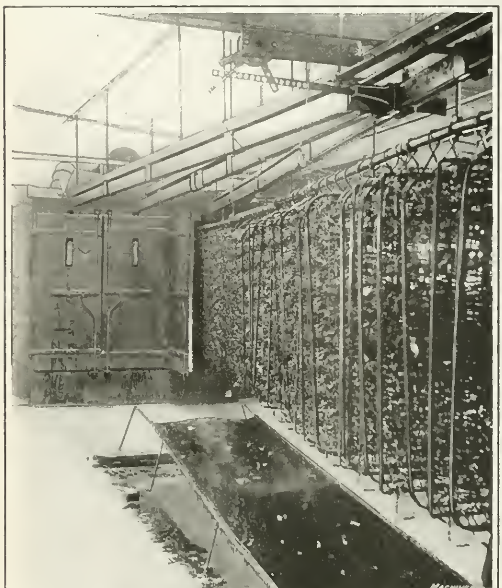


Fig. 7. Springs passing over Drain Board to fill One Compartment of Japan Baking Oven

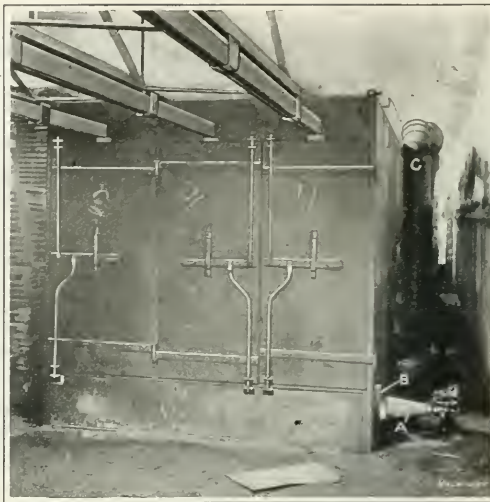


Fig. 8. Back of Oven where Springs are pulled out to be crated. Oil Burners for heating Ovens are shown in Passageway

When the new ovens are run at their full capacity, they will bake 585,000 cubic feet of springs per month of twenty-five working days of ten hours each. The old equipment had a capacity of only 378,000 cubic feet of springs during the month of January when working twenty-one hours per day. Thus, it may be seen that the new ovens have a capacity nearly three times as great as that obtained by the former equipment in a ten-hour day, and 55 per cent greater than that obtained by working the old ovens twenty-one hours per day in comparison with ten hours per day for the new ovens. Two compartments of the new ovens have a capacity of 390,000 cubic feet of springs during a month of twenty-five working days of ten hours each. This amount is 3 per cent more work than that produced by the gas-fired brick oven baked during January while working day and night shifts. The new ovens were built by the Detroit Heating & Lighting Co.

The back end of the oven is shown in Fig. 8, this being the point where the springs are pulled out and sent into the crating and shipping rooms. Fig. 9 shows the spring loads which have just come from the oven and are waiting to be removed by the men who do the crating. The Gilbert & Barker process for burning fuel oil under low pressure is used in heating the japan baking oven. Special features applied to this system make it most efficient for the work.

Method of Using Fuel Oil

In the construction of the oven, the heat is not applied directly to the work, as in heat-treating furnaces, but pipe coils are laid in the bottom of the oven and the oil flames are sent through these. In this way the ovens are heated by radiation, much as steam radiators are used for heating. The purpose of this arrangement is to prevent any of the products of combustion from entering the baking compartment to discolor, dull or otherwise ruin the smooth, glossy surface of the japan. Furthermore, the currents of air are prevented from starting up in the oven and stirring up dust particles that settle on the fresh japan. It is important to prevent this as far as possible, as these dust particles raise small lumps on the smooth japan surface, which are pyramidal in form so that they radiate light from all sides, which makes them appear much larger to the eye than they really are. When the pipe coils are arranged in this way, a dry heat is secured which bakes the japan quicker and harder than when moisture is present, as in the case of an open flame or when using steam heat. The atmosphere in the oven is also kept neutral, because there is no open flame to burn up the oxygen and leave an excess of nitrogen. Owing to these facts, less than 2 per cent of the work requires to be done over, while

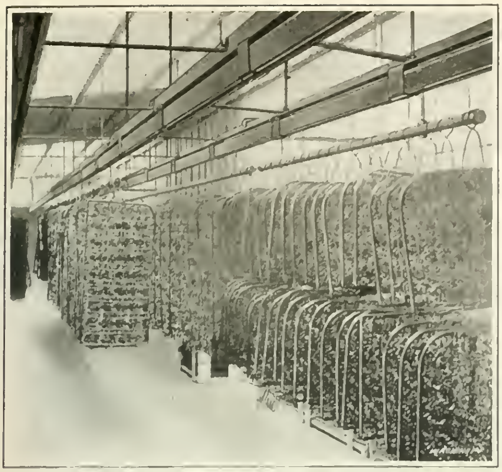


Fig. 9. Springs removed from Oven waiting to be crated and shipped

in the case of gas fires or steam-heated japanning ovens, from 10 to 20 per cent of the work has to be re-japanned and re-baked.

Details of Oil Burning Apparatus

Fig. 8 shows the special type of oil burners having a megaphone at A on the end. Five of these burners are arranged along each side of the 50-foot length of oven and each burner shoots the oil flame into a separate coil of 10-inch wrought iron pipe. The end of one of these coils is indicated at *B*. A sheet metal pipe *C* is used to convey the spent gases to a central stack that goes to the roof at the point where the coil leaves the oven. The fuel oil is vaporized inside the megaphone and combustion first takes place at this point, so that only the clean flame shoots into the pipe coil, as shown. This arrangement allows the operator to see the flame that enters the pipe coil and adjust the burner in such a way that there will be complete combustion of the fuel oil. If there should be an excess of oil, it would drop to the floor at the end of the megaphone. The importance of the megaphone burner should be emphasized in connection with construction of this kind, as without its use, the pipe coils will be destroyed in a few weeks, while with the construction advocated they will last several months. Another point of importance is that the pipe coils should be supported on rollers so that the expansion and contraction will not crack the piping. If any of the small details of this system are neglected, the result will be failure, but when all details are perfect the process works successfully and is by far the cheapest of any in fuel consumption and upkeep of which the writer has knowledge.

A special casting is placed in the outlet end of the pipe coil to reduce the 10-inch diameters to 4 inches, which leaves a large enough opening to carry away all the spent gases and holds the heat inside the pipe coil where it will radiate to the japan baking oven. If this were not done, 40 per cent of the heat generated by the oil flame would pass through the pipe coil and out of the stack. In one case known to the writer, a heavy sheet metal stack 3 feet in diameter was burned through by these gases some 2 feet above the roof of the building and 50 feet away from the heating coils, as measured by the piping through which the burning oil gases travel.

With a 10-inch pipe left open to the draft from a stack, the burning gases travel fairly quickly through vent pipes like that at *C*, and their heat will not be effective until they accumulate in the larger stacks outside the building. In an oven arranged like this, with ten burners and pipe coils venting into one central stack, it can be readily seen that there would be an intense heat at the point of concentration unless the flames were held back in the pipe coils until they had burned out. The simplest method of doing this is by means of a casting which reduces the outlet end of the pipe coil, thus obviating the necessity for dampers which burn out too easily.

Fig. 10 shows a floor plan and elevation which indicates the location of these pipe coils and oil burners. It will be seen that a heat insulated partition *F* extends clear to the floor and separates compartments 1 and 2 from compartment 3. This arrangement permits compartment 3 to be fired alone; although within the same shell as the others, it is still an oven by itself. Compartments 1 and 2 only have a sheet metal partition *G* between them. This partition starts 18 inches above the floor and extends to the roof of the oven, so that these two compartments operate as one oven. This construction gives the oven a flexibility that will take care of any quantity of springs that may be ready to bake. All three compartments may be operated at the same time, two at one time, or one alone.

The japan baking outfit noted herewith may be considered as the equal of electric ovens, while the cost for fuel is about one-tenth and the installation about one-third that of the electric oven. Some of the good points of the system mentioned are quick baking, a neutral atmosphere, no air currents and

COMPARATIVE COSTS OF GAS AND FUEL OIL IN HEATING JAPANNING OVENS

General information	Gas Fuel—Three Ovens	Fuel Oil—Three Compartments	Fuel Oil—Two Compartments
Truck and carrier capacities (cubic feet)	105	260	...
Oven or compartment capacities (cubic feet)	630	780	520
Number of cubic feet of springs baked per 24-hour day (24 heats day and night)	15,120	...	...
Number of cubic feet of springs baked per day (30 heats in 10 hours)	...	23,400	15,600
Number of cubic feet of springs baked per month (25 working days)	378,000	585,000	390,000
Number of gallons of fuel oil burned per month (25 working days)	...	3,325	...
Cost of fuel per month*	$225.00	$182.88	...
Cost of fuel per cubic foot of springs baked*	$0.0006	$0.0003	$0.00028
Cost of fuel per month†	...	$116.38	
Cost of fuel per cubic foot of springs baked†		$0.0002	$0.00017
Saving in cost of fuel (spring capacity 378,000 cubic feet per month)		$112.50	.
Saving in cost of fuel (spring capacity 390,000 cubic feet per month)*	..		$124.80
Saving in cost of fuel (spring capacity 585,000 cubic feet per month)*	...	$175.50	.
Saving in cost of fuel (spring capacity 378,000 cubic feet per month)†	....	$149.40	.
Saving in cost of fuel (spring capacity 390,000 cubic feet per month)†	....	...	$167.70
Saving in cost of fuel (spring capacity 585,000 cubic feet per month)†	....	$234.00	..

Machinery

* Gas, 70 cents per thousand feet, fuel oil, 5½ cents per gallon.
† Gas, 70 cents per thousand feet, fuel oil, 3½ cents per gallon.

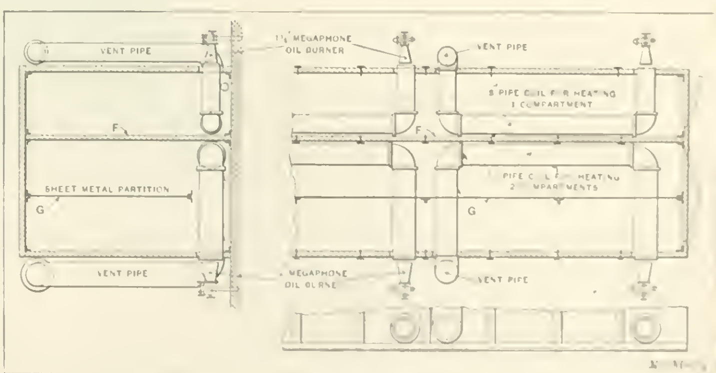


Fig. 10. Sectional View of Ovens, showing Method of installing Pipe Coils for Fuel Oil Heating

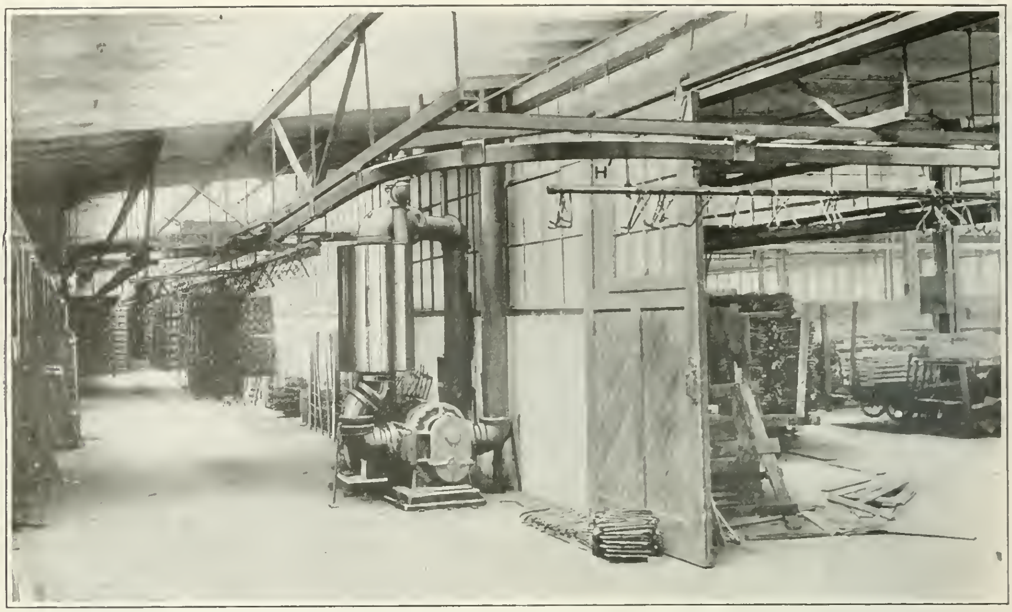


Fig. 11. View of Shipping Room, showing Point at which Empty Carriers return to be reloaded, and Oil Burning Power Plant

no products of combustion to attack the work. In citing a comparison of cost, let us take a group of radiator shells that were japanned and baked in an electric oven having a capacity of fifty-four shells. The electric current for baking three coats of japan costs twenty-one cents for each shell, or seven cents per shell for each coat. The electric ovens were replaced by an oven heated with illuminating gas, and the gas cost for baking the same three coats was five cents per shell, or less than two cents per coat. The cost for fuel in an oil burning oven would be less than one cent per shell for each coat of japan with fuel oil at the present war price of 5½ cents per gallon.

A tabulated comparison of costs between gas and oil fired ovens is illustrated in the accompanying table. The figures included in this table were obtained from the work done in the gas fired ovens operated in this factory during the month of January, and also from the work done in the oil fired ovens during the first twenty-eight working days after they had been installed. It seems probable that even better results than those shown in the table will be obtained when the workers have had more experience in handling the work and operating the oil burners. The saving will be greater when fuel oil returns to its nominal price, as the war price of 5½ cents per gallon was used in this tabulation.

Power Plant and Shipping Room

One side of the shipping room is shown in Fig. 11, the japanning outfit being in evidence at the far end and the springs hanging from the trolley waiting for the craters. The method of hanging the track from angle irons can be clearly seen at the point where the three-oven tracks merge into one, and empty spring carriers can be seen coming through the curve and switches at this point, while another one is moving through the doorway on its return to the inspector's benches to be reloaded. The power plant that delivers fuel oil to the megaphone burners and produces the air blast needed for its proper combustion can be seen in the center of the illustration against the wall. An electric motor, a No. 8 air compressor or blower and an oil pump are all located on one bed-plate. The oil pump is driven by a chain and sprocket from the blower shaft which is driven by the motor through a system of gearing. To shut down the baking oven, it is only necessary to pull the switch that starts the motor; then the oil at the burners all drains back to the storage tank. It is unnecessary to caution the workers to turn off the oil before they shut down the blower, as the plant is fool-proof in that respect. Explosions occur from neglect to turn off the fuel oil when the arrangement is such that the blower and oil pump are driven separately. Serious accidents, bad burns and fires have resulted from such explosions but these are entirely overcome by making the oil pump stop automatically when the air blast ceases.

* * *

PATCHING CONCRETE FLOORS

One of the principal objections often raised against the use of concrete finished floors is the difficulty and cost of successfully repairing places that have become worn or damaged. For best results it is usually considered necessary to cut down the worn place at least 1½ inch into the unbroken concrete, under-cut the edges, clean out the dust and loose particles thoroughly, wash with a thin cement grout, fill in with a paste grout and finally float to a level surface a mortar of cement and crushed stone or gravel. The patch must then be kept moist for at least a week or ten days, keeping all traffic off in the meantime.

W. P. Anderson, president of the Ferro Concrete Construction Co., states that his company often uses a method of patching concrete floors which is much cheaper and requires far less time than that commonly used. Mr. Anderson's method requires the use of a mastic material made from a mixture of asbestos fiber and rubber gum. This mixture is applied with a trowel after thoroughly cleaning the damaged surface. Very little cutting of the old concrete is necessary, other than to break off loose particles. The gum can be worked to a feather edge so that it will readily join with the undamaged concrete surface and eliminate the under-cutting required with the old style of patch. A patch of this sort can be opened to foot traffic within a few hours and to heavy traffic within a day or so. It is thus possible to repair a much-used portion of a mill or factory floor almost over night. The cost varies with the size of the patch but amounts to from sixteen to eighteen cents per square foot.

* * *

CORRECTION

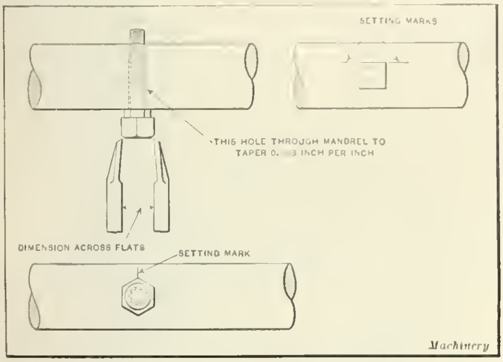
On page 885 of the June number of MACHINERY, the twenty-first line in the second column of the table reads 54 — 37 — 0.6602959. The number of teeth in the driven gear given as 37 should read 47.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

FACING BOLT HEADS ON A LATHE

The accompanying illustration shows an ingenious method of facing square or hexagon bolt heads on a lathe. The bolt is held in a transverse hole in an arbor which is supported on the lathe centers, and index marks are provided for setting the head of the bolt to bring its faces in the desired relation to each other. As the diameter of stock bolts is likely to vary considerably, a taper hole is provided through the mandrel



Method of holding Square- and Hex-headed Bolts for facing on Lathe

to allow for this variation in size. This results in the heads of different bolts being located at various distances from the mandrel, and for this reason the bolt head is simply "sighted" on the index marks instead of employing a positive stop for locating different surfaces.

It will be evident from the illustration that two surfaces are faced at the same time by means of straddle tools, and the method of supporting the work is sufficiently firm to enable heavy cuts to be taken. After the arbor has been set up on the lathe centers, a bolt is placed in the transverse hole and driven lightly home by means of a lead hammer, the diameter of the mandrel being such that the point of the bolt projects about 1/4 inch. The first cut is then taken, and when two surfaces of the head have been faced in this manner, the bolt is released by striking the point with the lead hammer, after which the finished faces are sighted on the index marks in order to locate the work for facing the next pair of surfaces on the head. It will be evident that two operations complete the work on a square bolt head, while three operations are required in facing a hexagon bolt head.

Plainfield, N. J. J. B. MURPHY

WHERE THE PROOF FAILS

On page 65 of MACHINERY'S HANDBOOK, under the title "Rapid Proof of Multiplication and Division," is given a method of proving the results of examples in multiplication by the digit system which is similar to the method of eliminating nines that I formerly used. This method never failed until one day I had occasion to convert 32.25 millimeters into the equivalent fraction of an inch, which I did in the following manner:

```
  0.03937
    32.25
---------
    19685
    7874
   7874
  11811
---------
0.1358265
```

It will at once be apparent that the result of the preceding calculation is incorrect, but according to the rule for checking the result given in MACHINERY'S HANDBOOK, we find: $3 + 9 + 3 + 7 = 22$, and $2 + 2 = 4$; $3 + 2 + 2 + 5 = 12$, and $1 + 2 = 3$. Then $3 \times 4 = 12$; and $1 + 2 = 3$.

Carrying through the same process for the result of the preceding process of multiplication, we find: $1 + 3 + 5 + 8 + 2 + 6 + 5 = 30$, and $3 + 0 = 3$. This indicates a correct result

```
  0.03937
    32.25
---------
    19685
    7874
   7874
  11811
---------
1.2696825
```

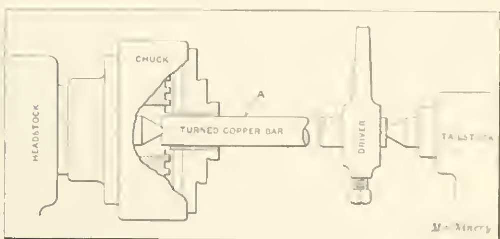
Adding the digits of the result of the preceding calculation which is correct, we find: $1 + 2 + 6 + 9 + 6 + 8 + 2 + 5 = 39$, and $9 + 3 = 12$, and $1 + 2 = 3$. Hence, the method of checking indicates that both results are accurate, while as a matter of fact the first is incorrect.

Brooklyn, N. Y. S. GOODMAN

[The method given on page 65 of MACHINERY'S HANDBOOK is based upon a proper arrangement of the work in performing the process of multiplication, and when the work is properly arranged the method is a reliable check on the accuracy of the result obtained.—EDITOR.]

TRUING JAWS OF SCROLL CHUCK

The method of truing up the inner gripping surfaces of scroll chuck jaws shown in the accompanying illustration has been found effective and much cheaper, quicker and more accurate than the use of an internal grinding attachment. If the jaws are trued up by an internal grinding wheel, they will be more or less slack during the truing process, and will probably run considerably out of truth when tightened onto the work. In using the method shown in the accompanying illustration, the live centers of the lathe must run perfectly true, and must not project beyond the inner face of the chuck jaws. The copper bar A must be turned cylindrical for a few inches near the headstock and a large driver must be attached to the tailstock. Over the turned length of the bar, carborundum powder and lard oil or some other equally good lapping compound should be evenly spread, taking care at the same



Truing Jaws of Scroll Chuck

time to keep the compound away from the live center. The chuck jaws may then be tightened so as to grip the bar lightly and the lathe started while the bar is prevented from turning by the driver.

As the lapping proceeds, the gripping faces of the jaws can be tightened up, adding a little kerosene and more lapping compound if necessary from time to time until the faces of the jaws have been properly trued. It is advisable to apply only light pressure to the jaws at first, but after the car-

borundum has been ground down fine, the work should be finished under the greatest pressure possible without absolutely gripping the lap. This is done to force the teeth of the jaws against the scroll of the chuck as firmly as possible, so there will be no backlash. Care must also be taken to see that the copper lap is held firmly between the lathe centers. As the lap can withstand considerable pressure, the work will be more accurate than when a grinding wheel is used.

Bradwardine, Bathurst, N. S. W. R. Gordon Edjell

[It is evident that a copper bushing could be used in place of the solid copper bar if desired. The bar could be of steel and the bushing forced onto one end and turned in position, since the present cost of copper is high.—Editor.]

IMPROVEMENTS ON INTERMITTENT MOVEMENT OF GENEVA WHEEL

Inertia is an important factor in intermittent motion, especially when large masses are involved. In order to apply intermittent motion at all to such masses, ratchets or other devices are required, and these cause large friction losses without overcoming in any way the effect of inertia. The intermittent action of the regular Geneva wheel, which is efficient enough for small pieces, is impracticable in machines of such size that they require the movement of large and heavy masses under power.

Recognizing this difficulty and finding the necessity of applying an intermittent movement, the writer found it necessary to use a Geneva wheel, 8 inches diameter, to move masses weighing over 200 pounds at a velocity of 50 R. P. M. In this particular case the inertia effects were severe, tending toward the destruction of the machine unless counteracted in some way. In order to provide for this I designed the following device which has been used with excellent results.

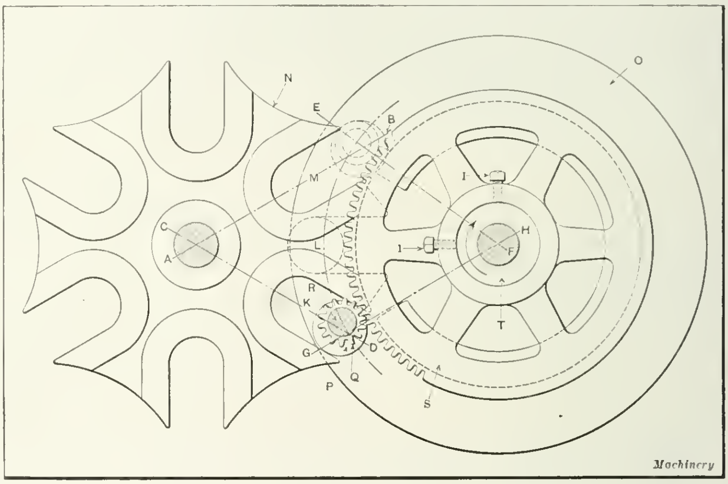


Fig. 1. Improved Movement applied to the Geneva Wheel

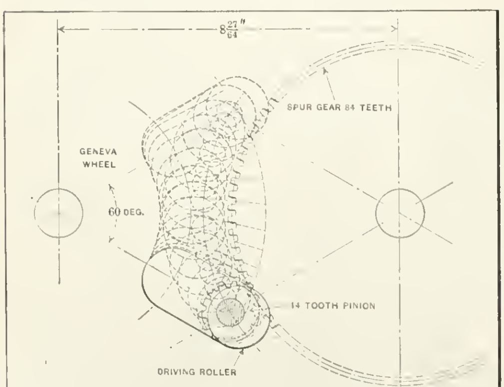


Fig. 2. Diagram showing Progressive Movement of the Geneva Wheel

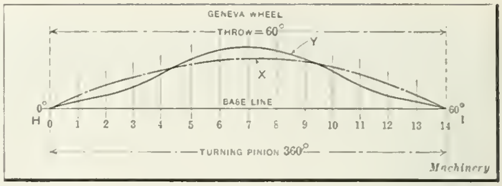


Fig. 3. Diagram showing Comparison in Movement of Regular and Improved Types of Geneva Wheel Operating Method

The point of connection between the driving roller and the Geneva wheel is placed at the points of intersection of the lines *AB*, *CD* and *EF*, *GH*, as indicated in Fig. 1. The driving roller is placed eccentrically with relation to these points of intersection, thus giving to the driver wheel different radii of leverage, which causes a gradual acceleration from the position *K* to *L*, diminishing in a similar manner from *L* to *M*. That is to say, the speed is slow at the beginning of the movement and gradually increases up to the half cycle, from that point diminishing gradually until the position *M* is finally reached. A curve representing the variations in speeds of the Geneva wheel when arranged in this way can be seen at *Y* in Fig. 3.

In order that the eccentric driving roll may make a complete revolution during the period of engagement with the Geneva wheel, it must be meshed with a stationary gear having a sufficient number of teeth in an arc of 60 degrees to produce one complete revolution of the roll.

In Fig. 1, *N* is the Geneva wheel, *O* the driver wheel, *P* the driving roll, *Q* a pinion gear attached to roll *P*, *R* the shaft bearing of *P* and *Q*, and *S* the spur gear which is held in position by the set-screws *I* on the bearing *T* of the driver wheel *O*. The gear pinion *Q* and the spur gear *S* always maintain the same relation radially, and the Geneva wheel moves 60 degrees for each revolution of the driver wheel, while the pinion and spur gear run together in the ratio of 6 to 1, the pinion having fourteen teeth and the gear eighty-four.

Referring to the diagram Fig. 2, the pinion and wheel can be noted in their fourteen positions, the graphic outline showing the path of the roll which accelerates up to the center, diminishing gradually thereafter in the same proportion until the end of the movement is completed. A comparison between the regular and improved Geneva movements can be noted in Fig. 3, in which *X* represents the uniform movement obtained by placing the driving roll concentric with the pinion, operating at a uniform radius, and *Y* represents the eccentric driving roll working at a variable radius. In working out this diagram, the line *HI* has been considered as representing a cycle of the driving roll in an arc of 60 degrees, alternating from 0 to 14 as shown by the position of each one of the fourteen teeth of the pinion in the driving roll during its complete cycle of 360 degrees. The principles involved in the mechanism described may be applied to many other cases where rapidity of movement and freedom from shocks are essential.

New York City. F. P. Ampudia

VARIATIONS OF PEAUCELLIER MOTION

The invention of the exact straight line motion by Peaucellier, an officer of the French army, gave an impulse to the study of the geometry of the straight line and circle; and students of modern geometry were not slow to recognize the value of this linkage as an illustration of the principle of inversion. The value of the mechanism in guiding a moving piece along a rectilinear path was at once apparent to the mechanical engineer; but it was reserved for the mathematician to discover the underlying principles of this combination of links.

Fig. 1 represents the arrangement of the Peaucellier linkage. It is composed of seven links moving about two fixed centers of motion *A* and *B*. The four equal links *E* form a rhombus; the links *F* are equal; and the center *B* is midway between *A* and *C*. If the point *D* be moved in the direction of the arrows, it is a simple demonstration in geometry to prove that it will be constrained to move in the straight path *D'D"*, which is perpendicular to the line of centers *ABCD*. This may be tested experimentally. The locus of the point *C* is the circumference *AC'C*; and the locus of *G* and *G'* is the arc described with the radius *F*. If the center line of the links *E* and *F* be assumed in any position such as *AC"D'* it will be found that the rhombus whose sides represent the length of the links *E* takes the position shown in the drawing.

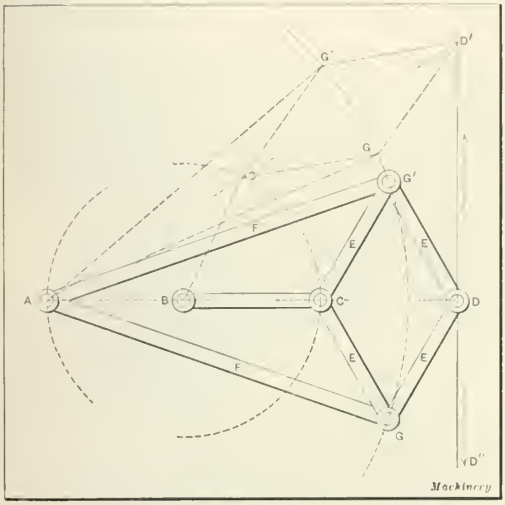


Fig. 1. Arrangement of Peaucellier Linkage for Straight Line Motion

In Fig. 1 the centers *A* and *B* are external to the links *E*.

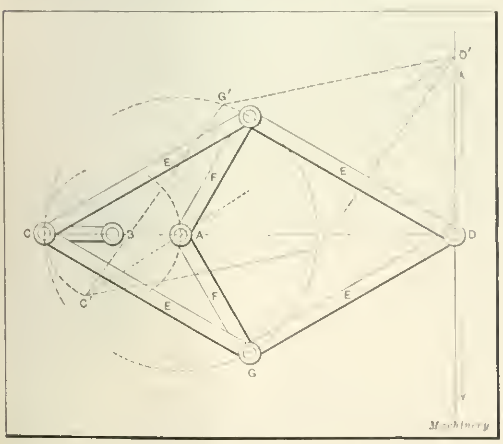


Fig. 2. Modification of Peaucellier Straight Line Mechanism shown in Fig. 1

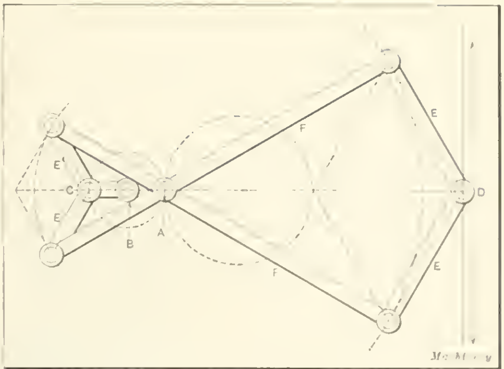


Fig. 3. A Third Arrangement of Peaucellier Straight Line Motion

A variation of the linkage is shown in Fig. 2, in which the centers *A* and *B* are within the rhombus. The links *F* are equal; and center *B* is midway between *A* and *C* as in Fig. 1. The corresponding links and points in the figures are labeled with the same letters; and it may be shown experimentally that the point *D* is compelled to move in a straight line perpendicular to the line of centers *CBAD*.

Fig. 3 shows another variation. On one side of the centers *A* and *B* are the two equal links *E*, and on the other side two equal links *E'*, which in each case form one-half of a rhombus which is completed by the dotted lines. The equal links *F* are divided at *A* into segments which are in the same proportion as *E*:*E'*. The geometry of this arrangement of links is shown in Fig. 4. While the point *D* moves in the direction of the arrow *A*, *D'* moves in the opposite direction *A'*.

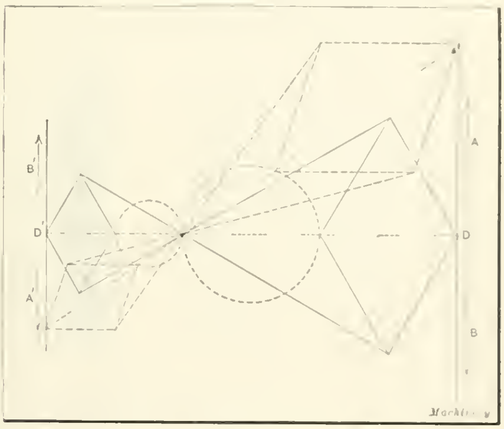


Fig. 4. Diagram showing Principle of Operation of Mechanism illustrated in Fig. 3

Hartford, Conn. FREDERIC R. HONEY

TURNING TAPER FITS

When using a compound rest to turn the taper fit in a piston and the correct taper has been obtained, the next step is to remove the work from the lathe and put the piston rod in place to see how it fits. Suppose it happens that the rod fails to go "home" by 1/2 inch; the method of procedure is as follows: Put the piston back in the lathe and set the tool so that it just scrapes at the end of the taper, next run the tool back 7/16 inch with the compound rest and then run the carriage forward the same amount. After this has been done, a finishing cut is taken without having used the cross-feed handle, and the amount of metal removed is such that the rod will come within about 1/16 inch of the desired posi-

tion. It can then be driven into place to secure a tight fit. For cases where the rod fails to enter by any other amount, the adjustment made with the compound rest will be in direct proportion, the idea being to leave a final 1/16 inch for the piston rod to be driven in to insure obtaining a tight fit.

Toronto, Ont., Canada. THOMAS MASON

GRINDING NARROW PARALLEL STRIPS

Recently, while I was walking through the shop, my attention was drawn to a method of finishing the edges of narrow parallel strips on a surface grinder. This consisted of stacking a number of blanks together and securing them with solder run along the ends, thus allowing the edges of several pieces to be ground at one time. In addition to saving time, this method allows the work to be turned over and ground on the opposite edges with the assurance that the two ground edges of each strip will be parallel. What struck me most forcibly was the fact that one of the first jobs I ever did on a surface grinder was similar to this one. I had to grind 200 pieces and did them one at a time, which was a very tedious piece of work. The thought that occurred to me was this: If the present method represents common practice, why did not my foreman tell me about it when he assigned me to that surface grinding job several years ago?

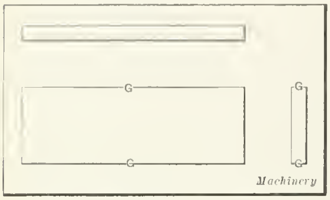


Fig. 1. Strip that had Edges ground Parallel

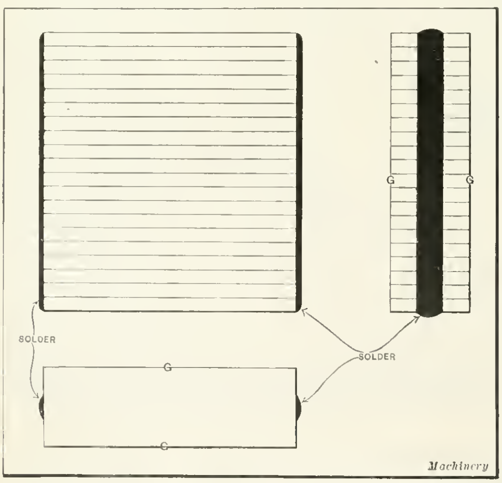
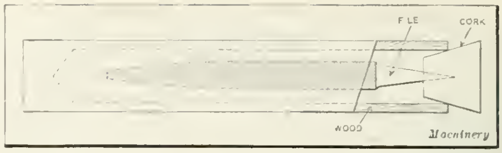


Fig. 2. Method of holding a Number of Strips with Solder while grinding Edges

SERVER

REMOVING CHIPS FROM TAPPED HOLES

While erecting or repairing machinery it is sometimes necessary to clean the chips out of tapped holes, and the deeper and smaller the hole, the more difficult it becomes to remove the chips. A very simple way of doing this is to have among your tools an old rat-tail file about 1/4 or 5/16 inch in diameter, which has been strongly magnetized so that when the file is inserted in the hole all the chips will cling to it. In addition to its use for removing chips, this will be found quite a handy tool for picking up nuts, screws or washers which have been dropped into places where it is hard to get at them. If necessary, the file may be lowered on a string to reach places which would otherwise be inaccessible. Where such a file is used, however, care must be taken to keep it away from other tools to prevent them from becoming magnetized. For this purpose I took a round piece of wood and drilled a hole in it of suitable size to receive the file. Reference to the illustration will make it evident that this case is virtually a wooden bottle being provided with a cork to keep the file in place.

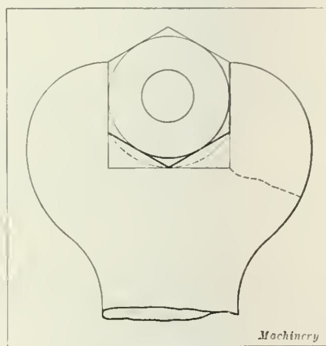


Wooden Case in which File is carried to prevent Other Tools from becoming magnetized

South Orange, N. J. WILLIAM PHILIP

IMPROVEMENT IN WRENCH DESIGN

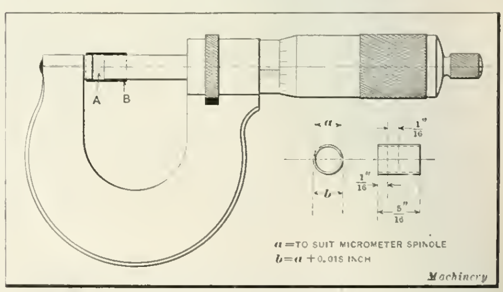
Despite their experience in the manufacture of S wrenches, there are still some manufacturers of these tools who persist in machining the openings with square corners. It will be obvious to any skilled mechanic that making a wrench opening of the form shown by the full lines reduces the strength to an unnecessary extent, because more than the required amount of metal has been cut away. The opening must be made deep enough so that opposite flats of a hexagon nut may be engaged by the jaws, but this result may be obtained with an opening of a form shown by the dotted lines, and such a wrench will possess considerably greater strength than one with square corners. N. G. NEAR



Wrench with Improved Form of Opening

COVER FOR MICROMETER SPINDLE AND ANVIL

In common with many other mechanics who frequently have occasion to use a micrometer, I always carry one of these tools with me, and have noticed that when I have to use it there is likely to be more or less grit between the anvil and spindle, making it necessary to clean off these surfaces before proceeding with my work. Occasionally the spindle becomes jammed down on the anvil in some mysterious way, and when this difficulty is encountered I usually find that the micrometer is "out" about 0.00025 inch, which makes it necessary to "set up" the spindle before the tool can be used. These



Cover for Micrometer Spindle and Anvil, with Cork Pad to prevent jamming Spindle down onto Anvil

troubles not only result in loss of time, but they also impair the accuracy of the tool.

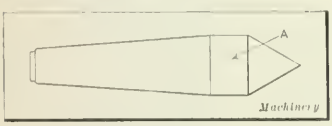
The attachment shown in the accompanying illustration entirely does away with annoyance from these causes, and it is so simple and easily made that it should be found of value by many mechanics. It is made of a piece of brass or copper rod bored to a nice push fit on the micrometer spindle and turned down on the outside to a diameter approximatoly 0.015 inch greater than the bore, so that the shell may be as thin as it is practicable to make it. After this work has been completed, a piece from 5/16 to 3/8 inch in length is cut off and finished on each end.

Next cut a disk of cork about 1/16 inch thick, which is pressed into the tube as shown at *A*; this disk should be a close fit in the tube and located about 1/16 inch from the anvil end. If the spindle fits properly into the bore of the tube, the application of a little oil will effectively prevent the contact surfaces of the micrometer from being damaged by grit or moisture; and the elasticity of the cork will prevent the micrometer thread from being strained through jamming the spindle down on the anvil. An advantage of this device is that it affords adequate protection and still leaves the micrometer ready for instant use without making the tool appreciably heavier.

Plainfield, N. J. J. B. Murphy

IMPROVEMENT IN LATHE CENTERS

The illustration shows a method of grinding lathe centers to facilitate the subsequent work of lining them up. At the time the taper shank is ground, part *A* which projects beyond the spindle is also ground straight and parallel on both the head and tail centers; and care is taken to have the diameter of this cylindrical portion exactly the same on both centers.



Lathe Center with Cylindrical Section A to facilitate lining up Headstock and Tailstock Centers

Then to line up the centers, an indicator or a tissue paper feeler is first applied to the head center, after which the carriage is run over to bring the indicator into contact with the tail center so that it may be adjusted to line up properly with the center in the headstock.

Jersey City, N. J. Donald Baker

COVERING A CONE PULLEY WITH LEATHER

Every machine shop that does a general business occasionally has a piece of work come in which taxes all the resources of the concern. A short time ago one of these jobs came into our shop, and as it was somewhat puzzling and required some study in order to work it out, it may be possible that the solution will help someone else out of a similar predicament.

We had a plain wooden cone pulley to cover with leather in order to keep a belt from slipping on it. This looks like a simple enough problem at first glance, and it seemed simple to me when I first attempted it, but as a matter of fact it did not prove to be as easy as it looked. The pulley in question was about 1 foot long and 1 foot in diameter at the large end. I was given a helper and told to go ahead with the work. I knew that a pattern could be laid out that would cover the pulley without trouble, but when it was laid out on paper as shown at *A* in the accompanying illustration, it was apparent that a great deal of material would be required. The helper said that he guessed it would take a whole side of leather and that there would be considerable difficulty in getting the superintendent to O. K. the bill. My next thought was that perhaps I might be able to get a strip of narrow belting and wind it tightly around the pulley and fasten it with tacks and glue, so that it would look something like *B* in the illustration.

We finally got hold of a piece of wide belting, the only thing of the kind which we could find around the shop that seemed anywhere nearly suitable for the job, and started on the work. At first there didn't seem to be any good way out of it, but after a little experimenting we got some heavy paper and cut it to the same width as the belting, and tacked it onto the pulley a little piece at a time until we covered the entire surface as shown at *C*. After this it was not a difficult matter to cut the belt to fit from the paper patterns. The pieces were then glued and tacked in place one at a time. When dry and trimmed up, the pulley made a very good appearance indeed.

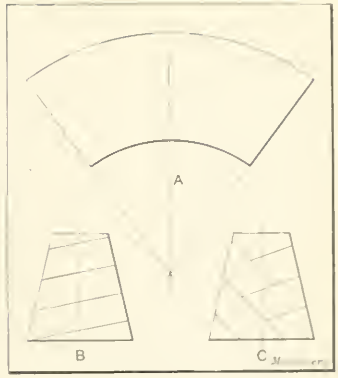


Diagram showing Method of covering Cone Pulley with Leather

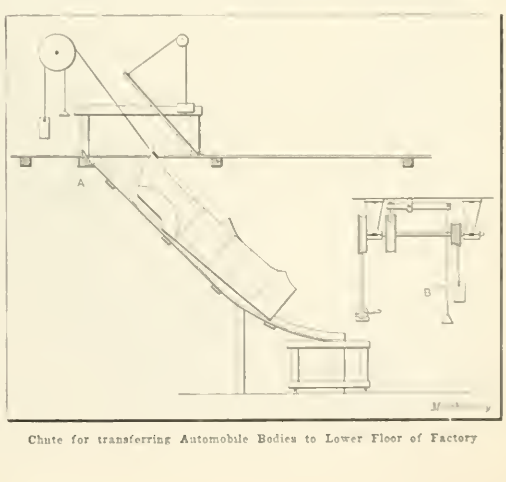
From the experience gained on this one matter, the writer has seen the folly of expressing an opinion before taking up a problem pretty carefully. The cone pulley was lagged in a satisfactory manner, but this point was of less importance than the realization that it is unwise to jump at a conclusion.

Frank McPherson

CHUTE FOR AUTOMOBILE BODIES

A labor-saving type of chute is used in the factory of a well-known automobile body manufacturer for transferring bodies in a partly finished condition to the floor below, where they are completed ready for shipment. A hole is cut in the floor through which the bodies are slid down a wooden chute covered with steel that is set at an angle of approximately 45 degrees. The chute is slightly curved at the bottom to avoid shock that would otherwise occur when the body strikes that point; and the bottom of the chute is located 30 inches from the floor level so that the bodies will slide onto trucks which are used to move them around during the performance of final operations in the process of manufacture. While on the upper floor of the factory, the bodies are pulled around on a small roller fastened to a block *A* which falls into the recess provided for that purpose when the body is tilted up ready to slide down the chute. A rope is secured to the rail on the body and the brake that controls the counterbalanced windlass allows the body to slide down easily. When the body has reached the bottom of the chute, a clamp is released and the rope is wound up automatically.

Two ordinary lineshaft hangers are set up with about



Chute for transferring Automobile Bodies to Lower Floor of Factory

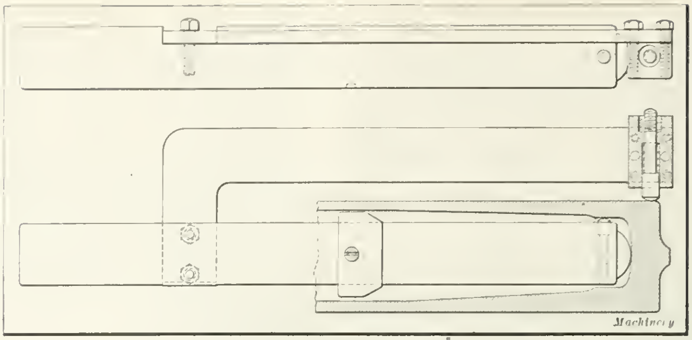
4 feet of shafting between them; fastened on this shafting there are two pulleys, one of which is 18 inches in diameter and one 4½ inches in diameter. The rope that attaches to the body is wound around the large pulley and a counterweight rope is carried on the small pulley. The counterweight weighs just a little less than the body, allowing it to slide down the chute without the speed being accelerated too rapidly; and the action of this counterweight also causes the rope to be automatically wound up after it is released from the work. A brake drum which controls the downward movement of the body can be set to stop it at any desired point; to operate this device, the brake is released by pulling down on rope *B*, which allows the rope to unwind from the large pulley and drop the automobile body down the chute. When this chute is not in use the trap door is closed and locked; and a hand-rail is provided on all sides to prevent anyone slipping through. AUTO CRAFT

ECCENTRICITY TESTING DEVICE FOR SHELL FORGINGS

One of the pitfalls into which many shell manufacturers have fallen to a greater or less degree is the expending of useless work on forgings that are so far out of round that when it comes to the finish-machining they will not "clean out." This trouble is due to the poor alignment of the forging tools from wear or improper setting.

The usual method of testing these forgings is to center the solid end, and mount the open end of the trimmed forging on a cone center; the shell is then checked when the roughing cut is taken. It is obvious that by this method considerable work is expended on every forging, whether it is true or not, and this cutting off to length, centering and turning wastes valuable time, if the shell is badly eccentric.

The accompanying illustration shows a forging testing device that has worked out satisfactorily in one of the largest shell manufacturing shops. It consists of a non-rotating arbor that is supported in a horizontal position by means of the stem end at the left. Supported from the rear end of the arbor is an arm that carries a spring plunger gage passing through a block and contacting with the shell forging.



Device for testing Shell Forgings

The end of the arbor is rounded to strike the bottom of the powder pocket. A gaging pin on the upper side of the arbor near the front end and a gaging ring at the rear end support the shell centrally. The shell is rotated by hand and any eccentricity is transmitted to the plunger gage. The upper end of the plunger gage is fitted with a pair of adjustable flanges, one of which acts as a check-nut for the other. The upper flange is so set that when gaging the lowest permissible point on the shell, the flange will be flush with the top surface of the gaging block. Therefore, whenever the flange drops below the top surface of the block, the operator knows he has a defective forging on the arbor and it is rejected.

The fixture is handled very rapidly, and an operator can gage many more shells than would be possible if these had to be mounted on centers previous to the actual testing. In addition, the forging may be tested before any work is done on the shell, and if it is eccentric it is thrown out at once without the expenditure of any labor upon it. C. L. L.

TABLE OF FRACTIONAL EQUIVALENTS TO NEAREST SIXTY-FOURTHS

Designers frequently have to reduce decimals to the nearest 1/64 inch, and the accompanying table was developed to facilitate doing this work. Its use does away with all guesswork and danger of mistakes. For instance, suppose it is required to reduce 0.333 inch to the nearest 64th; by referring to the table, we find 21/64 to be the required value. It will be seen that there are two decimal values after each fraction; the one directly opposite the fraction is its decimal equivalent; and in the third column, between each two decimal equivalents, is given the mean of these two values. This makes it an easy matter to determine rapidly the fractional equivalent of any given decimal to the nearest 1/64 inch. The use of the table will be made clear by solving another problem. Suppose it is required to find the value of 0.701341 inch to the nearest 64th. Reference to the table will make it evident that this value comes between 0.695313 and 0.703125 inch, so that 45/64 inch is found to be the desired result.

SAMUEL KAUFFMAN
Philadelphia, Pa.

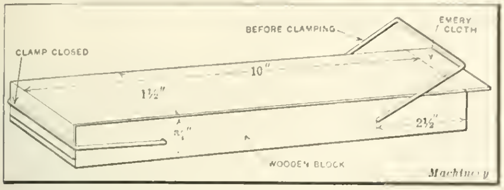
1/64	0.015625	0.007813	17/64	0.265625	0.257813	33/64	0.515625	0.507813	49/64	0.765625	0.757813
1/32	0.03125	0.023438	9/32	0.28125	0.273438	17/32	0.53125	0.523438	25/32	0.78125	0.773438
3/64	0.046875	0.039063	19/64	0.296875	0.289063	35/64	0.546875	0.539063	51/64	0.796875	0.789063
1/16	0.0625	0.054688	5/16	0.3125	0.304688	9/16	0.5625	0.554688	13/16	0.8125	0.804688
5/64	0.078125	0.070313	21/64	0.328125	0.320313	37/64	0.578125	0.570313	53/64	0.828125	0.820313
3/32	0.09375	0.085938	11/32	0.34375	0.335938	19/32	0.59375	0.585938	27/32	0.84375	0.835938
7/64	0.109375	0.101563	23/64	0.359375	0.351563	39/64	0.609375	0.601563	55/64	0.859375	0.851563
1/8	0.125	0.117188	3/8	0.375	0.367188	5/8	0.625	0.617188	7/8	0.875	0.867188
9/64	0.140625	0.132813	25/64	0.390625	0.382813	41/64	0.640625	0.632813	57/64	0.890625	0.882813
5/32	0.15625	0.148438	13/32	0.40625	0.398438	21/32	0.65625	0.648438	29/32	0.90625	0.898438
11/64	0.171875	0.164063	27/64	0.421875	0.414063	43/64	0.671875	0.664063	69/64	0.921875	0.914063
3/16	0.1875	0.179688	7/16	0.4375	0.429688	11/16	0.6875	0.679688	15/16	0.9375	0.929688
13/64	0.203125	0.195313	29/64	0.453125	0.445313	45/64	0.703125	0.695313	61/64	0.953125	0.945313
7/32	0.21875	0.210938	15/32	0.46875	0.460938	23/32	0.71875	0.710938	31/32	0.96875	0.960938
15/64	0.234375	0.226563	31/64	0.484375	0.476563	47/64	0.734375	0.726563	63/64	0.984375	0.976563
1/4	0.25	0.242188	1/2	0.5	0.492188	3/4	0.75	0.742188	1"	1.	0.992188

Machinery

Table of Fractional Equivalents to Nearest Sixty-fourths

EMERY CLOTH HOLDER

A friend of mine recently developed a handy method of holding emery cloth and has given me permission to pass the idea along to readers of MACHINERY. It is very simple

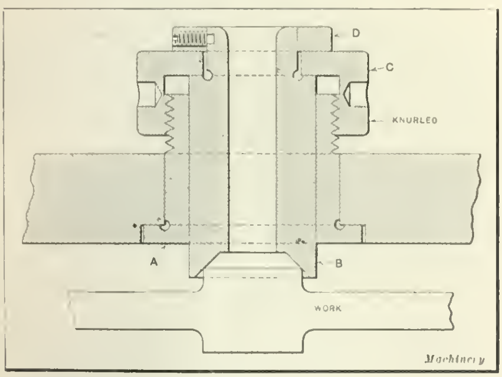


Block with Quick-acting Clamps for holding Emery Cloth

and is clearly shown in the accompanying illustration. Take a block of wood of about the dimensions illustrated—although the size will naturally depend upon the nature of the work—and instead of tacking the emery cloth on this block, secure it in place by means of bent wire clamps at each end. The emery cloth must be about 1½ inch longer than the wood, so that it may be turned down at the ends and overlapped sufficiently to be held in place. The emery cloth may be quickly removed when worn and a new piece substituted in its place. N. G. NEAR

CLAMP BUSHING

The clamp bushing for drill jigs, shown in the accompanying illustration, occupies no more space than the screw type of bushing, and has many features which commend it to the favorable attention of tool designers. This bushing is fully



Compact Type of Clamp Bushing that can be operated by Hand or by a Wrench

as efficient as the lever-operated type, which often cannot be used because of the amount of space which it occupies. It will be evident that a lining bushing *A* is provided, which has a collar at its lower end to prevent it from being pulled through the body of the drill jig when bushing *B* is forced onto the work by tightening knurled nut *C*. Thrust collar *D* is fastened to drill bushing *B* by small dog-pointed set-screws, and serves as a bearing for nut *C* when raising bushing *B* out of the work. Four spanner wrench holes are drilled in nut *C* to provide for the use of a wrench when more pressure is required to hold the work than can be provided by the knurled hand grip; and when so desired, the nut may be made hexagon shaped and operated by an ordinary wrench.

Cleveland, Ohio. R. J. KRUSE

MAKESHIFT TAPER REAMER

We had to ream a tapered hole on a rush job, and when the supply room was called upon for a reamer to handle the work it was found that the required tool was not in stock. There was just one No. 7 B. & S. taper hole to be reamed in a steel part, and it was out of the question to spend time waiting for a reamer to do the work. Accordingly, we made a makeshift tool out of an old file and secured very satisfactory results, both as regards fit and finish.

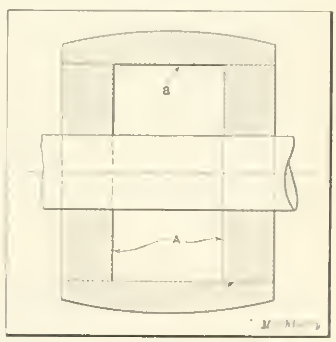
In making this special reamer the tapered end of an old 8-inch flat file was used; sides *A* and edges *B* were roughed out by hand on a grinding wheel, after which the tool was clamped in a vise on the shaper to enable edges *B* to be ground straight and true. An electrically driven toolpost grinder was mounted in the clapper box to provide for handling this operation; and after the grinding had been finished, the tool was sharpened with an oil-stone to obtain a keen edge and accurate finish. The tool was completed in less than an hour.

Makeshift Taper Reamer for Use on Repair Job

The accompanying illustration shows how this reamer was applied to the work; the file was left long enough at the back end to be engaged by a wrench, and feed was provided by the tailstock spindle. Soft wooden supporting wedges were driven in between the sides of the reamer and the steel bushing to provide firm support, and while in use the tool was flooded with oil. As previously mentioned, the results obtained were very satisfactory, the surface of the reamed hole being as smooth as glass and the taper quite accurate. C. T.

METHOD OF REPLACING SMALL PULLEYS

During the past eight or nine years I have been employed in machine shop work; and in repairing small pulleys which have been broken, such as motor pulleys and the pulleys on emery wheel mandrels, I have obtained satisfactory results by turning the two hubs *A* from cast iron and shrinking onto them a piece of "double-strength" steel pipe *B* of the desired size for the pulley. After this part of the work has been completed, I start at the center of the piece of pipe and turn a taper to first one edge and then the other in order to form the required crown on the pulley. One of the first pulleys which I made in this way has been in constant use for a little more than three years, and is giving just as good service as the one which it replaced. A pulley can be made by this method in a very short time, and saves waiting for a casting to be made or ordering a pulley from an outside concern.



Substitute Pulley made of Two Cast-iron Plugs and Steel Pipe

Anamosa, Iowa. ALBERT PARKIN

* * *

A plain knee type milling machine with attachments will do all that a universal machine can do and is a simpler and stiffer machine. The swiveling table of the universal type is limited to an adjustment of about 50 degrees each side of the right-angle position, whereas a swiveling vertical attachment may be set at any angle. Many concerns buy universal machines when they could use the plain type with attachments and have a better machine for ordinary work.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

SPECIFYING HOLE SIZES

A. R. H.—There is a difference of opinion between the drafting-room and the factory on the following question: The drafting-room practice is to specify a reamed hole thus: "One-inch ream"; the factory practice is to use a standard one-inch plug gage to size the hole. Is the factory right in using the gage?

A.—We believe that the drafting-room should merely specify the size of holes that can be expressed in whole numbers and common fractions and leave the factory free to use standard plug gages to size the holes. If the drafting-room specifies a one-inch hole, it is up to the factory to make this hole one inch diameter, and there is no better means of determining the size of the hole than to test it with a one-inch standard plug gage.

DIES FOR CUTTING PAPER AND LEATHER

J. K.—I have seen many dies for cutting paper and leather made with sharp edges, while the punch was made with a square face. Recently, however, I saw a die for cutting paper that worked successfully, having a square face the same as the punch. Will you kindly tell me if this is coming to be common practice?

A.—Dies with square cutting faces are being used successfully for cutting paper, cardboard and leather. It is necessary to have a close-fitting punch and to keep the dies sharp. With a properly fitted punch and sharp die the resistance to cutting is no greater with a square-face die than with the old type of sharp-face die. The square-face die has a longer life, is simpler to make and less likely to be damaged in use.

UNIT OF ACCELERATION

A. J. C.—Why do some writers express acceleration as feet per second and others as feet per second per second? Which is right?

A.—Acceleration may be defined as increase (or decrease) of velocity in a unit of time. If the unit of time for velocity is one second and the unit of space is one foot, then the unit of velocity is one foot in one second, or one foot per second. If the unit of time for acceleration is also one second, then the unit of acceleration is one foot per second in one second, or one foot per second per second. If the unit of velocity were one mile per hour and the unit of time for acceleration were one second, then the unit of acceleration might be written one mile per hour per second. It is customary to use the same unit of time for both velocity and acceleration; hence, some authors write the unit of acceleration as one foot per second^2, or as abbreviated, 1 ft. per sec.^{2}. J. J.

LIMITS OF CYLINDER AND PISTON VARIATIONS

R. E. N.—Perhaps some reader of MACHINERY will be able to advise what is considered standard practice with reference to the limits of steam pistons and cylinders. Pistons are seldom made an exact fit in the cylinders, and the cylinders are seldom bored perfectly round and cylindrical. What are the maximum and minimum limits in diameter for a piston of the following sizes: 3, 4, 5, 6, 7, 10, 12, 14, 16, 18, 20, 22, 24 26, 28, 30, 36, 42 and 48 inches diameter? What is the permissible distortion of steam cylinders corresponding to the foregoing piston sizes? The character of the engine, no doubt, makes some difference in the permissible variation from standard, as, for instance, a high-speed engine may not require as close limits as a slow-speed engine. The permissible variation may differ for vertical and horizontal engines of the same class. Similar information applying to stationary internal combustion engine cylinders and pistons would be of value.

The questions are submitted to the readers for reply. Anyone who can furnish this information is invited to submit it, preferably in the form of a short article.

CHROMATIC SCALE PROGRESSION

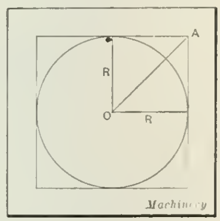
A. B. H.—What is the chromatic scale progression of speeds in machine tools, and how does the chromatic scale progression differ from the ordinary geometrical progression ratios of speeds?

A.—The so-called chromatic scale progression of speeds is merely a special form of geometrical progression in which the ratio is 1.4142, the square root of 2. If this ratio is too high, then 1.189 (the square root of 1.4142 or the fourth root of 2) is used instead. The advantage of the chromatic scale progression is that in the series the ratios 2, 4, 8, 16, 32, etc., appear. This makes it possible to have the back-gears of a lathe that is geared in the chromatic progression in an even ratio, such as 8 to 1. This is advantageous when quick-pitch screws are to be cut and the lathe is so arranged that the back-gears can be thrown in so as to drive the spindle while the lead-screw is driven direct from the cone pulley.

LARGEST BALL THAT CAN BE PUT BETWEEN ANOTHER BALL AND CORNER

H. T. O.—A ball 20 inches in diameter is placed in a cubical box measuring 20 inches on each edge (inside). If eight other balls are placed in the box, one in each corner, what is the greatest diameter of these balls and how is it calculated?

A.—Referring to the diagram, the circle represents the projection of the ball on the bottom of the box, and its radius is the same as the radius of the ball; the center O' is directly under the center of the ball. The distance $O'A$ is the hypotenuse of a right triangle; hence $O'A^2 = R^2 + R^2 = 2R^2$. The center O of the ball is at a distance R from O', and the line from O to A is the hypotenuse of another right triangle $OO'A$; hence, $OA = \sqrt{2R^2 + R^2} = R\sqrt{3}$, and the distance from the point where OA intersects the ball to the point A is $R\sqrt{3} - R = R(\sqrt{3} - 1)$. The center of one of the small balls must lie on the line OA and the distance from the point where it touches the large ball to the point A is evidently $r\sqrt{3} + r = r(\sqrt{3} + 1) = R(\sqrt{3} - 1) = 10(\sqrt{3} - 1)$, r being the radius of one of the small balls. Solving this equation for r, $r = 2.679485$ inches, and the diameter of one of the small balls is two times this, or 5.35897 inches. J. J.



Largest Ball that can be placed between Another Ball and Corner

HAND OF SPIRAL ON MILLING CUTTERS

O. W. M.—In making a number of taper-shank spiral teeth end milling cutters, the question came up as to whether the spiral of the teeth should be of the same hand as the cutter or the reverse. The advantages claimed for a right-hand spiral on a right-hand cutter are that the end teeth have a positive rake and that the chips tend to curl away from the end. The only advantage claimed for the left-hand spiral is that the pressure of the cut, being perpendicular to the face of the tooth, tends to drive the cutter back into the socket and does not tend to loosen and draw it out, as is the case with the right-hand spiral. The disadvantages of the left-hand spiral are that the finish of the work is very rough and the corners of the teeth break easily, both of which I believe are due to negative rake of the end teeth and to the fact that the chips flow to the front end of the cutter, thereby choking it. My experience has led me to believe that the advantages of the right-hand spiral more than offset the tendency to draw out, which is very slight if the cutter is driven firmly into its socket as it should be. An examination of a large number of cutters in the tool-room showed that there were three or four times as many left-hand spiral cutters with broken corner teeth as there were right-hand cutters. It would be interest-

ing to know the opinion of MACHINERY'S readers who have had experience with small tools.

A.—Manufacturers of end-mills, as a rule, use a left-hand spiral for right-hand milling cutters and a right-hand spiral for left-hand cutters, notwithstanding that the practice produces inefficient cutting tools. The fact that the left-hand spiral on a right-hand mill tends to push the cutter firmly into the socket is generally considered to outweigh the disadvantages mentioned. This applies, of course, only when the cutter is used for milling slots and a considerable number of the axial teeth are engaged. If the mill is used as an end cutter only, then the spiral on the right-hand cutter should be right-handed, because the teeth can be given a positive front rake. Some manufacturers of milling cutters prefer end-mills with teeth cut straight for ordinary use, in order to avoid the difficulties due to either the right-hand or left-hand spirals. Discussion of the subject is invited.

HORNER'S METHOD

C. J. B.—Will you please explain, step by step, Horner's Method, which is referred to by J. J. in the How and Why section of the July number of MACHINERY?

A.—A detailed description of Horner's Method would require more space than the editor feels able to spare. The method is fully treated, however, in the following works: "Theory of Equations," Vol. 1, by Burnside and Panton; "Theory of Equations," by Todhunter; and "University Algebra," by Olney. These are all quite advanced works, particularly the first two. It may be remarked that Horner's Method is conceded by practically every authority to be the best general method for solving numerical algebraic equations. J. J.

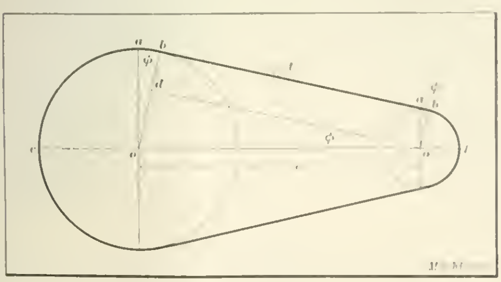
FORCE OF A BLOW

E. M.—I wish to secure the effect of a freely falling weight of 4 ounces dropping 6 inches, when the weight is attached to an arm 8 inches long. In other words, what effect will the attachment of the weight to a pivoted arm have on the velocity and force of the blow, supposing the pivot to be frictionless?

A.—The formula for determining the force of a blow is $ft = mv$, in which f is the force of the blow, t, the time required to bring the body to rest, m, the mass of the body, and v, the velocity at impact. Since it is not usually possible to measure t, the force of a blow is generally calculated by using the principle of work, as explained on pages 278 and 279 of MACHINERY'S HANDBOOK. The velocity is determined solely by the height through which the body falls, and is independent of the path it takes. Hence, the velocity will be the same when the weight moves along the path of an arc of a circle as when it falls freely, provided the height of the fall is the same. The only effect that the attaching of the arm to the weight will have on the force of the blow is that the mass moved is greater; therefore, the rebound will be less, and the penetration will be greater. The striking force will also probably be somewhat greater. J. J.

LENGTH OF OPEN BELT

S. C. J.—Will you please show me how the formula for the length of an open belt, given on page 722 of MACHINERY'S HANDBOOK, is derived?



Length of Open Belt

A.—This formula may be derived in several ways, but the writer prefers the following, as it leads to more accurate results. Referring to the diagram, the angles aob, $a'o'b'$, and $do'o$ are evidently equal, and may be represented by ϕ.

Let D = diameter of large pulley;
d = diameter of small pulley;
R = radius of large pulley;
r = radius of small pulley;
c = distance between centers of pulleys;
L = length of belt

Then $L = 2(ca + ab + bb' + b'f)$

$$= 2\left[\left(\frac{\pi}{2} + \phi\right)R + \left(\frac{\pi}{2} - \phi\right)r + c\cos\phi\right]$$ when the angles are expressed in radians

$$= \frac{\pi}{2}(D + d) + \phi(D - d) + 2c\sqrt{1 - \sin^2\phi}$$

Letting $S = D + d$, $s = D - d$, $S = 2D - s$, and $\sin\phi = \frac{s}{2c}$; the last expression then becomes:

$$L = \frac{\pi}{2}S + s\phi + 2c\sqrt{1 - \left(\frac{s}{2c}\right)^2}$$

From trigonometry:

$$\phi = \sin\phi + \frac{\sin^3\phi}{6} + \frac{3\sin^5\phi}{40} + \text{etc.};$$

$$\text{hence } \phi s = \frac{s^2}{2c} + \frac{s^4}{48c^3} + \frac{3s^6}{1280c^5} + \text{etc.}$$

By the binomial formula:

$$2c\sqrt{1 - \left(\frac{s}{2c}\right)^2} = 2c - \frac{s^2}{4c} - \frac{s^4}{64c^3} - \frac{s^6}{512c^5} - \text{etc.}$$

Substituting these values (and also $2D - s$ for S) in the last expression for L, and letting $\frac{s}{c} = a$, we obtain, after reduction:

$$L = \pi D + 2c - \frac{c}{2}\left(\pi a - \frac{a^2}{2} - \frac{a^4}{96} - \frac{a^6}{1280} - \text{etc.}\right) \text{ or}$$

$$L = \pi D + 2c - \frac{s}{2}\left(\pi - \frac{24sc}{48c^2 - s^2}\right) \text{ very nearly} \qquad (1)$$

The term s^2 in the denominator is small compared with $48c^2$; if it be dropped and s be replaced with its equal $D - d$, Formula (1) will reduce to:

$$L = \frac{\pi}{2}(D + d) + 2c + \frac{(D - d)^2}{4c} \qquad (2)$$

which is the same as the formula in MACHINERY'S HANDBOOK, when $3\frac{1}{7} = \frac{22}{7}$ is substituted for π. Neither formula is quite exact, because the thickness t of the belt has been neglected; if this be also considered, D must be replaced by $D' = D + t$. Formula (2) will give results sufficiently correct for ordinary purposes; but for extreme cases, when $n = \frac{D}{d}$ is large and c is small, Formula (1) should be used. For example, suppose $D = 15$, $d = 3$, and $c = 24$; then, neglecting t, $L = 77.78230$ —; by Formula (1), $L = 77.78219$ —; and by Formula (2), $L = 77.78571$ +. As will be observed, Formula (2) is sufficiently exact for all practical purposes. J. J.

TO CALCULATE THE FIFTH ROOT OF A NUMBER

R. J. B.—Please show me how to calculate the fifth root of a number. I wish a method that does not require the use of an extensive table.

A.—The extraction of the fifth root is always a long and laborious operation, and the writer prefers Horner's method to any other; a full description is too long to give here. As an alternative, the following may be used. Let r = the root to be found; m = the given number; n = the index of the root, so that $r = \sqrt[n]{m}$; then, if x = an approximate value

TABLE OF FIFTH POWERS

x	x^5	
1	1	4.3
2	32	80
3	243	475
4	1024	1735
5	3125	4830
6	7776	11265
7	16807	23200
8	32768	43600
9	59049	76300
10	100000	

Machinery

of r, $r = \left(\frac{m}{x^n} + n - 1\right)\frac{x}{n}$, approximately; and when $n = 5$, $r = \left(\frac{m}{x^5} + 4\right)\frac{x}{5}$, approximately. When $x = r$, $x^5 = r^5 = m$, and the equation reduces to $r = r$, as it should. To apply the formula, first compile a table giving the fifth powers of the numbers from 1 to 10, as shown herewith. The remaining steps are best explained by means of an example; thus, what is the fifth root of 12045.63? By reference to the table, it is seen that the first figure of the root is 6, since 6^5 is less and 7^5 is greater than $12045.63 = m$. By reference to the third column, it is seen that m is greater than 11265; hence, use 7 for x. Had m been less than or equal to 11265, 6 would have been used for x. Now substituting in the formula, $\left(\frac{12045.63}{16807} + 4\right)\frac{7}{5} = 6.60$, to two decimal places. Repeat the process, substituting 6.6 for x, obtaining $\left(\frac{12045.63}{6.6^5} + 4\right)\frac{6.6}{5} = 6.550$ —, to three decimal places. Repeat the process once more, substituting 6.55 for x, obtaining $\left(\frac{12045.63}{6.55^5} + 4\right)\frac{6.55}{5} = 6.548860$ +. The exact root to eight decimals is 6.54886293 —.

The number of figures to which any approximate root is correct can always be determined from the quotient of m divided by x^5 by multiplying the number of 9's at the extreme left of the quotient by 2, adding 1 if the figure following the last 9 is greater than 4. In the first case above, the quotient is 0.72 —; there are no 9's, but the first figure is greater than 4; and the root is therefore correct to $0 + 1 = 1$ figure. In the second case, the quotient is 0.962 —; here there is one 9, and the figure following being greater than 4, the root is correct to $1 \times 2 + 1 = 3$ figures. In the third case, the quotient is 0.99913; here there are three 9's, and the figure following the last 9 being less than 5, the root is correct to $3 \times 2 = 6$ figures. If the number is wholly decimal, multiply it by 100,000 and then divide the root by 10; if the number is greater than 100,000, divide it by 100,000 and then multiply the root by 10. Note that $100{,}000 = 10^5$. While the table of fifth powers is not strictly necessary, it is of great assistance. The formula may be used for any root. Thus, for cube root, $r = \left(\frac{m}{x^3} + 2\right)\frac{x}{3}$, approximately. J. J.

TO FIND THE MAXIMUM BENDING MOMENT OF A BEAM

M. A. P.—I enclose a sketch showing a simple beam AB, 25 feet long, which carries a uniform load (including its own weight) of 32 pounds per foot and several concentrated loads distributed as shown. Please show me how to find the maximum bending moment.

A.—It is necessary first to find the reactions of the supports. Denote the reaction of the left support by R_1 and that of the right support by R_2, and take the left support as the center of moments. Noting that the entire weight of the uniform load is $25 \times 32 = 800$ pounds and that the center of gravity is midway between the supports, or 12.5 feet from each, we have: $25R_2 = 800 \times 12.5 + 250 \times 2 + 150 \times 5 + 400 \times 9 + 200 \times 16 + 350 \times 22 = 25{,}750$; whence $R_2 = 1030$ pounds. Taking R_2 as the center of moments, $25R_1 = 800 \times 12.5 + 350 \times 3 + 200 \times 9 + 400 \times 16 + 150 \times 20 + 250 \times 23 = 28{,}000$; whence $R_1 = 1120$ pounds. Next, add successively, and in order, the various uniform and concentrated loads until the sum equals or exceeds the left reaction $R_1 = 1120$ pounds, as shown.

$32 \times 2 =$	64
	250
	314
$32 \times 3 =$	96
	410
	150
	560
$32 \times 4 =$	128
	688
	400
	1088
$32 \times 7 =$	224
	1312

Note that there are three concentrated loads between the left support and that point on the beam where the sum of the loads on the left of the section at that point is equal to $R_1 = 1120$. The sum of these three loads is 800 pounds; subtract this sum from R_1, obtaining $1120 - 800 = 320$. Now divide this result by the weight of the uniform load per foot, obtaining $320 \div 32 = 10$ feet = the distance from the left support to the dangerous section, marked x in the illustration. The maximum bending moment is then equal to (taking n as the center of moments) the moment of the left reaction minus the moments of all loads on the left, or $M = 1120 \times 10 - 32 \times 10 \times \frac{10}{2} - 250 \times 8 - 150 \times 5 - 400 \times 1 =$ 6450 pound-feet = 77,400 pound-inches.

That this method is correct is easily shown. Thus, draw the vertical line am through the point of left support, and on this line (to any convenient scale) lay off $ar = R_1$ and $rm = R_2$; the line am is called the load line. On this line, lay off a–$1 = 32 \times 2$ (the first section of the uniform load), 1–$2 = 250$ (the first concentrated load), 2–$3 = 32 \times 3 = 96$ (the second section of the uniform load), 3–$4 = 150$ (the second concentrated load), and so proceed until all the loads have been laid off. Through the points where the various loads are concentrated on the beam, draw vertical lines, as shown, and through the points 1, 2, 3, etc., on the load line, draw horizontal lines intersecting the vertical lines in the points b, c, d, etc. Connect these points by the broken line *abcdefghijkl;* this line is called the shear line. Through the point r, draw the horizontal line *rs;* this line is called the shear axis. In works treating of the strength of materials, it is shown that the dangerous section occurs where the shear line crosses the shear axis; in this case it would pass through the point t in the diagram and the point n on the beam, which lies on the vertical through t. From the method of construction, it is evident that ab, cd, ef, etc., are parallel. Produce hg until it intersects the load line in g'; then the triangles $a1b$ and $g'rt$ are similar right triangles, and $\frac{b1}{1a} = \frac{tr}{rg'}$, or $tr = x = \frac{b1 \times rg'}{1a}$. But, $b1 = 2$, and $1a = 64$; hence, $\frac{b1}{1a} = \frac{2}{64} = \frac{1}{32}$, the reciprocal of the uniform load per foot. Finally, rg' is evidently the uniform load from A to the dangerous section at n. J. J.

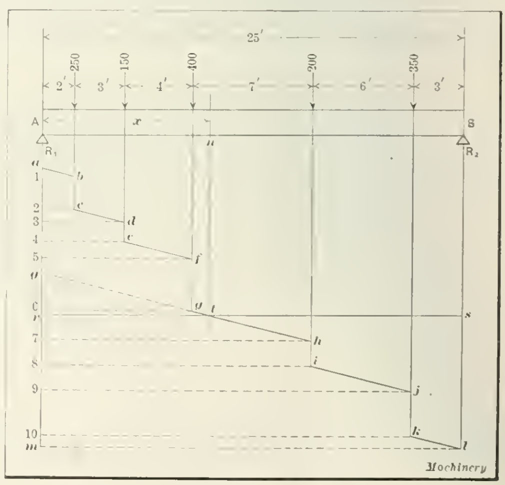


Diagram for calculating Maximum Bending Moment of Beam

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

FRASER UNIVERSAL CONVERTIBLE GRINDING MACHINE

The Fraser grinding machine meets the demand for a small universal grinding machine to handle cylindrical, internal, and surface work. The feed mechanism of the machine is accessible and the entire table control mechanism may be removed in a unit by the withdrawal of six screws. By means of the improved table reverse mechanism, a table stroke as short as one-half inch may be obtained.

The Warren F. Fraser Co., Freeport St., Boston, Mass., has developed and put on the market the universal grinding machine shown in Figs. 1 and 2. This machine is designated as the No. 1 size and can be used as a cylindrical grinding machine for handling work up to 8 inches in diameter and 20 inches in length; as an internal grinding machine for work up to 8 inches outside diameter; and as a surface grinding machine for handling work 5 inches wide and 20 inches long.

As is shown in Figs. 1 and 2, the base is of box type and is very broad to afford adequate support for the working parts of the machine. The three-point principle is employed for supporting the upper part of the machine. A feature of the machine is the unit construction of the apron that permits all the feed mechanism to be taken out as a unit by removing six cap-screws that attach this apron to the front of the machine. Figs. 3 and 4 illustrate the apron and its mechanism removed from the machine. The lubrication of the apron shaft is effected through oil pipes that run from the apron plate to the various shaft bearings, as indicated in Fig. 4. Those shaft bearings that run at high speed are hardened and ground and run in bronze bushings.

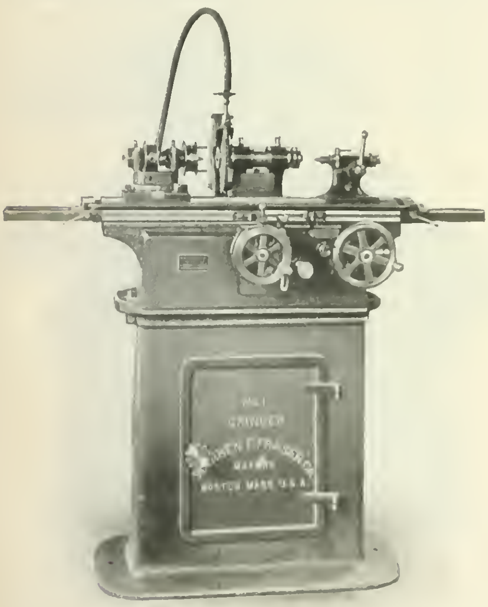


Fig. 1. Fraser Universal Grinding Machine—Front View

Headstock and Tailstock

The headstock is of the swivel base type and can be set at any angle in a horizontal plane. It is graduated to give any reading from 90 degrees on one side of the center to 45 degrees on the opposite side. Both headstock and tailstock have a liberal length of bearing on the table. The headstock spindle is of bessemer steel, carbonized, hardened and ground at all points except the thread diameter. The taper seats for the centers are also ground in the headstock and tailstock. The headstock spindle runs in bronze boxes, the front one being a double angle bearing—5 degrees and 45 degrees—thus providing adjustment for wear. The rear headstock bearing is a solid bronze bushing which, considering the low speed at which the work-spindle runs, amply takes care of the bearing needs. The wheel-spindle can carry wheels up to 8 inches in diameter and $\frac{1}{2}$ inch face, and it will be noticed that the spindle is double-ended so that the wheel may be mounted at either end. The wheel-head may be swiveled to any angle on the slide regardless of the position of the slide and its base. This is graduated to 45 degrees on each side of a right-angle position. The tailstock spindle is hardened and ground and is provided with a No. 1 Morse taper for the tail-center. The tailstock is provided with a spring center and a lever binder.

The wheel-head bearings are wick-oiled, and the oil is inserted in the oil-cup at the top and runs down to the bottom and into a reservoir; from there it is fed to the contacting surfaces by wicks that preclude the admission of grit to the actual bearing surfaces. The spindle adjustment for the bearings is made by turning collars on the ends of the bearing bushings, bringing them together and adjusting both bearings at the same time.

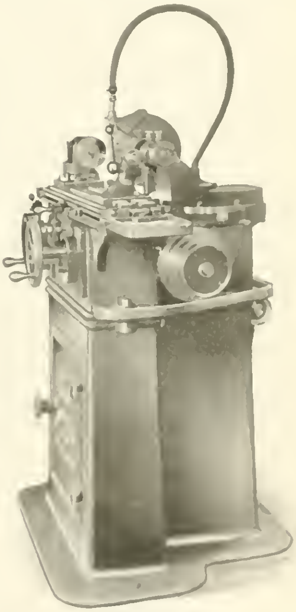


Fig. 2. Fraser Universal Grinding Machine—Side View

Table Controlling Mechanism

The table swings upon its bearings on the carriage about a hardened and ground spindle stud. An eccentric binding screw at each end of the table holds it in any desired position. The end scale is graduated to provide settings at angles up to 70 degrees each side of the center and for grinding any taper up to 2 inches per foot. A screw adjustment is provided.

The working surface of the table is $5\frac{1}{4}$ inches wide and 32 inches long, not including the surface outside of the waterways at the end, which if included, gives a total length of 36 inches. The working surface has a central part $3\frac{1}{2}$ inches wide, and is raised $\frac{3}{8}$ inch above the table proper. The headstock and tailstock are lined against the front edge of this raised surface. A single T-slot furnishes the means of attaching headstock, tailstock, center-rest and surface grinding chuck. At the front face of the carriage are the dogs that limit the length of the grinding stroke. The ways on which the carriage runs are of V type, and are 35 inches long and spaced $5\frac{1}{2}$ inches apart. The carriage has long extension

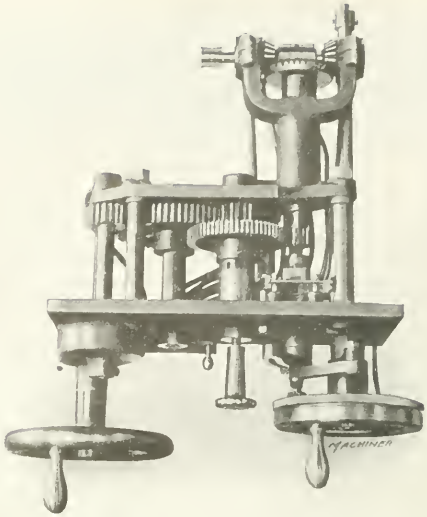


Fig. 3. Apron Unit, comprising Entire Mechanism of Table Control

ends that overhang and protect the ways at all points of the travel.

All the movements of the carriage are controlled by the single apron unit attached to the front of the bed. All the operating mechanism for the various table movements is therefore contained in a unit and entirely enclosed in the frame of the machine. Rack and pinion operated mechanism is used for reciprocating the table, and this, as well as the automatic cross-feed mechanism and the reversing mechanism, is controlled directly from the apron. The "load and fire" mechanism for the reversal of the table is very accurate and changes the direction of travel within a minimum length of $\frac{1}{2}$ inch, so that if necessary, a $\frac{1}{2}$ inch longitudinal travel of the table may be given. There are four changes of table travel provided, giving from four to thirteen feet travel per minute. By referring to the side elevation of the machine shown in Fig. 2, it will be seen that there is a four-step cone on the drive-shaft that provides for the different table feeds and speeds. The work-spindle is provided with speeds ranging from 60 to 150 R.P.M. through the countershaft. The wheel-spindle may be operated at 2750 or 3850 R.P.M. as desired.

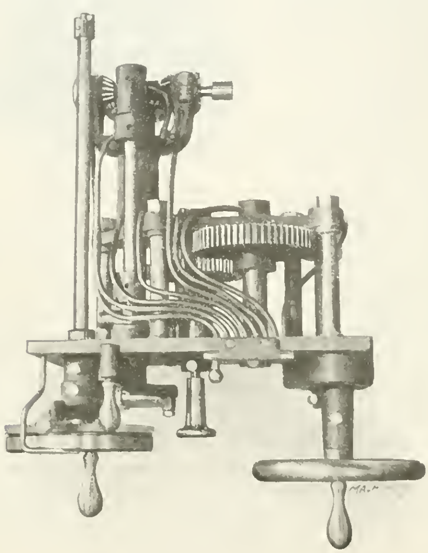


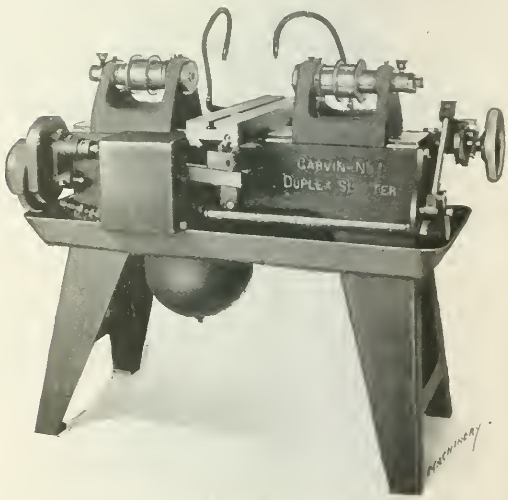
Fig. 4. Lubricating System for Apron Unit

An automatic cross-feed is provided for the wheel-head that may be adjusted to give as low a feed as 0.00025 inch per table stroke. Lubrication for the work while in operation is secured from a water pump in the tank at the left-hand side of the machine at the rear. The approximate weight of the machine is 1500 pounds without countershaft, surface or internal attachment; the shipping weight of the machine complete is about 2700 pounds.

GARVIN NO. 1 DUPLEX SLOTTING MACHINE

In operating the full automatic duplex slotting machine which forms the subject of the following description, it is only necessary to put the work in place, after which the machine will complete the operation without requiring further attention and stop cutting when the work is finished. A wide range of operations can be handled, among which may be mentioned milling in steel or other materials, slots from $\frac{1}{4}$ inch to 4 inches long by $\frac{1}{4}$ to $1\frac{1}{2}$ inch in width right through work up to 4 inches in diameter. Among the classes of work for which the machine is adapted are cutting drift holes in drill press spindles, slots in toolposts, keyways, elongated holes or slots in castings, taking mortising cuts, and a great variety of similar operations. Working from both sides at once, machining is done in half the usual time; two pieces can be handled at the same time without extra effort on the part of the operator. The work is done much faster than by the method of jig drilling and slotting, partial sawing out or butt milling.

The work-table is moved back and forth at uniform speed by a cam and adjustable lever, which can be conveniently and quickly set for any length of stroke within the capacity of



No. 1 Automatic Duplex Slot Milling Machine built by Garvin Machine Co.

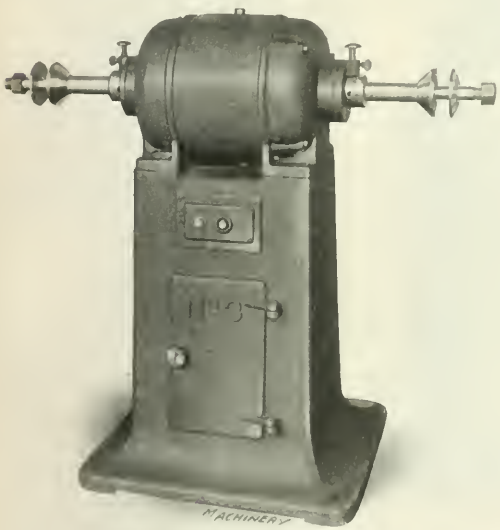
the machine. A cone pulley drive and change-gears provide changes of speed suitable for different conditions, short cuts being taken quickly and longer cuts more slowly. The cam has a large size groove and hardened roller, being driven by a worm-gear; and both the cam and driving gears are adequately protected. The spindle heads are designed for operation at high speed and the spindles are tapered at both ends and run in solid bronze boxes that have adjustment for wear, and means of supporting the thrust. Tapered gibs are provided for the headstock and work-slide, the heads being fed in to cut automatically and simultaneously by right- and left-hand screws controlled by a ratchet. In milling a "through" slot, provision is made for backing away one head automatically when the slot has been almost cut through, so that the other head can continue to advance and complete the slot. In this way no partition is left in the bottom and the work does not require subsequent attention from the operator. The feed by pawl and ratchet is adjustable, and can be set to lift out and

stop feeding automatically when the required depth of cut is made, thus insuring absolute uniformity of product without attention from the operator. Feeding takes place at each end of the stroke.

Each head is independently adjustable along the bed to suit different lengths and conditions of cutters, positions of work on the table, etc. The headstocks are moved in and out simultaneously by a handwheel and may be brought to any position without interfering with the setting of the machine. Work can be set at any angle on the table to produce a taper end in a slot. Two-prong "fish-tail" cutters are used, and adjustable fixtures may be furnished to hold round work. Changes of speed for different sizes of cutters are provided by friction cone pulleys on the countershaft. The spindle pulleys are driven by drums on the countershaft and all working parts are outside the bed where they are readily accessible. All gearing is protected and the machine is equipped with a steel oil-pan and tank, strainer, pump and piping for handling the lubricant. This machine is a recent product of the Garvin Machine Co., Spring and Varick Sts., New York City.

GARDNER POLISHING LATHE WITH PUSH-BUTTON CONTROL

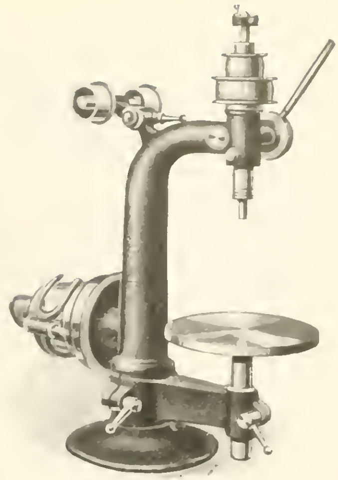
The accompanying illustration shows a No. 3 motor-driven polishing and buffing lathe built by the Gardner Machine Co., Beloit, Wis., which is equipped with push-button control for starting and stopping the motor.



No. 3 Gardner Polishing and Buffing Lathe with Push-button Control

The push-button control station is a very effective and convenient feature; the button on the right is used for starting, and is located below the surface of the plate in order to remove the possibility of accidental starting; the left-hand or stopping button is provided with a simple locking device which constitutes a further precaution against accidentally closing the circuit. Either adjustable or constant speed direct-current motors can be furnished. When adjustable speed is used, the lever within the base is moved to the desired point, and by pressing the starter button the motor comes up to the speed at which it is set. In alternating-current motor-driven machines only certain speeds are available.

The motor is fully enclosed, making it absolutely dust- and dirt-proof. For ventilation a fan attached to the motor shaft within the cover draws air up from the base at the right-hand side and forces it through the motor and down into the pedestal at the left. Perfect air circulation is obtained under all normal conditions. Ample power is provided as demonstrated by the fact that under tests the motors have withstood 50 per cent intermittent overloads of considerable duration. The spindle is provided with a locking device. A button-head pin acting over a coil spring is pushed down into one of the four holes in the spindle collar, which locks the spindle when it is desired to change wheels. In addition to the No. 3 size shown in the accompanying illustration, these machines are manufactured in several other sizes.



Cleveland No. 1 Sensitive Drilling Machine

CLEVELAND SENSITIVE DRILLING MACHINE

The Cleveland Lathe & Machinery Co., Section E, Whitney Power Bldg., Cleveland, Ohio, is now building the No. 1 10-inch sensitive drilling machine here illustrated and described. This machine is built in two types, one of which has the spindle mounted in ball bearings, making it suitable for operation at 5000 revolutions per minute, while the other has a plain spindle bearing and may be run at 1000 revolutions per minute. The design is extremely simple and clearly shown by the illustration. The following are the principal dimensions of the machine: The maximum distance from spindle to table is $7\frac{1}{2}$ inches; maximum vertical movement of spindle, $2\frac{1}{2}$ inches; maximum vertical movement of table, $7\frac{1}{2}$ inches; diameter of table, $8\frac{1}{4}$ inches; distance from center of spindle to frame, $5\frac{1}{8}$ inches; drilling range, all drills up to 5/16 inch in diameter; size of tight and loose pulleys, 4 inches in diameter by $1\frac{1}{2}$ inch face width; and weight of machine, 50 pounds.

AMERICAN CORK-INSET PULLEY

The American Pulley Co., 4208-60 Wissahickon Ave., Philadelphia, Pa., is now manufacturing a line of cork-inset pulleys, one of which is shown in the accompanying illustration. For many classes of service, but especially on main drives, the use of pulleys of this type is the means of materially improving the efficiency of power transmission systems. In many cases belt slippage is not an evidence of faulty pulleys, but is an indication of a too heavily loaded or greasy belt. Where it is found that the load is too great for the drive, the usual practice is to add another pulley to the shaft or substitute a larger one. It is claimed that the same results may be obtained by substituting a steel pulley with cork insets, as the cork improves the grip of the belt on the pulley. The corks are firmly set in the steel, wear indefinitely and are

American Split Steel Pulley with Cork Insets

practically unaffected by dust, oil or water.

Loss of efficiency through belt slippage not only reduces the rate of production and wastes power, but in certain cases failure of machines to operate at the desired speed may be the cause of turning out defective work. In many factories an effort is made to overcome troubles of this kind by lagging and relagging pulleys or by running belts at an excessively high tension, which results in injury of the belt and an abnormally high journal friction. Various belt dressings are also used, and in some cases this practice is followed on a scale that means an appreciable yearly charge on the expense account.

The following results of tests conducted at the Lowell Textile School and at the Worcester Polytechnic Institute show the increase of efficiency which was effected by applying cork insets to different types of pulleys: Gain in steel pulley with cork insets over same pulley without insets, 60 per cent; gain in iron pulley with cork insets over same pulley without insets, 51 per cent; gain in wooden rim pulley with cork insets over plain steel without insets, 42 per cent.

The American Pulley Co. has developed a method of applying cork insets to belt pulleys which does not add to the weight of the pulley. For heavy drives with cork-inset pulleys and little or no belt slip, the first point to be considered is the required width of belt to transmit the load without overstraining the belt. As in the case of other types of pulleys, the face width should be suitable for the belt.

MILBURN WELDING AND CUTTING TORCHES

The illustrations presented in connection with the following description show welding and cutting torches, and the acetylene generator for use in connection with them, which are recent products of the Alexander Milburn Co., 1420-1426 W. Baltimore St., Baltimore, Md. The welding torch shown in Fig. 1 is designed to take advantage of a special method of mixing which produces a uniform welding flame and eliminates back-firing at the tip. Mixing of the gases begins just ahead of the grip, where both the acetylene and oxygen enter a conical shaped chamber under pressure; and the process of mixing continues throughout the passage to the head, being finally perfected within the tip itself. The mixture becomes absolutely uniform through this thorough intermixing, resulting in great steadiness and fine quality of flame. It is also claimed that the torch is economical in its use of oxygen and acetylene. The torch is substantially built of tubing, all parts having ample weight to give the required strength without any unnecessary metal to make the torch cumbersome to use. The arrangement of the grip and valves insures easy handling, and the whole torch is extremely simple and has few parts. Six interchangeable copper welding tips are provided to handle all classes of work encountered in ordinary practice; and union hose couplings facilitate connection and changes of torches. The length of the welding torch is 18 inches and its weight 2½ pounds.

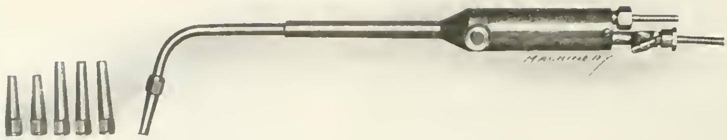


Fig. 1. Oxy-acetylene Welding Torch made by Alexander Milburn Co.

The cutting torch has ample power for working on any thickness of steel within the range of oxy-acetylene cutting; and at the same time it is highly efficient when operating on very light metal. The mixing principle for the heating flame is the same as that employed in the welding torch, resulting in great economy in the use of gas and eliminating trouble from back-firing. The heating gases are mixed throughout their passage from the handle to the head and mixing is finally completed within the tip, the mixed gas being delivered to the flame at uniform positive pressure. The high-pressure cutting oxygen is controlled by a positive thumb valve which opens and closes quickly with a spiral motion; this valve will remain fixed in either the open or closed position without pressure from the hand. The cutting oxygen is led to the center of the flame by means of the upper tube and a central orifice in the tip, producing a thin, sharp kerf. The head and tip of the torch are of very simple construction, with no small parts to get out of adjustment or burn out. No parts are concealed in the handle and all valves are accessible from the outside. Three interchangeable tips are provided for light, medium and heavy cutting operations. Union hose couplings are used which are interchangeable with the welding torch. The length of this torch is 18 inches and its weight 3½ pounds.

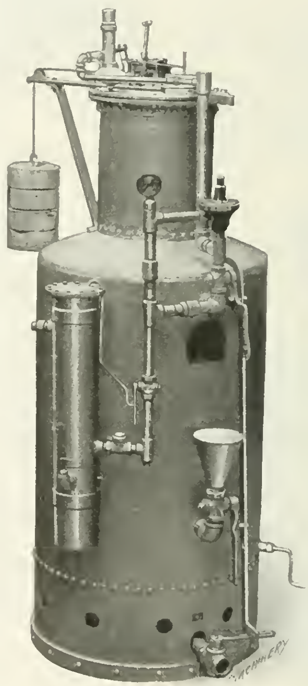


Fig. 2. Acetylene Generator built for Use with Milburn Welding and Cutting Torches

The Milburn acetylene generator shown in Fig. 2 is substantially constructed and provided with positive automatic feed mechanism and all devices for safety and convenience. It is included in the list of standard devices published by the National Board of Fire Underwriters and has also been approved by the New York Fire Department. The generator is built of heavy gage steel with oxy-acetylene welded joints, and is galvanized complete after the welding has been finished. All fittings are made of malleable iron, steel or brass. For use in connection with welding and cutting outfits, the company is prepared to furnish oxygen and acetylene pressure regulators which insure steady regulation of gas and eliminate valve and gage troubles. These regulators are very accurate and give any desired pressure from the full tank pressure down to a few ounces per square inch.

CLEVELAND ENGINE LATHE

The 18-inch double back-geared engine lathe illustrated and described herewith is a recent product of the Cleveland Lathe & Machinery Co., Section E, Whitney Power Bldg., Cleveland, Ohio. The hollow spindle is made of 50-point carbon steel; and the feed-shaft and lead-screw drives are both reversing in the head. In ad-

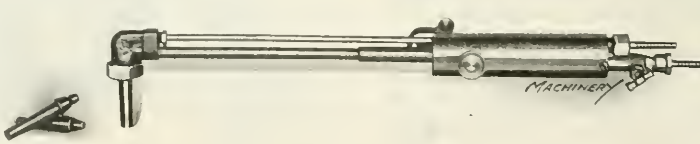
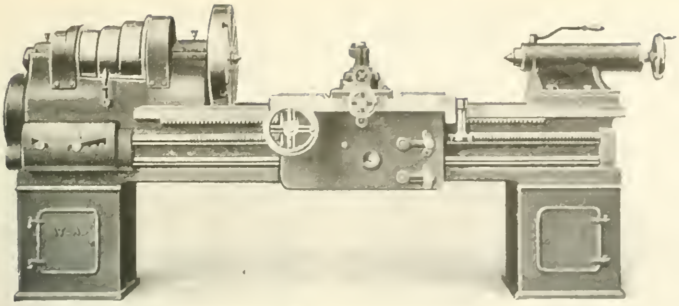


Fig. 3. Milburn Oxy-acetylene Cutting Torch



Double Back-geared 18-inch Engine Lathe built by Cleveland Lathe & Machinery Co.

dition, separate reverse for the feeds is provided in the apron. Eighteen changes of speed are available; and a positive quick-change drive is provided for the feed-shaft. The carriage has a bearing for its entire length on the vees; and the apron is of the double plate type which affords a double bearing for all shafts and studs, thus preventing overhang and consequent strain. The regular equipment included with the lathe consists of a steadyrest, large and small faceplates, change-gears, a double friction countershaft, indicating dial for thread cutting, and the necessary wrenches for making all adjustments.

The principal dimensions of this lathe are as follows: swing over bed, $18\frac{1}{2}$ inches; swing over carriage, $12\frac{1}{4}$ inches; distance between centers for an eight-foot bed, 45 inches; diameter of front journal, $3\frac{1}{2}$ inches; length of front journal, $6\frac{1}{2}$ inches; diameter of rear journal, $2\frac{3}{4}$ inches; length of rear journal, 6 inches; length of carriage on shears, 30 inches; diameter of hole through spindle, 1 9/16 inch; diameter of tailstock spindle, 3 inches; travel of tailstock spindle, up to $7\frac{1}{2}$ inches; taper of spindle centers, No. 5 Morse; diameter of cone pulley steps, 9, $10\frac{1}{2}$ and 12 inches; width of driving belt, 4 inches; ratio of back-gears, 3.7 to 1 and 10 to 1; pitch of lead-screw, 4; range for thread cutting, 2 to 24 threads per inch; and net weight, with eight-foot bed, 3400 pounds.

JENCKES BAND TURNING LATHE

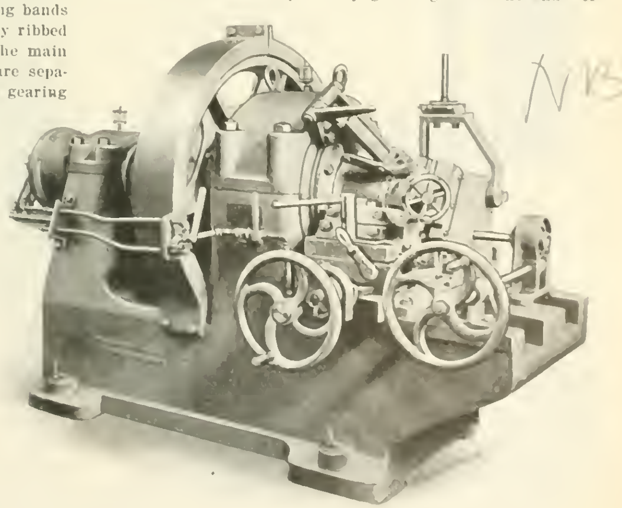
The Jenckes Machine Co., Ltd., Sherbrooke, Quebec, Canada, has recently placed on the market the single-purpose lathe illustrated and described herewith, for turning copper bands on British shells. This machine is especially adapted for operation on 8- and 9.2-inch British shells, and is equipped with an air chuck to facilitate rapid handling of the work. The spindle is enlarged to provide for turning and finishing bands on shells up to the 12-inch size. The bed is a heavily ribbed box section that extends to the rear and supports the main driving shaft and pinion. Bearings for this shaft are separate and bolted to planed pads in order to match the gearing properly. The main spindle bearings are cast integral with the bed, the front bearing being 16 inches in diameter by 14 inches long, and the rear bearing 9 inches in diameter by 10 inches long. The bearing caps are machine fitted and held to the bed by four heavy studs in each cap. The bearings are lined with babbitt metal which is hammered into place, bored and scraped to fit the spindle accurately. Means of compensation for wear are provided by placing a number of shims between the cap and bed before the boring operation; and when the final adjustment is made, the cap is drawn solidly down onto the shims.

The spindle is a heavy steel casting finished by turning on the outside, boring on the inside and finally grinding to the required size. The shell is held in this spindle by a Jenckes collet type of chuck, controlled by an air cylinder at the rear of the spindle, and the jaws are positively closed or opened by means of a four-way valve. The drive is transmitted through a heavy back-shaft and cut gearing having a reduction of $4\frac{1}{2}$ to 1. An air clutch pulley is provided on this shaft, which is of the taper type with cork insets, the clutch being controlled by means of an air cylinder and three-way valve located near the operator's stand. Springs under compression release the clutch when the air is turned off.

The rough-shaping of the band is accomplished by means of two form tools made of high-speed steel, which are comparatively long-lived, as they are ground on the ends in sharpening, which does not change their shape. Each of the tools is securely held in a dovetailed fit in a steel tool-block by two $\frac{3}{4}$-inch taper-head bolts. Both tools are further supported by an adjustable jack, so that the clamping effect of either tool helps to hold the other, and permits of quickly replacing the tools after they have been ground. Each tool cuts approximately one-half the band width, and the tool-block has a quick and convenient shift in a sidewise direction by means of a rack and pinion; it is accurately located by a single stop-rod and lock-nut.

An accurate method of determining the depth of cut is provided by means of a graduated dial and two adjustable pins that can be screwed in or out, and which come flush with the face of the feed-screw housing when the tool has approached the desired depth of cut. The exact depth is determined, however, by means of a pointer and adjustable dial, making it possible for the operator to hold the cut within close limits. The under-cutting operation is effected by means of a separate tool and block mounted on the main or roughing tool-block. This is in line with the under-cut when the tool nearest the base of the shell has finished its work and been slightly withdrawn.

The band is finally finished by means of a shaving tool which is arranged to feed down an inclined block at the rear of the shell. This block is furnished with a slight adjustment to or from the shell, and means are also provided to rotate the block slightly in order to vary the diameter of the band at each end. The feed of the tool is through a rack and pinion on the block, and then through a worm and wheel to the handwheel at the front of the machine on the operator's right hand. The tool used for this work is made of high-speed steel with the face milled to the exact contour of the finished band. It is located in the slide by a dovetail that supports the full length of the tool, and is held securely by a clamp and two bolts. The tool is sharpened by grinding it on the end. A



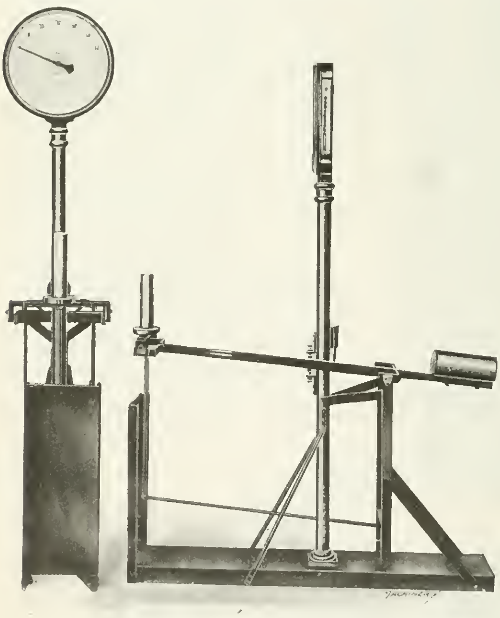
Special Lathe built by Jenckes Machine Co. for turning Copper Bands on British 8- and 9.2-inch Shells

double scraper tool is attached to this back tool-block and is made adjustable sidewise to bring it into alignment with the finishing tool. The two scraper tools are set in slots in the tool-block at the correct distance apart for the width of the band; each tool is adjustable by means of set-screws so that they can be made to come down close to the shell without actually cutting the steel.

The tool-block is counterbalanced and swung up out of the way while the shell is being set up or removed from the machine. The work is located in the chuck by means of a swinging stop attached to the cap above the spindle; this stop swings down and is located in position by means of a toggle lever, the shell being pulled back until the band bears against a stop, after which the operator turns on the air to close the chuck, swings the stop up out of the way, turns the air on the clutch pulley which starts the machine, and proceeds to feed in the roughing tool which performs the first operation.

CHATILLON AUTOMATIC TEST SCALE FOR SHELLS

John Chatillon & Sons, 85-93 Cliff St., New York City, have recently developed a scale for indicating whether a shell is under or over the prescribed weight, which in the case of the shell shown in the accompanying illustration is 5 pounds, 11 ounces and 5 drams. It will be observed that the weight of the shell is entirely counterbalanced, thereby confining the fluctuations of the pointer to an indication of variation. In



Chatillon Test Scale for determining Variation of Shells from Standard Weight

order to show this clearly, a reading index 13 inches in length is provided, which covers a range from 8 to 14 ounces by drams. For the shell referred to, a test weight of 5 pounds, 8 ounces is furnished, so that the operator can see at any time if the scale is in balance. While this scale was developed primarily for handling 3-inch shells, it can be adapted for handling larger sizes.

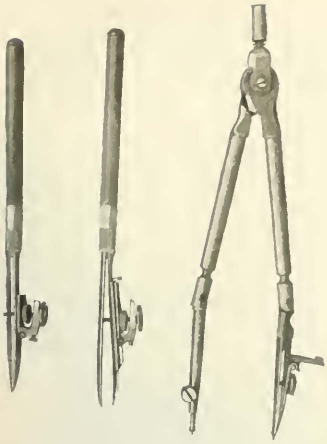
NORRMAN AUTOMATIC MULTIPLE ADJUSTING PEN

Many have undoubtedly noted the inefficient and unscientific methods employed at present in tracing or inking in drawings —especially machinery drawings—where many fine, heavy and dotted lines are intermingled. It is, of course, impossible to work out any standard methods, since the conditions vary with each individual case, and the draftsman has generally been allowed to follow his own judgment in doing this work. Sometimes he frequently adjusts and readjusts the pen in drawing these lines, without any system at all. This, of course, results in slow and inefficient work; and the experienced draftsman, in order to do his work quickly and neatly, traces in the heavy lines first and then inserts the fine and dotted lines later, or *vice versa*. By this method, however, the draftsman will have to locate the lines twice and adjust the T-square or triangle twice before a line can be completed. The expenditure in physical and mental energy is consequently about twice as great as it actually should be; and before a drawing is completed this has been repeated several hundred times. Furthermore, in inking in fine lines exclusively, it frequently occurs that the ink will not run freely. It dries in the pen, forming a crust that can be removed only by cleaning. As a result, inking in is a slow and tedious process.

It was in an endeavor to improve these conditions that A. E. Norrman, P. O. Box 701, Portland, Me., gave this matter thorough consideration and found that the modern principles of efficiency could be applied to advantage in the process of tracing or inking in, thereby improving the present wasteful methods. For that purpose it was, however, necessary to design a drawing pen with entirely new facilities, making the pen automatically adjustable for lines of different thicknesses in such a way that the adjustment could be altered at will. This problem was successfully solved, and the specific improvements are embodied in a detachable adjusting device that can be applied to any standard drawing pen without necessitating alterations of any kind in the pen itself. This device is shown in the accompanying illustration in different modifications, in combination with a standard pen, a compass and a pen with a special attachment for spreading the blades for cleaning. It will be seen that the detachable adjusting device for the standard pen consists principally of a specially shaped lever and cam-lever that is pivoted to the lever formed so as to fit the upper blade of the pen and clamped to it by means of the ordinary adjusting screw. The cam-lever is provided with two operating points, both co-acting with adjusting screws located on each side of the pivot, so that in the operative position of this cam-lever both points will bear evenly on the blade, while a projecting part of the lever forming an operating handle extends over the head of the adjusting screw of the pen. The operating point toward the nib of the pen is shaped as a cam and co-acts with an adjusting screw in the rear part of the cam-lever, while the operating point in the front is shaped distinctly as a lever and co-acts with a screw in the operating handle immediately above the ordinary adjusting screw.

When the cam-lever is in its inoperative position, the pen can be adjusted to draw a heavy line by means of the ordinary adjusting screw, the cam-lever being kept firmly in place by the spring action of the blades of the pen. It will now be noticed that in holding the pen in the correct position for drafting, the index finger of the user rests directly on the wide-headed adjusting screw in the operating handle of the device, and enough pressure may be exerted on the head of this screw to hold the pen firmly. The pen, of course, will now draw a heavy line. If sufficient pressure is exerted on the head of the large adjusting screw to overcome the spring action of the blade of the pen, the adjusting lever will act on the blades, forcing them to close until the co-acting adjusting screw rests on the head of the adjusting screw of the pen. The pen will now draw a fine line that can be adjusted by means of the large adjusting screw of the device. As soon as the pressure is removed, the spring action of the blades will force the pen back into its former adjustment, thus drawing a heavy line. The pressure required for this adjustment is slight, yet very distinct, and thus we have the means to change quickly and accurately the adjustment of the pen during drafting.

The operating lever can also be swung back into a position where the small adjusting screw in the rear will rest on the upper blade of the pen. In this position the adjusting cam will act on the pen, and the pen will draw a fine line that can be adjusted by the small adjusting screw. This adjustment will be self-locked by the spring action of the blades, and the



Norrman Detachable Adjusting Device for Standard Drafting Pen; Adjusting Device with Means for spreading Blades; and Compass fitted with Adjusting Device

pen will draw a fine line as long as the operating lever remains in this position. It is desirable that adjustment of the pen from a heavy to a fine line and *vice versa* should be accomplished in a minimum of time, in order to draw lines that appear partly heavy and partly fine. This is accomplished with the adjusting lever that requires a motion of only a few hundredths inch for the adjustment. On the other hand, in drawing fine lines exclusively or fine lines with an intricate curvature, it is not always possible or convenient to exert the required pressure on the head of the large adjusting screw, and in that case the self-locking cam adjustment should be used. Therefore, if the three line adjustments are all made different, the self-locking adjustment should be made fine to draw center lines, dimension lines and lines for cross-hatching, while the self-releasing adjustment should be used for dotted lines only, and made just a shade finer than the heavy line adjustment. In this way, very attractive and clear drawings are secured.

It must be mentioned that the operating handle is in immediate proximity to the index finger of the user so that efficient handling of the pen will be easily acquired. Great care has also been exercised to make the details of the device fulfill all requirements. The multiple adjusting pen is neat, simple and of a practical construction. The pen with the attachment for spreading the blades is practically the same as the standard multiple adjusting pen, except for a special filler piece between the base of the adjusting device and the upper blade of the pen. A sliding motion of the filler piece will effect the closing and the opening of the blades. For the compass, only the self-locking adjustment has been provided, and the device has been clamped to the compass pen in a somewhat different manner, as it can be operated to better advantage in this position.

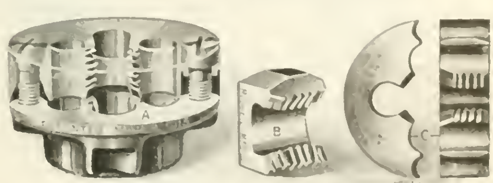
It seems obvious that up to the present time very little attention has been given to the process of inking in or tracing drawings. So, for instance, it is possible to see draftsmen who handle the pen in an entirely incorrect and unwieldy manner, and it seems that many students in receiving instructions simply have been requested to produce a certain drawing to conform with a given sample, but they have been able to suit themselves as to how to produce it. Also the time and personal effort required to make a certain drawing has never been seriously investigated. However, in using the new multiple adjusting pen in a systematic manner it is evident that great saving in time and energy can be achieved, besides making the occupation of drafting easier and more pleasant for the draftsman. Instead of searching all over the drawing for lines of the particular thickness for which his pen is set, he can confine his attention to one part of the drawing, inking in fine lines, dotted lines and heavy lines as he proceeds from one part of the drawing to the other. He will finish his work in less time and make a better looking drawing, as all the various lines are of a uniform thickness. He will also save much mental effort and worry, as the annoying search for small odds and ends will practically be eliminated. It will also be noted that in constantly changing the automatic adjustments of the pen the crust that forms in the drying of the ink will be broken up, and actual experience in using this pen has proved that the ink will run freely and the lines will be of uniform thickness, whether the pen is full of ink or nearly empty.

There is, furthermore, another side of the question that has not been given due attention. This is the time it requires to read a drawing. In many factories it is customary to send out from the drafting department almost unreadable blueprints from pencil sketches. Frequently it is requested that the dotted lines be of the same thickness as the full lines, screw threads are not always shown with the customary alternate fine and heavy lines, and the use of light and shade lines has already long been abolished—all in an effort to cut down the cost of drafting to the absolute minimum. However, there can be no question of the advantage of a clear and easily read drawing. It eliminates the possibility of costly mistakes. The man in the shop, the patternmaker, machinist or assembler—whoever it may be—will spend less time in studying the drawing and more for actual productive work, and as he is often a higher paid man than the draftsman, the saving will be worth considering. Many times the chief engineer or the superintendent has to spend much of his valuable time in studying a drawing that could have been made much clearer by a little more care and attention on the part of the draftsman. Therefore, if we sum up all the advantages derived from the use of the new multiple adjusting pen, we find that it not only facilitates the work of the draftsman and enables him to give better service to his employer, but it will also indirectly result in greater efficiency in the shop.

RUSSELL DOUBLE REVERSIBLE DIES

The dies in all screw plates made by the Russell Mfg. Co., Greenfield, Mass., are now made to cut from both faces and are known as "double" dies. This development enables them to do certain classes of work which cannot be performed with other styles of dies. For instance, when a thread is to be cut close up to a shoulder or a very short piece is to be threaded, the cut should be made from the front face of the die. In this way, the space which the thickness of the guide prevents being utilized when cutting from the guide side of the die can be threaded, enabling the die to cut right up to the shoulder or work-holder. This double die feature makes it possible to use the same die for either hand or machine work, as well as to accomplish the kinds of work described without turning the die over. The dies are also reversible, making it possible to turn the die over in its holder when a set of cutting edges has become worn out, thus bringing the other set of cutting edges into action and doubling the life of the die. Double dies have been made before and also reversible dies, but we believe that this is the first case in which the double and reversible features have been combined in a single die.

In the accompanying illustration, the view shown at *A* illustrates the Russell style A die, where it will be seen that the double reversible feature is provided by countersinking and counterboring the screw holes in both faces, so that the die may be turned over on the guide. The Russell style B die is shown at *B*, and this view illustrates how the same result is obtained by having a double bevel on the outside of the die so that it may be turned over in the collet. One of the Russell full mounted dies is shown at *C*, where it will be seen that the same result is obtained for this type of die by having the screw holes countersunk from both faces, so that the die may also



Russell Styles A, B and C Double Reversible Threading Dies

be turned over on the stock. This is a development in threading dies which should be greatly appreciated by all mechanics who are called upon to use tools of this kind.

SIPP SPECIAL DRILLING MACHINES

The machines described in the following article were developed to meet special requirements met with in machining crankshafts provided with a forced-feed lubricant system. They combine the features of this company's regular drilling machines with special means for the performance of those drilling operations referred to in connection with the machines. The automatic power feed mechanism represents an improvement recently developed for use on the standard Sipp drilling machines.

For the purpose of drilling all angular oil-holes for the forced-feed lubrication system in crankshafts, the Sipp Machine Co., Paterson, N. J., is now building the special drilling machine illustrated in Figs. 1 and 3. In addition to its use for this purpose, the machine may be employed for the performance of light vertical milling operations; and it is also well adapted for the performance of various classes of toolroom work. It will be evident from the illustration that provision is made for tilting the table to any required angle by rotating the table support through a worm and worm-wheel; and a graduated collar on the support facilitates setting the table to an angle corresponding to the required angle for the oil-hole in the crankshaft. In addition, the table is provided with the usual vertical movement by means of a screw, which amounts to 14 3/16 inches irrespective of the traverse movement of the spindle bracket and spindle sleeve. The spindle bracket has a traverse movement of 14¾ inches, and the sleeve has a feed movement of 5½ inches. The table may be tilted to an angle of 80 degrees from the horizontal to either the right or left of the neutral position; and, as previously mentioned, it is equipped with a graduated ring for the entire circle of 360 degrees; when the table has been moved to either the right or left through a distance of 3 or 4 inches, the ball-crank will clear the base, and the table can then be turned through a complete circle, if so desired.

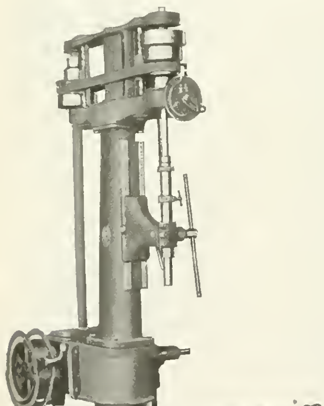


Fig. 1. Sipp Crankshaft Oil-hole Drilling Machine with Table in Horizontal Position

The working surface of the table is 10 by 36 inches, and the minimum distance between the spindle and table is 2 5/16 inches, while the maximum distance from the spindle to the table is 31½ inches. The travel of the table from right to left or *vice versa* is 14 inches on each side of the center, making a total table travel of 28 inches; and the cross-slide has a traverse of 4 inches forward and 3 inches backward from the central position, making a total traverse motion of 7 inches. The entire table support can be swung around the column 65 degrees to the left and 48 degrees to the right of the central position. The table is provided with two longitudinal T-slots, spaced 6 inches apart from center to center. This machine will drill a hole to the center of an 18-inch circle.

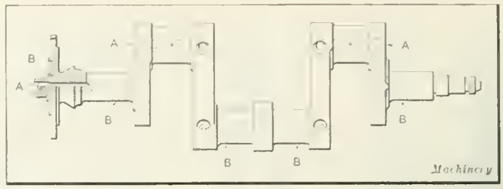


Fig. 2. Crankshaft with Forced Lubrication System, showing Angular Holes drilled on Sipp Machine shown in Figs. 1 and 3

Machine for Drilling End Hole in Crankshaft Forced Feed

The machine shown in Fig. 3 was especially developed for use in drilling the hole in the center of the bearing at the inlet end of the crankshaft forced-feed lubrication system. The jig is clamped at the top of the table and the crankshaft is located in this jig with ample space from the top of the table to the foot of the base for handling crankshafts up to and including 32½ inches in length below the coupling flange. In addition, it will be evident from the illustration that this machine can be used for regular drilling operations. Important dimensions are as follows: maximum distance from end of spindle to top of table, 32½ inches; size of working surface of table, 16 by 40 inches; distance between centers of two longitudinal T-slots, 6 inches. The table is raised and lowered by a crank-actuated rack and pinion, and the use of this machine eliminates any obstruction under the center of the table, allowing the crankshaft or other work to hang in free space.

Crankshaft Centering Machine

Fig 4 illustrates a machine designed for use in centering crankshafts. A dead male center is brought up into position by depressing a foot-treadle, and the cup center locates the crankshaft ready for the centering operation. It has an overhang of 8 inches; the maximum distance from the nose of the spindle to the cup centers is 40 inches, and the minimum distance from the nose of the spindle to the cup centers, 25 inches. The maximum length of hand feed is 5½ inches, and the maxi-

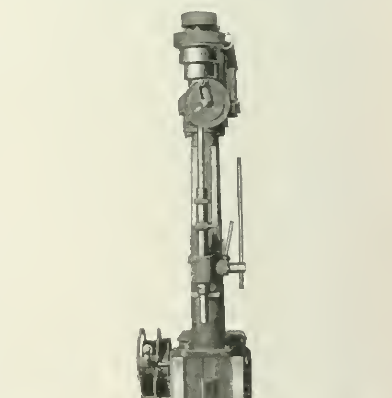


Fig. 3. Sipp Machine for drilling Hole at Inlet End of Crankshaft Forced-feed Lubrication System

mum traverse of the spindle head, $9\frac{1}{4}$ inches; the total spindle adjustment is $14\frac{3}{4}$ inches, and other dimensions are the same as those of the single-spindle Sipp drilling machine illustrated and described in the January, 1915, number of MACHINERY.

Automatic Regulation of Belt Tension on Sipp Drilling Machines

All the Sipp drilling machines are equipped with a special form of adjustment for the belt tension which automatically compensates for any differences in the load. For instance, consider the moment when the spindle has been fed down to the point where the drill engages the work; any one who has observed the belt action at this time will have noticed that the tight or driving side of the belt stretches, and that there is a corresponding increase of length on the slack side. Similarly, if the belt is carefully watched at the time the drill breaks through the work, it will be noticed that the driving tension is reduced, and consequently the length of belt on the short side is correspondingly decreased. In either of these cases the adjustable idler pulley shown at *C* in Fig. 5 changes its position so that the belt tension is maintained constant. This result is obtained by means of a torsion spring contained in case *E* which causes the idler pulley to move in or out as the case may be. The strength of the spring may be adjusted so that exactly the required belt tension is obtained, and it is important to note that at those times when an exceptionally heavy load is imposed on the drive, the idler pulley will slack off and reduce the tension of the belt before the strain becomes great enough to stretch the belt beyond its elastic limit, or strain any part of the machine. In this way the life of the machine and belt are materially increased.

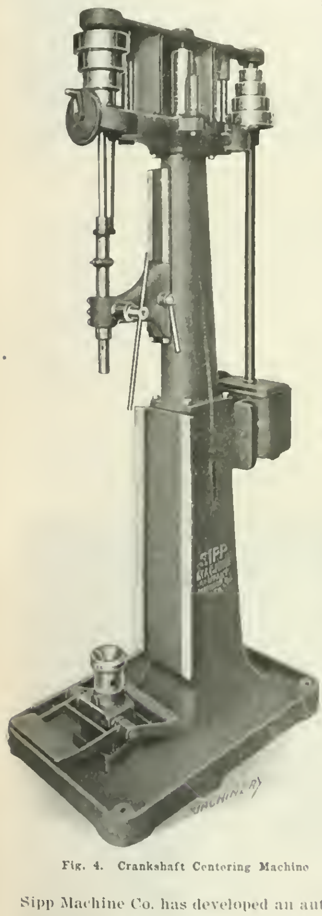


Fig. 4. Crankshaft Centering Machine

Automatic Power Feed for Drilling Machines

With the view of giving machine operators the maximum amount of time for handling finished work and getting new blanks or castings ready for drilling, the Sipp Machine Co. has developed an automatic power feed mechanism for use on its drilling machines. This provides for feeding the spindle down by hand until the point of the drill is brought into contact with the work, at which time the power feed mechanism is automatically engaged; the operator can then leave the machine, as the power feed is disengaged when the required depth of hole has been drilled, and the spindle is then returned automatically by a counterweight inside the column. An air cushion absorbs the shock at the time the spindle reaches the top of its travel.

The mechanism by which these results are obtained is shown in Fig. 6 on the spindle at the right-hand side of the machine. Referring to this illustration, it will be seen that a rod *A* is carried by brackets attached to the spindle quill; this rod moves with the spindle, and at the time when the point of

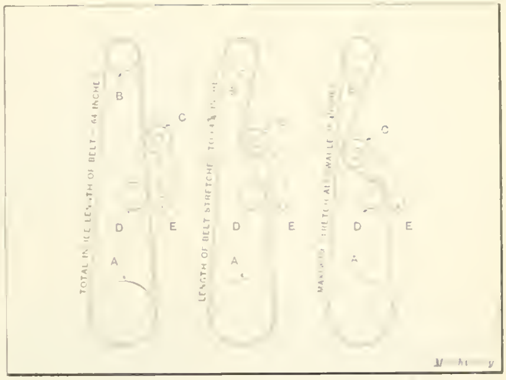


Fig. 5. Device used on Sipp Drilling Machines for maintaining Uniform Belt Tension

the drill comes into contact with the work, a stop carried by rod *A* engages trip lever *B* which results in automatically throwing in the power feed that is obtained through the familiar form of worm and worm-wheel. The feeding of the drill then continues until the hole has been cut to the required depth, at which time knock-out *C*, which is of the usual form, disengages the power feed and allows the spindle to be automatically returned by means of the counterweight previously referred to. The momentum of the rising spindle is absorbed by an air cushion effect contained in dash-pot *D*, so that no vibration is set up at the time the spindle reaches the other position. It will be evident that this automatic feed mechanism replaces the previous type in which it was necessary to engage the power feed by hand after the drill had been brought down into contact with the work. The three left-hand spindles on the machine shown in Fig. 6 are equipped with the form of mechanism in which the feed is engaged by hand by pulling out the smaller lever shown at *E*. The reason for this design was that the holes drilled by the three left-hand spindles are deep enough to give the operator plenty of time to handle the finished work.

The spindle sleeve is controlled and held in rigid alignment by a steel saw blade running in a spline $3\frac{1}{4}$ inches in length, which insures positive rigidity and long wear and does not allow of any rotation or loosening of the sleeve. This is par-

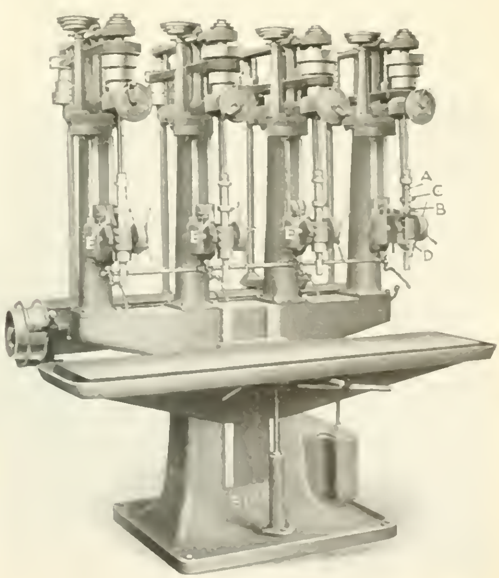


Fig. 6. Sipp Four-spindle Drilling Machine on which Right-hand Spindle has Automatic Power Feed Mechanism

ticularly advantageous in case the machine is to be used at some future time in connection with a multiple drill head, for in such a case it is necessary for the spindle sleeve to be held in a rigid manner to insure the drilling head being held in proper alignment so that the drills will not bind.

LUNDVALL FUSE RING MILLING MACHINES

These machines for rough- and finish-milling the powder train groove in time fuse rings are of similar design, the chief distinction lying in the fact that the roughing cut is taken with a circular milling cutter and the finishing cut with an end-mill. The roughing cutter leaves an arc of metal at each end of the groove, and in order to obtain the highest efficiency in operating the finishing machine, means are provided for using a slow speed while the cutter is taking a heavy cut at the ends of the groove, and automatically increasing the speed during the time that the light cut is being taken in finishing the remainder of the groove.

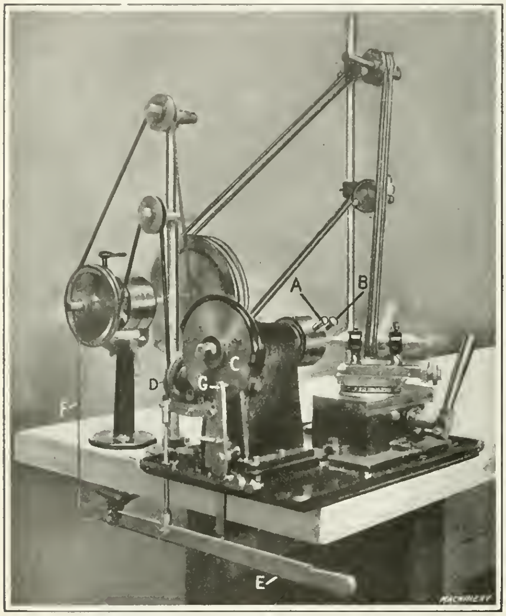


Fig. 1. Lundvall Machine for roughing out Powder Train Groove in Time Fuse Rings

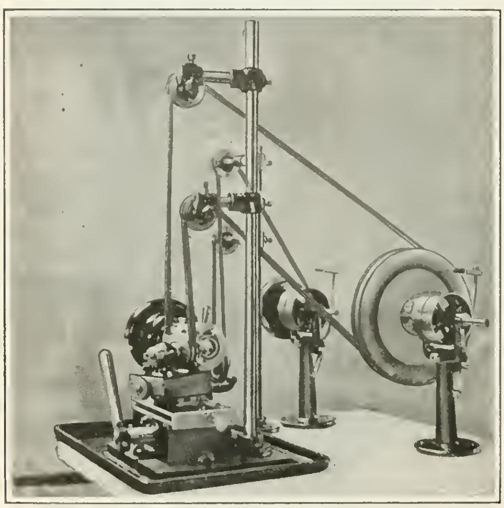


Fig. 2. View of Machine showing Work in Chuck and Roughing Cutter

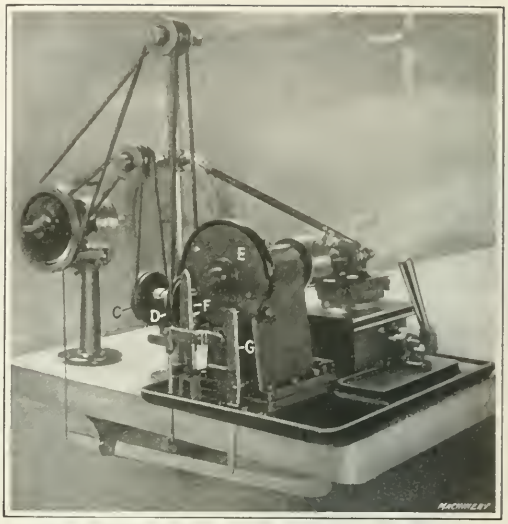


Fig. 3. Lundvall Machine for finish-milling Powder Train Groove in Time Fuse Rings

For use in rough- and finish-milling the powder train groove in fuse rings, E. A. Lundvall, 24 Belmont Ave., Jersey City, N. J., is now building the milling machines illustrated and described herewith. It is general practice to rough out the groove with an end-mill, but experience has shown that the use of a circular milling cutter of the type used on the roughing machine enables the work to be done much more rapidly. When the first machine has done its work, the fuse ring is transferred to the finishing machine which uses an end-mill to finish the groove to exactly the required size.

The Roughing Machine

The machine employed for roughing out the powder train groove is illustrated in Figs. 1 and 2. It will be seen that the work is held in a two-jawed chuck which is opened and closed by turning lever *A* that actuates the jaws through a cam ring. The work is located in the chuck by means of sliding pin *B*. After the fuse ring has been set up in the chuck, the desired location for the powder train groove is obtained by means of index plate *C*, which has two notches that govern the length of the groove and its location. Reference to these illustrations will make it apparent that the cutter-head is driven by two round leather belts, the double belt being provided in order to give the required driving force

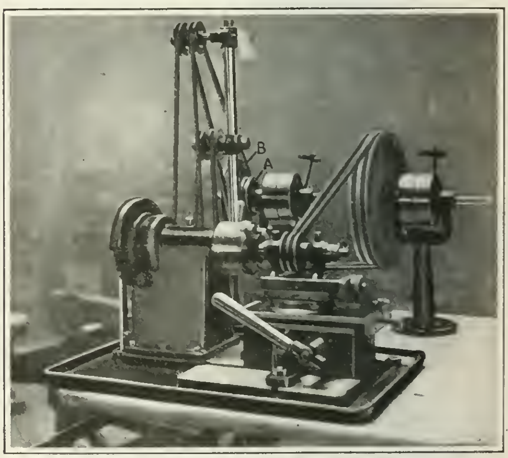
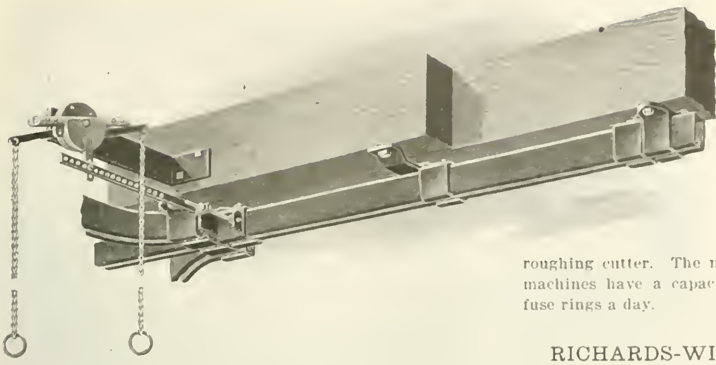


Fig. 4. Lundvall Machine showing Work in Chuck and Finishing Cutter



Richards-Wilcox Three-way Trolley Overhead Switch

without employing an unduly high belt tension. The work is fed to the rotating cutter by means of pulley *D* which is also driven by a round leather belt.

After the work has been set up and the cutter-head moved over to feed the cutter into the work to the required depth, the cutter-head is locked against longitudinal movement by means of a suitable latch. The operator then pulls up on lever *E* which results in withdrawing the locking pin from index plate *C* and at the same time throwing the driving belt onto the tight pulley of the countershaft, thus starting the machine. It will be apparent that the locking pin is withdrawn through the action of a system of links connected with lever *E*, and the simultaneous shifting of the driving belt to the tight pulley is effected by a wire *F* which connects the end of lever *E* with the belt shifter. When the work-spindle has rotated through a sufficient distance to complete rough-milling the groove, the plunger comes opposite the second notch on index plate *C*, and at the same time a stop on this plate engages the upper end of lever *G*, allowing the plunger to drop into the notch in the index plate and lever *E* to shift the belt back onto the loose pulley.

The Finishing Machine

After comparing Figs. 1 and 2 with Figs. 3 and 4, the reader will have observed that the machines for rough- and finish-milling the powder train groove are similar in many respects. The chief points of difference are that an end-milling cutter is used for the finish-milling operation; and in order to obtain the highest possible efficiency, the work must be run at a slower speed during the beginning and end of the operation, while the cutter is removing the arc left by the circular milling cutter which performs the roughing operation; then while the intermediate part of the cut is being taken, it can run at high speed, as the cutter is only removing a very small amount of metal at this time. The change of speed is effected automatically by means of a two-speed drive from pulleys *A* and *B* (Fig. 4) on the countershaft, from which belts run over the idlers to pulleys *C* and *D* between which is located a positive clutch. The ratio of pulleys *A* and *B* is 1 to 2.

The work is set up in the machine and the machine started by operating the hand lever, as in the case of the machine for rough-milling the groove. Then during the first part of the operation the work is rotated at slow speed, while the end-mill is removing the arc left by the circular rough-milling cutter. When this part of the operation has been completed, a pin carried by index plate *E* engages the top of lever *F* which actuates the load and fire clutch between pulleys *C* and *D*. This results in throwing the clutch out of engagement with the slow-speed pulley and connecting it with the high-speed pulley, so that the speed of rotation may be doubled while the central part of the groove is being finish-milled. Then when the cutter comes into contact with the arc of metal left at the opposite end of the groove, a second stop on index plate *E* engages lever *F* and results in throwing the clutch back into contact with the slow-speed pulley, thus reducing the speed to the proper number of revolutions per minute for milling out the second arc of metal left in the groove by the roughing cutter. The manufacturer claims that two of these machines have a capacity for rough- and finish-milling 3000 fuse rings a day.

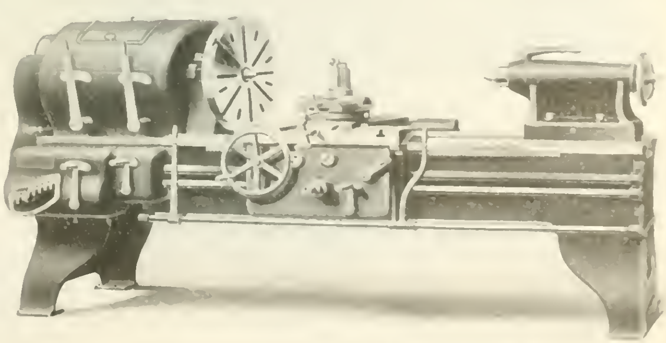
RICHARDS-WILCOX TROLLEY OVERHEAD SWITCH

The chief claim made for the trolley overhead switch that forms the subject of the following description is that the design has been worked out to make the switch as compact as possible. It frequently happens that this is a matter of great importance because economy of space is absolutely necessary in many congested factories. The accompanying illustration shows a section of straight and curved track with a three-way switch, but the same type of switch is made in a two-way type. Both types are made for use with two sizes of track; they are provided with a positive locking attachment and finished with japan. This switch is a recent product of the Richards-Wilcox Mfg. Co., Aurora, Ill.

CLEVELAND ENGINE LATHE

The accompanying illustration shows the 20-inch size of a line of heavy-duty single-pulley drive engine lathes with quick-change gear box and all-geared head, which have recently been added to the line of the Cleveland Machinery & Supply Co., Cleveland, Ohio. The machines are of heavy construction, making them suitable for all classes of heavy work within their range, although they are particularly adapted for the requirements of automobile and forge shops. The bed is of the box-section type and has a large compensating vee at the front and a flat way at the rear. The headstock is of the geared type with single-pulley drive, and nine changes of speed are available, which are obtained by operating two levers. All gears are made of steel and the single pulley is equipped with a powerful friction clutch operated from the front of the machine, either at the headstock or apron as desired. All bearings, including the spindle bearing, are lined with bronze; and the spindle is provided with a ball thrust bearing.

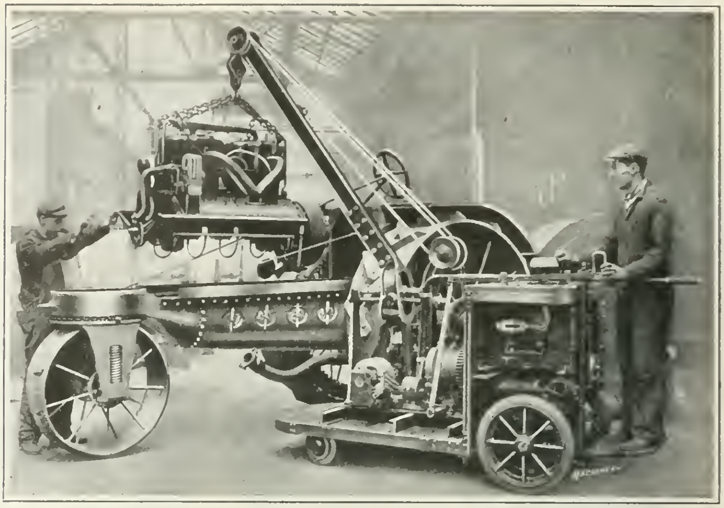
The carriage is gibbed front and back, and has a bearing on the bed through its entire length. The cross-slide and compound rest both have taper gibs to afford compensation for wear; and both the front and back wings of the carriage have felt wipers to protect the vees. The apron is of heavy



Cleveland Machinery & Supply Co.'s Heavy-duty 20-inch Engine Lathe with Single Pulley Drive and Geared Head

box section, with all gears made of steel and all bearings lined with bronze. The bearings in the back wall of the apron are oiled from a single reservoir, which is reached from the top of the carriage. Only one friction is used for operating both the longitudinal and power cross-feed; and automatic stops and reverse for the feeds are furnished. The apron is equipped with a safety device that prevents engaging the half nuts without first throwing the feed lever in the central position. As a result, it is impossible for the operator to engage both the lead-screw and feed-rod at the same time.

The quick-change gear-box is of the familiar cone type of construction, and it is equipped with all steel gears and bearings lined with bronze. The driving mechanism for the lead-screw and feed-rod is arranged so that the two cannot be engaged simultaneously. These machines may be equipped with a taper attachment, four-tool turret toolpost, heavy hexagon carriage turret, and power feed bed turret. When so desired, they may be provided with alternating-current or direct-current motor drive; and the motor may be direct connected through gearing or the power transmitted by a silent chain, as desired. Reverse to the spindle can be supplied at any time either for belt or motor drive. These lathes are made with 18, 20, 22, 24, 26, 28, 30, 32 and 34 inches swing, and with any desired length of bed.

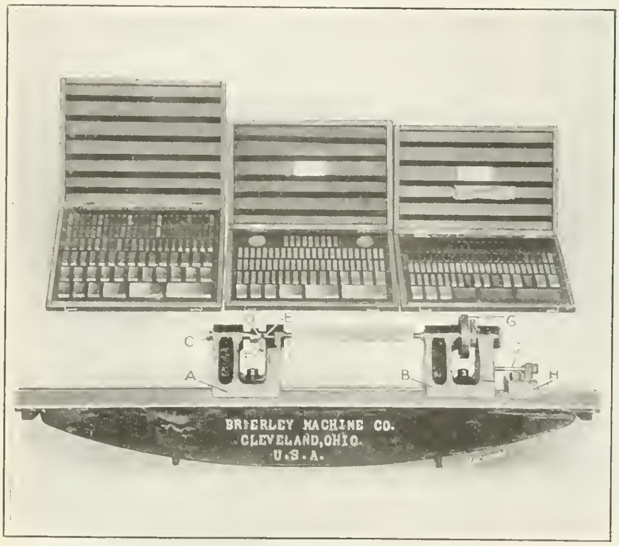

Crane Truck built by Elwell-Parker Electric Co.

ELWELL-PARKER CRANE TRUCK

The Elwell-Parker Electric Co., Cleveland, Ohio, has recently added to its line of industrial trucks the "rocking" type of crane truck illustrated and described herewith. The boom and hoist are motor driven by an Elwell-Parker crane type motor, which receives energy from the same storage battery that furnishes power to the separate propelling motor; and the arrangement is such that the operator does not need to leave the driving platform to raise the boom or hoist the load. In handling automobile engines between inspection, test and installation on the chassis, this crane has a decided advantage due to its being mounted on a "four-wheel-steer" truck that may be driven into very close quarters to deliver the load in exactly the required position. Trucks of this kind are also employed for handling heavy dies used on drop-hammers, for lifting castings onto or off the planer, and for a great variety of other lifting work which must be done in industrial plants. Those experienced in the employment of labor know that it is difficult to secure men for doing just this class of work, and one truck has the capacity of a number of men. The capacity is for lifting work up to 1000 pounds.

BRIERLEY PRECISION MEASURING MACHINE

A precision measuring machine in which the pressure of measuring points on the work is controlled by the dropping of a plug is shown in the illustration. The machine is built by the Brierley Machine Co., 1736 E. 22nd St., Cleveland, Ohio, and is used for handling this company's own work. It consists of a heavily ribbed bed on which are carried two adjustable slides *A* and *B*. Slide *A* carries the pressure mechanism, which is of simple design; at the rear of sliding spindle or measuring point *C* there is a spring (not shown) which exerts a pressure of 6 pounds. Attached to spindle *C* is a yoke that carries a point *D* located in line with stationary point *E*, which is supported by the frame of slide *A*. Between these two measuring points is a plated rod *F*, which drops when pressure applied to the work by the measuring point reaches 6 pounds.



Precision Measuring Machine developed by Brierley Machine Co. for gaging its own Work, and now built for Market

Slide *B*, located at the other end of the base, carries a measuring spindle provided with a screw having forty threads per inch. On this screw is mounted graduated ring *G* that is divided into 250 spaces, and a pointer attached to slide *B* facilitates the taking of readings on graduated ring *G*. The measuring machine can be set with Johansson blocks, as shown, and the dial *G* set so that it records zero. Then the work to be measured is placed between the measuring points, and if larger than the blocks the pressure will, of course, be greater on the sliding spindle *C* and will cause the plug *F* to drop out.

For the purpose of making rough adjustments of the position of slide *B* on the base, an additional block *H* is provided which has a screw *J* operated by a knurled head. It will be evident that as the pitch of the measuring screw is 1/40 inch and graduated dial *G* is divided into 250 spaces, direct readings can be made on the machine to 0.0001 inch. But the spaces on dial *G* are sufficiently wide so that it is an easy matter to estimate readings to 0.00001 inch with a high degree of accuracy. The machine has a capacity for measuring work up to 26 inches in length.

GREENFIELD "GUN" TAP

The term "gun" tap, which is the name by which this tool has been familiarly known during the time that it has been in process of development, was derived from the fact that it was originally designed for use in gun shops. On account of the exceedingly tough and wiry material used in this class of work, ordinary taps were very likely to break. The name, however, should not be confusing, as this tap is designed for all kinds of materials and work.

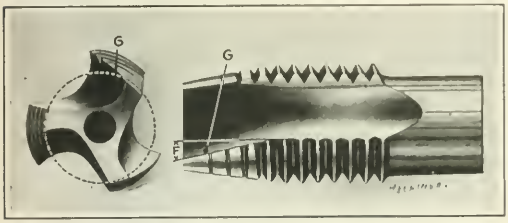


Fig. 1. Close View of "Gun" Tap made by Greenfield Tap & Die Corporation

Reference to the accompanying illustrations will show the differences in construction from an ordinary tap. The cutting edges *G* at the point are ground at an angle *F* to the axis of the tap in order to cut with a shearing action. This throws the chips, unbroken, ahead of the tap instead of allowing them to collect in and clog the flutes. The two- or three-flute construction is thus possible, and much shallower flutes can be used than is possible in the ordinary tap. The "gun" tap has almost the strength of solid stock, and this strength, combined with the easy cutting qualities, makes a tap which practically never breaks. If the gun tap should break, due to either carelessness of the operator or some unnatural condition of the stock, it will only chip off the sharp cutting edge, which can be easily reground.

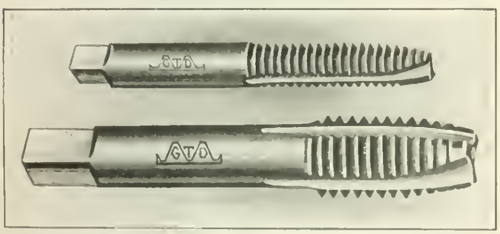


Fig. 2. Two-fluted and Three-fluted Greenfield Gun Taps

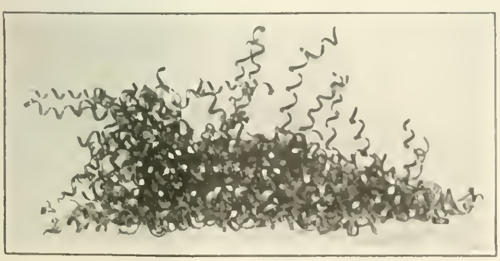


Fig. 3. Chips made by Greenfield Gun Taps

The gun tap does all its cutting on the first few teeth. The rest of the thread acts as a lead-screw, steadying the tap and producing a very accurate thread. This enables the tap to hold its size very close in all materials. It is ground on the angular cutting edge instead of in the flutes, as in the case of ordinary taps, and can be reground repeatedly until there are only three or four full threads left, and will maintain its size to this limit.

A simple gun tap can be used in many places where two and three taps, used successively, have formerly been required, as the free cutting qualities of the gun tap permit working under much more difficult conditions and in tougher materials than is otherwise possible. One instance where the gun tap proved valuable was on a job where it was necessary to tap a small hole, drilled at an angle, through two kinds of material of different degrees of hardness. This proved a puzzling problem, as each tap that was tried broke as soon as it struck the second layer of metal. The gun tap was tried and worked perfectly, tapping hole after hole with perfect ease. These taps have recently been added to the line of tools manufactured by the Greenfield Tap & Die Corporation, Greenfield, Mass.

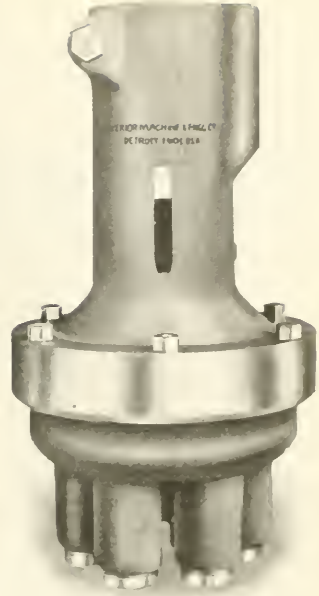


Fig. 1. Six-spindle Superior Drill Head

SUPERIOR DRILL HEAD

The outstanding feature of the multiple-spindle drill head illustrated and described herewith is the simplicity of its design and adaptability for a variety of work. The central drive consists of an internal gear attached to a driving shank made to fit the machine spindle, which gives the correct speed for the drills without the use of intermediate gears. Provision is also made for increasing the speed, which is very desirable in cases where small drills are to be used on a heavy machine. The spin-

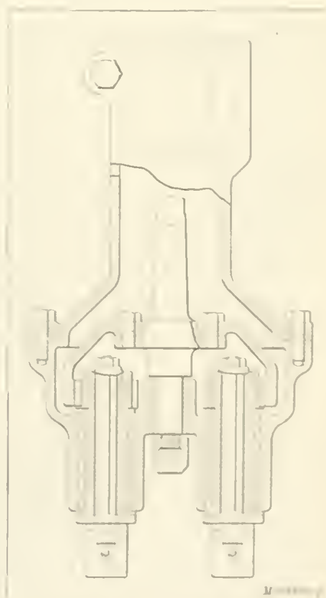


Fig. 2. Cross-sectional View showing Arrangement of Internal Gear Drive

dles may be made either fixed or floating and adapted for drilling and tapping operations. It will be noticed that the gears are completely enclosed in a housing which is designed to form an oil bath, thus giving maximum life to the gears and ample lubrication for the spindle bearings. This drill head is a recent product of the Superior Machine & Engineering Co., 51-53 Fort St., E., Detroit, Mich.

NEW MACHINERY AND TOOLS NOTES

Heavy-duty Pulley: Medart Patent Pulley Co., St. Louis, Mo. A heavy-duty pulley of light weight, in which the arms are made of flat wrought steel, and the hubs and rim lugs of semi-steel that is cast to the end of the arms which are formed to produce a solid anchorage.

Electric Crane: Whiting Foundry Equipment Co., Harvey, Ill. An exceptionally large alternating-current electric crane built for handling locomotives in the new shops of the Seaboard Air Line, Portsmouth, Va. This crane has a capacity of 160 tons and there are two 80-ton trolleys, one of which is equipped with a 10-ton auxiliary hoist.

Storage Battery Truck: Elwell-Parker Electric Co., Cleveland, Ohio. A storage battery truck provided with a hopper to make it suitable for carrying small castings, chips, foundry sand and any other form of loose material. The hopper may be arranged to dump from either the end or the side. Trucks of this kind are made with hoppers having capacities ranging from 22½ to 36 cubic feet.

Boring Lathe: Osborne & Sexton Machinery Co., Columbus, Ohio. A heavy-duty machine for boring 6-inch shells. The bed is of heavy construction and is 12 feet, 6 inches in length; it is provided with double-webbed box type girths to eliminate vibration. The machine swings 40 inches, and a hole 4½ inches in diameter by 12¾ inches deep can be bored in a 6-inch solid shell billet in twenty-five minutes.

Straightening Press: John T. Towsley Mfg. Co., Cincinnati, Ohio. This machine is provided with V-blocks, the distance between which may be adjusted to suit the work. By using pieces of copper in the V-blocks and under the screw head, tools and finished work are rapidly and easily straightened without marring the surface. The capacity is for work up to 2½ inches in diameter by 48 inches in length.

Belt Clamp: Cleveland Fabric Belting Co., Cleveland, Ohio. A safety clamp for use in taking up slack in belts and for lacing them. Each side of the clamp is provided with a swing bolt which enables the clamp to be quickly attached to a slack belt or slipped over the ends of a broken belt. Then the two ends of the belt are drawn together by a rack and pinion which actuate the movement of the two clamps.

Seam Welding Machine: Toledo Electric Welder Co., Langland and Knowlton Sts., Cincinnati, Ohio. A motor-driven seam welding machine especially adapted for welding the side seams of coffee pots, pails, phonograph horns and similar products. The stock overlaps from 1/32 to 1/8 inch and the pressure of the rolls forces it together so that the thickness is only 0.002 to 0.003 inch greater at the joints than at other points.

Vertical Milling Machines: Becker Milling Machine Co., Hyde Park, Boston, Mass. The general features of design of both of these machines are similar to those of the high-powered continuous milling machine previously built by this company. Both machines are equipped with rotary tables so that suitable fixtures for the performance of continuous milling operations can be used. One is a single-spindle machine, while the other machine is provided with two spindles.

Electric Furnace: Electric Furnace Co., Alliance, Ohio. An electric heat-treating furnace on which a patent was granted to T. F. Bailey and to F. T. Cope, and assigned by them to the above company. The material to be heated rests on a hearth and the heat is reflected down onto it from a brickwork arch. At each side of the hearth there are spaces filled with granular coke or charcoal which forms the resistance members, the electrodes being located at the end of these charcoal filled chambers.

Plain Milling Machine: Kempsmith Mfg. Co., Milwaukee, Wis. An improved model of the No. 33 milling machine formerly manufactured by this company. The design has been modified to meet conditions met with in manufacturing the machine and in using it. Changes in the rate of feed and speed are made by means of change-gears which are enclosed in a single gear-box. Narrow guides are used on the column. The floor space occupied by the machine is 64 by 106 inches, and the net weight is approximately 4500 pounds.

Marking Machine: Martin Machine Co., Greenfield, Mass. A hydraulic machine designed for marking round or flat surfaces. The work is placed on a table and raised into contact with the marking die. The table adjustment is provided with a set of ball bearing thrust collars which relieve the lock-nuts of pressure, leaving them free and easy to move by a slight turn of the hand. The maximum travel of the slide is 8 inches; maximum adjustment of table, 6 inches; floor space occupied, 30 by 24 inches; and weight of machine, 950 pounds.

Gage Grinding Machine: Gem City Machine Co., Dayton, Ohio. A machine especially designed to meet the requirements of tool-room work. The Gem City Machine Co. does a large business in making punches, dies, and gages, and designed the machine with especial reference to handling this work, for which purpose the machine proved so successful that it was decided to build it for the market. The table which is 6 by 14 inches in size swivels through an included angle of 20 degrees. The table traverse is 4¼ inches; adjustment of grinding head, 12 inches; cross-feed lever movements, 3 inches; and weight of machine, about 700 pounds.

Universal Grinder: Thompson Grinder Co., Springfield, Ohio. The design of this machine follows that of this firm's former grinding machine in general features, but certain details have been changed to make the operator's work easier or to meet special conditions that have been discovered since the original design was worked out. The capacity is for grinding cylindrical work up to 10 inches in diameter by 36 inches in length, and for surface grinding work up to 8 inches in width by 48 inches in length. Internal grinding up to 12 inches in depth can be handled on the machine. The maximum floor space occupied is 11 by 11 feet, and the weight of the machine, 3600 pounds.

Alloy for Cutting Tools: Darwin & Milner, Inc., 281-283 Water St., New York City. An alloy known as "Reactal" which is suitable for use in making cutting tools for machine tools. This material is offered as a substitute for the best grades of high-speed steel and is said to be tougher than stellite. It is cast in bars of any required size and does not require heat-treatment, the tools being ready for use after grinding. Bars are provided of any required size so that the work of grinding tools can be done with the minimum amount of labor cost. At the present time this company is working on a method of casting such tools as milling cutters so that they are of the required form and the only grinding required is to sharpen the cutting edges.

Welding and Cutting Torches: Bishop-Babcock-Becker Co., Cleveland, Ohio. A new line of oxy-acetylene welding and cutting torches. The welding torch is equipped with two needle valves which are conveniently located beneath the handle to provide for governing the pressure. The mixing chamber is designed to reduce danger of back-firing to a minimum. The oxygen has a straight passage from the inlet tube to the tip, and the acetylene enters an annular cavity in the mixing head and is fed through small ports into the mixing chamber. In the cutting torch, the acetylene is controlled by a needle valve and passes through five holes in the tip which surround the oxygen opening. The oxygen is controlled by a thumb valve at the top of the handle. The torch is made of brass and is 24½ inches long.

* * *

APPARATUS FOR HEAT-TREATING MAGNETIC METALS

Prof. R. B. Fehr of State College, Pa., has been granted a patent on a method of and apparatus for giving heat-treatment to magnetic metals; that is, iron and its alloys, such as carbon and other steel. Carbon steels which hold in solid solution iron carbides in the form of austenite, martensite, troostite, osmandite and pearlite, when cooled from a molten condition, show a sharp jog in the cooling curve known as the recalescent point, where heat is given up by the molecular changes in the ferrite and carbides. Conversely, when steel is heated up, reactions again occur and heat is absorbed, the jog on the heat curve being known as the decalescent point. The usual treatment of steel consists in heating it through its critical range represented by the two points mentioned, and noting the temperature by the indications of a pyrometer, to ascertain when these points are attained. But the decalescent and recalescent points do not coincide, on account of hysteresis and other causes, within from 20 to 50 degrees C., the decalescent point always being the higher.

Prof. Fehr's invention provides a method and means by which the decalescent point can be quickly and accurately determined. The method consists in heating the steel and causing a magnetic flux to pass through it from a point outside the source of heat, and indicating the difference between the magnetic induction and the residual magnetism.

* * *

Never mark with white chalk on finished cast-iron surfaces. The chalk will rust the iron and will persist for years after all traces have been apparently wiped off.

POST WAR TRADE AGREEMENTS

METHODS TAKEN BY EUROPEAN NATIONS TO OBTAIN PART OF THE WORLD'S TRADE—AMERICAN DYE CONDITIONS—ONE OF RUSSIA'S SOURCES OF STRENGTH

DURING the past month, the British government approved the resolutions passed by the Paris Economic Conference of representatives of the Entente Allies. These resolutions provide for an economic war to succeed the war now in progress and are in line with the recommendations of many of the British commercial bodies. They are also in line with the policies of Great Britain as far as it has been able to carry them out. The results of these policies on the commerce of these nations, though, may prove more harmful than the nations think. In fact, many of the English leaders are admittedly against these recommendations claiming that they will work great harm. Many are loud in their denunciations of them and demand that there be no change in the fiscal policy of the nation. Some say that to accept these plans is to confess the failure to obtain that for which Great Britain says it went to war—the destruction of Prussian militarism. Others think that the only results of such plans will be the building up of a stronger German competition than before. J. A. Hobson, the English economist, said, "To stop the trade of Germany would be to stop her wealth, and the recoil would be equal to the blow."

These plans are only an extension to its allies of the policies that have governed trading with the various parts of the British Empire. Laws compel the Australian and New Zealand governments to favor local manufacturers in the purchase of supplies even though the local is inferior to the foreign. Great Britain and its colonies are then given the preference by the tariff laws over all other lands. Yet when the effort has been made, American goods have won a place from which it is difficult for all other goods to displace them. If these plans carry, some of the allies may find themselves in the position of the Germans when they got possession of the rich Shantung district of China. They caused the Chinese government to make a treaty by which the Germans were to be given preference of all trade in that region and no trading could be done with any people unless the Germans had first refused it. But Germany was never able to put the conditions into force, for it knew that as soon as it did, it would be shut out of the trade with those parts of the Chinese Empire in which the French and British influences predominated.

Speaking of this conference, the *Hamburger Nachrichten* says:

> We therefore express no opinion about the intention of the allies to impose special conditions on the shipping of their present foes, or on the permanent measures England and her friends propose regarding raw materials and manufactured articles which they could hitherto only obtain from Germany. Events will surely take a different course than the theorists gathered around the Paris conference table imagined. Let our enemies remember once for all that war is only ended on the basis of negotiations, and that the victorious side is easily in position at the signing of peace to slash to pieces with its sharp sword such paper agreements as those to which it has neither assented nor is inclined to assent.

Germany's most forceful answer to these plans is the formation of stronger combinations for the carrying on of her trade. Sixty thousand men are included in the engineering association just formed to foster German trade at the end of the war. Besides, the older associations are strengthening their organizations and recently a company was formed to sell coal in the Balkan states and Turkey where England has been sending 2,500,000 tons annually. The Germans are also resenting the action of the London Chamber of Commerce when it expelled all Germans from its membership, even those that had become British citizens.

Count Kokovtsev of Russia, president of the Council of Ministers, a position corresponding to that of prime minister of England, in a recent interview said:

> It has been said that, financially speaking, I have been friendly to Germany. This is not true, but I realize that after the war, in a few years perhaps, people will turn to Germany if other nations are harsh and excessive in their demands, if they ask too much interest, and if Germany pursues the sensible and astute commercial policy she did before the war of giving people what they wanted, of good quality and on convenient terms. If a peasant wants an agricultural machine somewhere in Siberia, do you think he will pay cash for it, especially if he needs the money for other things, when he can get a good quality machine on long credit and from a company which keeps plenty of spare parts constantly on hand in warehouses situated conveniently for him to obtain without delay? I do not mean that Germany will obtain her former position with us as regards agriculture and land owning in Russia, for there will be laws to prevent that, but commercially and industrially she will come back if the other nations let her.

Many of the nations entering into this agreement will find it most embarrassing later because of their other agreements and arrangements. The French Society for Commercial Development, which has a capital of $100,000,000, has been formed to "bring the commerce of the United States into direct touch with that of France." Its principal object is to eliminate all middlemen and brokers so that buyers on both sides may deal directly with the producers. The American representative, Dr. Arnaud Rosenthal, says, "The society will build a line of ships that will sail direct from the United States ports to those of France. There will no longer be the stop in England with the English commissions to pay. Plans for these vessels are already under way and before the end of the war the first of them will probably arrive in New York."

Another international agreement that may cause trouble, if the recommendations of this conference are carried out, is the treaty between Russia and Japan relating to the Chinese Republic. In their discussion of this treaty, some people call attention to the fact that Japan, outside of strengthening herself in Asia, has done nothing to gain the enmity of Germany, and they claim that as soon as the war is over the two nations will be allies on the far eastern question. These people claim that there is friction between the Japanese and the English and that the British are jealous of the success of their Eastern trade rival and that the Japanese resent the restrictions that the British are putting on their trade. They also point to the fact that Japan and Germany are keen commercial rivals of the United States and will therefore unite against a common commercial rival.

Both Russia and Japan are seeking to obtain the privilege of developing the resources of China. As Siberia is being developed, Russia will want both markets and supplies from China, so that the interests of the parties to this treaty are inimical.

Effect of Recommendations on Russia

The nation that will suffer most from these recommendations is Russia. That nation is just awakening to its greatness and its people are just beginning to realize the conditions under which they have lived. Wages in the textile industries have increased nearly one hundred per cent during the past sixteen months. Savings deposits have grown so rapidly that the banks are astounded at their amounts. The scale of living is changing so quickly that the people will never be satisfied with their former life. Plans are being made to develop the natural resources on the most economical basis possible. These resources consist of 250,000,000,000 tons of coal and countless million tons of iron, copper, gold, silver, platinum, lead, manganese, mercury, nickel, and other metals. Besides Russia's oil fields stand second in the world, and are only partly developed, while its forests cover one-fourth of the empire's area. Although it has a most extensive system of canals, these are now being augmented by thousands of miles of railroads, so that goods can be transported irrespective of weather or seasons. Thousands of miles of new roads are being planned and built for the development of different parts of the empire.

One of the greatest factors in the awakening of Russia, and one that will take a most important part in its development is the cooperative society. Speaking of this factor, Nicholas

Tchaykovsky, a member of the Central Cooperative Committee of Petrograd, recently said:

> And despite the war our cooperative societies are growing at a wonderful rate. In one district alone the number of cooperative unions has grown since the war from 50 to 302. We had only forty wholesale societies last year. Now there are over 400. In 1911 there were but eleven credit unions in all Russia, whereas at present there are over sixty through which about 10,000 separate cooperative credit societies are working. Our Moscow, or mother, committee alone is coordinating the work of more than 2000 groups, each group composed of several societies. We have organized a Central Cooperative Credit Bank in Moscow which has its own office in London executing our foreign orders, buying and selling. The Siberian societies have their own bank in London.
>
> We are branching out in every direction, building our own flour mills, starch works, oil plants, machine shops and so on. We are going to start paper and sugar mills. At Staro-Bardinsky, in Siberia, we have our own light plant giving the inhabitants electricity for a dollar a year. Over forty papers in Russia are devoted exclusively to our work. In conjunction with the Zemstvo Union we are helping Russia and the Allies. Since the beginning of the war Siberia alone has furnished the army with 31,000,000 pounds of butter, with thousands of tons of hay, with lard, oats and other supplies, in all about $7,000,000 worth.

American Trade in Argentine

The *China Press* of Shanghai, recently had the following interview with Commander Jorge Yalour, of the naval training ship *Presidente Sarmiento*, of Argentine:

> The foreign trade of the republic has been affected by the war, as the Argentine cannot obtain goods from Europe. But the United States is now covering the whole field that the European countries formerly covered. The friendly relations of the United States and Argentine are increasing day by day. Trade is pouring in from all parts of America, and during the last year and a half the number of branches and establishments of American firms founded all over the republic has been large. The National City Bank of New York is doing a great business with its chief branch at Buenos Aires, and branches are also being established all over the country. The greatest quantity of imports during 1914-1915, as well as this year, has been supplied by the United States.

Miscellaneous Notes

Much has been written of the visit of the German submarine to Baltimore, but the real purpose of that visit has been ignored. Its consignment of dyes showed that Germany was becoming greatly alarmed over the prospects of losing its rich dye markets, as the American manufacturers of coal tar and natural dyes are rapidly increasing their exports.

Italy, which in April was the largest buyer of American colors, as reflected by the New York exportations, in May yielded first place to Russia, which took colors worth $260,720, Italy coming next with purchases set down at $105,645. English requirements reached $62,516. In spite of the disturbed conditions in Mexico, New York color shipments to that country in May were returned at $41,500. France's share was $29,587, and that of Spain $24,251. Brazil took colors worth $13,334; Argentine, $13,172; Chile, $5904; other South American countries between $2000 and $3000 worth each, while Ecuador's purchase here made the rather unimportant total of $1. Portugal purchased $11,177 worth while Greece's purchases were valued at $7027. Scottish shipments footed $3443, British India $1240, and Japan $722. Australia bought American dyes valued at $1281, while fair purchases were made by Cuba and the West Indian Islands generally.

England, too, is seeking to retain its trade, but is doing it largely by means of the boycott, mail seizures, and discrimination in freight rates. The blacklisting of eighty-two American firms is condemned by all as an unwarranted interference with American trade. Notwithstanding its promises to expedite the mails and its claims that it does not interfere with the trade between neutrals, American commercial associations are daily receiving evidence that it does. For instance, a letter mailed in Stockholm on March 7, as shown by the postmark, was not received by the addressee in New York until June 20. In the meantime, the sender sent several cablegrams and a letter to the addressee, none of which he received.

A sewing machine advertisement in a Hamburg newspaper indicating the temper of German interests follows:

> Germans! Remember that American factories supply our enemies with munitions to kill our sons and brothers or to make them cripples. Were it not for the war material thus delivered to our enemies the war would have been finished many months ago. Buy only real German sewing machines. Protect thereby the German workman and the German sewing machine industry, which provides 60,000 persons with bread. Take care to keep the money in the country.

D. E. J.

* * *

SHARPENING MILLING CUTTERS

A milling cutter deteriorates rapidly if it is used when dull, and a slight amount ground off to sharpen it prolongs its life. The selection of wheels for grinding cutters is of importance. In grinding the cutter, the temper of the cutting edge should not be drawn. Hence, a soft, free cutting grade of wheel should be used with as light a feed as possible. It is a common fault to use a wheel that is too fine, and for most cases a medium wheel about grain 46 and never finer than grain 60 is best suited for high-speed steel and carbon steel cutters.

Some operators prefer to use a cup wheel, as the periphery of a regular wheel leaves the clearance of the teeth slightly concave or hollow, and it is the contention that concave teeth become dull sooner than those having a straight angular relief. This defect may be overcome by swinging the table of the machine so that the work passes across the wheel at an angle instead of parallel to the face. However, the concave effect is of little consequence unless the wheel is less than 3 inches in diameter. It is wise to use as large a wheel as possible.

The wheels most commonly furnished by the Norton Co. for grinding milling cutters are alundum, grain 38-46, grade J and K, and alundum, grain 38-60, grade I. Both vitrified and silicate wheels have been found to be very satisfactory for shapes such as Brown & Sharpe No. 60.

Practice varies as to the direction in which the wheel should run. It is safer to run a wheel off the cutting edge, especially when the operator is inexperienced. When cutter grinding machines are constantly used and experienced operators attend to them, the wheel is often run toward the cutting edge instead of away from it with good results. By this method there is less danger of burning and a keener cutting edge is produced.

To equalize the wear on the wheel, it is the practice among some cutter grinders to grind completely around the cutter, then revolve it half way, starting anew on a tooth just opposite the original starting point, and take another cut all the way round. By repeating this method and taking light cuts, the wheel wear is equalized and a cylindrical cutter is produced. Under favorable conditions the cut may be 0.003 inch, but the average cut should not be more than 0.001 or 0.002 inch. A very light finishing cut should correct any slight error. Ordinarily twice around will put the cutter in good condition.

The angle of relief on the cutter should be sufficient to allow it to work freely. The common practice is to allow an angle of between 4 and 5 degrees clearance. The amount should depend, however, on the material upon which the cutter is to work and the diameter of the cutter. Four degrees for plain milling cutters over 3 inches diameter has been recommended, and 6 degrees for those under 3 inches diameter. Too much clearance will cause vibration in operation.

Form cutters are generally ground with a saucer type alundum wheel, grain 38-60, grade J and K. For grinding gear-cutters, the wheel recommended is grain 38-46, grade K, although grain 38-50, grade J, is used to a large extent. A satisfactory wheel for inserted milling cutters is grain 38-46, grade J and K. Under some conditions, it may be found necessary to use a coarser wheel or grain 38-36, grade I.—*Grits and Grinds.*

* * *

A broken tooth in a tap does not make the tap useless. As a matter of fact, if all of the broken tooth is carefully ground out, leaving no jagged edges to tear the thread, the efficiency of the tap as a threading tool has been reduced but slightly. A tap will do the work required of it as long as there are three good threads left, and the man who has the habit of throwing away broken taps that can so easily be put into working condition again needs to be taught this principle of economy.—*Grits and Grinds.*

HIGH BULLET VELOCITIES

A rifle bullet fired horizontally begins to fall toward the earth as soon as it leaves the muzzle. The effect of gravity is exactly the same on a horizontally moving bullet as on one falling freely. If a bullet were suspended by a thread at the muzzle of a rifle so that the thread would be cut by a bullet fired in a horizontal direction over a level plane, the bullet fired would strike the ground, theoretically, at the same moment that the bullet suspended by the thread reached it immediately beneath the muzzle. Elevating the sights is the means employed to counteract the effect of gravity so that the bullet will strike the point at which it is aimed. The sportsman actually points the bore of his rifle at a spot considerably higher than the target he wishes to hit when firing at a range of 200 yards. The elevation of the sights results in carrying the bullet to a height that compensates for the free fall in the time required for the bullet to reach the target.

The efforts to minimize the effect of gravity on rifle bullets have resulted in greatly accelerating muzzle velocities. Twenty years ago, the velocities obtained with black powder cartridges were about 1300 to 1400 feet per second. These velocities meant high trajectories in long-range shooting, and great care had to be taken in estimating distances and setting sights when shooting at ranges greater than 150 yards. Smokeless powder made a great change, the muzzle velocities being raised by its use to 1800 to 2200 feet per second with corresponding flattening of the trajectories. With smokeless powder cartridges, the sportsman could set his sights at point blank range at all ranges up to, say, 200 yards.

But these velocities are considered comparatively slow now. Improvements in barrel making and powders have continued, and sporting cartridges are now available which give muzzle velocities to Spitzer bullets of 3000 to 3100 feet per second, the trajectories being so low that no adjustment of sights is required for big game shooting at distances less than 300 to 400 yards.

Some sporting and military enthusiasts are claiming that velocities of 3500 to 4000 feet per second will be realized in the near future, their predictions being founded on the improvements in barrel steels and powders that will be made as a result of the experience in the great European war. But it is well to bear in mind what the velocity of 4000 feet per second means as compared with one of 3000 feet per second. Given two cartridges loaded with bullets of the same weight, the cartridge that would propel its projectile at the velocity of 4000 feet per second must develop nearly twice the energy of that required of the 3000 feet per second cartridge, inasmuch as the energy of a moving body increases as the square of the velocity. This means that breech pressures must be greatly increased and probably will reach 65,000 to 70,000 pounds per square inch if the dreams of the enthusiasts are realized.

There is, of course, the possibility that some means may be discovered by which a bullet of comparatively small caliber may have expended on it the energy of a large powder charge without involving very high breech pressures. The bullet might be centered by wings or flanges in a comparatively large bore and propelled by the gases without loss of pressure. The wings or flanges that fitted in the bore would have to be instantly dropped at the muzzle in order to minimize atmospheric resistance, and would have to be very light in order that a large percentage of the effort of the propelling charge would not be wasted in giving them the required initial velocity.

Or the bullet might be made with a longitudinal hole tapering each way from a cross-section near the head end. The shape of the longitudinal section should be somewhat like that of a double injector tube or expanding nozzle. This hole would be packed at the base with a slow-burning powder, highly compressed, and so graduated that the plug would be consumed shortly after the bullet left the bore. With this form it would be possible to give a 0.303 bullet about the same head resistance in the air as a 0.22-caliber bullet, while it would be propelled by the pressure on the base of 0.303 diameter. The possibility of greatly increasing muzzle velocity with present breech pressures is obvious.

NON-RECOIL GUNS FOR AEROPLANES

The rapid development of the aeroplane for military purposes has made it necessary to consider the question of providing it with a suitable weapon of defense. The two factors that limit the power of the armament for aeroplanes are the force of the recoil and the weight of the weapon. In order to overcome these limitations, the non-recoil gun has been developed, and its tests have thoroughly demonstrated that, regardless of the caliber, there is practically no recoil force. The absence of recoil is due to the fact that instead of having the gun closed at the breech end, it is left open by substituting a complete barrel for the usual breech-block, and firing through this barrel to the rear a charge of fine shot (equal in weight to the front projectile) that quickly scatters and loses its velocity. In this way the action and reaction are of equal force, so that there is no tendency for the gun to move in either direction. The powder charge is so arranged that it is all in one chamber, and the ignition and combustion of the two charges are necessarily simultaneous.

The elimination of the shock of the recoil makes it necessary to consider only the question of weight in limiting the size of an aeroplane gun. This weight has been greatly reduced by a departure from the usual method of gun design and by the adoption of the most suitable material in its construction. The material used for the barrels of all non-recoil guns is chrome-vanadium steel, having a minimum elastic limit of 100,000 pounds per square inch after heat-treatment. It might seem that the necessity for using two barrels in this type of gun would present a considerable handicap in the matter of weight, but this is readily overcome by the use of vanadium steel, thus permitting barrels to be used that, although having a larger factor of safety than is customary in ordnance work, are yet very thin as compared to barrels made of other materials. An as example of the reduction in weight, it may be stated that the six-pounder Mark IV gun complete weighs only 103 pounds. This gun has an over-all length of 10 feet, and on its proof test developed a muzzle velocity of about 1100 foot-seconds with a chamber pressure of 7.53 tons per square inch. The maximum thickness of the barrel in this gun is 0.470 inch over the chamber, while near the muzzle the thickness is reduced to 0.102 inch. The maximum fiber stress in the barrels on firing was somewhat over 52,000 pounds per square inch.

The two-pounder Mark II gun of this type has the lightest barrel ever used in any gun of equal caliber. The bore of this gun is 1.575 inch diameter, and the maximum thickness of the barrel is 0.315 inch over the chamber, being gradually reduced to 0.078 inch near the muzzle. This gun has a muzzle velocity of 1200 foot-seconds and weighs 75 pounds. The guns mentioned are both breech loaders and use fixed ammunition. The two barrels are joined by interrupted threads and the rear barrel is kept in alignment with the front barrel by means of a rotating shaft held in place underneath the gun by having bearings in four bands; two of these bands are on the front barrel and are shrunk on so that they are not movable. The construction is such that the rear barrel rotates in its band when the breech threads are being unlocked and slides to the rear clear of the front barrel through the same band, and finally the rear barrel and band swing as a unit to the right about the rotating shaft as a center until brought to rest against a stop at the front spiral breech band. The complete operation of opening or closing the breech is effected by continuous pressure on an operating handle which is guided in its movement by a slot in the handle guide band

The ammunition for these non-recoil guns resembles that used in the ordinary breech loading guns and the weapons are in reality light-weight, high-powered, quick-firing pieces of ordnance. Hundreds of these guns are now being built for foreign governments by the General Ordnance Co., Derby, Conn., five hundred men being employed exclusively on this special type of gun. The United States government has not as yet acquired any of these guns for its aeroplane service, owing to the fact that up to the present time the number of aeroplanes in the hands of the government has not been sufficient to warrant the purchase of these guns in any quantity.

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VANADIUM STEEL BATTLE-PLANE

Vanadium steel has been found to be an important factor in the construction of every important instrument of modern warfare, whether as a protective armor, as a means of securing lightness with strength, or for making invulnerable some of the small but vital parts on which the highest efficiency of a piece of mechanism depends. Under the conditions created by military necessities in which nothing but the best is good enough, vanadium steel has come to be used to an extent which even the most optimistic engineers would have believed impossible in such a short time. The estimated production of vanadium steel in 1913 was 90,000 tons, while the estimate for 1915 placed the production at 450,000 tons.

One of the most recent and interesting applications of vanadium steel is the new armored battle-plane built for the United States government by the Sturtevant Aeroplane Co. In this new type of fighting machine, many novel features are employed, one of the important points being the fact that the entire craft, wings and all, is built from vanadium steel. The machine mentioned was designed by Grover C. Loening, formerly aeronautic engineer of the United States Army, and every detail has been worked out in the most conscientious manner so that this new machine may be considered as representative of the latest fighting aeroplane developments.

On the first model in which steel was used, the saving in weight as compared with wood construction was not great, but by careful refinement in detail and by utilizing to the fullest extent the exceptional strength of vanadium steel, the various sections were greatly lightened without a sacrifice of strength, so that in the later models the weight was reduced from 25 to 30 per cent. The class of vanadium steel used for the framework is cold-rolled stock, this being selected only after exhaustive comparative tests made by the Massachusetts Institute of Technology, of different kinds of cold-rolled steel stock. These tests proved conclusively the high merits of vanadium steel for the purpose. In addition to the cold-rolled vanadium sheet steel stock, it may be noted that vanadium steel wire is also extensively used. The new battle-plane was given the most rigorous test on its trial trip by Lieut. Byron Q. Jones, one of the United States government's foremost aviators. In these tests a straight away speed of 90 miles an hour was attained, after which the aviator "looped the loop" and made the "side-tumble."

An interesting feature of the machine is the standardization of the parts, so that it can be built in any size by the addition of units and installation of an engine of corresponding horsepower. Two armored gun turrets are provided to make up the fighting portion of the machine, one of these turrets being on each side of the torpedo shaped body where the pilot sits. The fighting men have an excellent view ahead and below and a clear range for gun fire on all sides, with the added advantage that the two guns can be concentrated for a broadside forward. By tilting the craft laterally, both guns may be fired at the same target on the sides. The engine used is 140 H.P.; the spread of the wings is 50 feet with 700 square feet of surface, and the length of the machine is 25 feet. Gasoline and oil tanks are provided having a capacity sufficient for an eight-hour flight, or roughly 800 miles. Armor protection against gun fire is provided for the pilot, and everything has been "stream-lined" to decrease the head resistance, this idea being even applied to the cables and turnbuckles. The capacity of the machine is a live load of 1200 pounds.

* * *

ASSOCIATION OF FRENCH IMPORTERS OF MACHINE TOOLS

The Chambre Syndicate des Importateurs Francais de Machines-Outils, or Association of French Importers of Machine Tools, has been incorporated under the French law with headquarters at 15 Rue Fenelon, Paris, France. The services of the association are offered to French importers and dealers, old or new, large or small, and it includes already some of the largest machine tool merchants. The association seeks by cooperation to improve and further develop the importation of American machine tools into France.

INERTIA OF FALLING BODIES

The effect of inertia on falling bodies is strikingly shown in the action of tall brick chimneys when overturned. They invariably break at some point between the base and the top, and the top portion falls much closer to the base than it would if the chimney remained intact. The cause is simply that all portions tend to accelerate in response to gravital pull at the same rate, but when falling in the arc of a circle the top must fall much faster than the base portion if the chimney remains whole—that is, it will sweep through an arc of greater length. But inertia prevents this, and the effect on the chimney in mid-air is the same as though it were a beam supported at both ends, and of course it breaks.

An accident recently occurred in a Corning, N. Y., glass factory which gave another striking illustration of inertia effect. A chimney about twenty-seven feet diameter at the base and 120 feet high was being repaired when it fell vertically eight feet, crushing the piers supporting it. The chimney was the flue of the furnace for melting glass in pots, and twelve pots were ranged around the base. Brick arched openings gave access to the pots, and the piers between supported the chimney. One of the piers was weakened by the workmen, and as it crushed, more weight was thrown on the other piers which also crushed, letting the chimney settle vertically into the furnace hole. The chimney did not overturn, as might have been expected, because the inertia effect delayed overturning long enough when one pier crushed to permit the others to crush also. After settling, the chimney stood about four feet out of plumb.

PERSONALS

E. C. Newman, of the Newman Mfg. Co., Cincinnati, Ohio, was married to Miss Henrietta Cohen, of New York City, July 2.

Charles F. Scribner has taken a position as efficiency engineer on the staff of the New England Westinghouse Co. at Springfield, Mass.

J. A. Eden, Jr., is no longer connected with the Baush Machine Tool Co., Springfield, Mass., having resigned the position of general manager June 24. Mr. Eden has no plans for the future.

Henry M. Sonnenthal and Frederick M. Sonnenthal, two of the directors of the Selson Engineering Co., Ltd., with offices at 78 Broad St., New York City, have changed their surnames to Selson, and will in future take the names of Henry M. Selson and Frederick M. Selson.

Walter J. Newman, manager of the Chicago plant of the Newman Mfg. Co., Cincinnati, Ohio, manufacturer of lathe tool attachments, architectural and ornamental brass, bronze and wrought steel work, was married to Miss Ella Hochbaum, of Chicago, June 11, at the Hotel LaSalle.

John Calder has been appointed assistant to H. H. Pinney, vice-president of the Remington Arms-Union Metallic Cartridge Co., and will represent Mr. Pinney as chief executive at the Remington plant in Bridgeport. Mr. Calder was general manager of the Remington Typewriter Co. in Ilion for several years.

John W. Horne has resigned as secretary and treasurer of the Horne-Dale-Brown Co., Chicago, and has sold his interest in the company. Mr. Horne has arranged to represent some tool and machinery manufacturers not already represented in Chicago territory. During the last eighteen years, he was Chicago manager for the Norton Co., Worcester, Mass., and manager of the machinists' supply department for H. Channon Co. and Samuel Harris & Co.

OBITUARIES

George Gilmour, chief engineer of the Travelers' Insurance Co., died June 15, aged fifty-one years. Mr. Gilmour was a trustee of the American Museum of Safety. He had given much attention to accident prevention methods and was recognized as one of the authorities in safety engineering.

William A. Warman, mechanical superintendent and designer of the Keller Mechanical Engraving Co., Brooklyn, N. Y., died July 2 of tuberculosis, aged fifty-five years. Mr. Warman was a mechanic of unusual ability, being inventive and resourceful. He had developed a number of inventions and was interested in more that had not been brought to a practical conclusion.

COMING EVENTS

August 15.—Annual meeting of the International Railroad Master Blacksmiths Association, Chicago, Ill. A. L. Woodworth, secretary and treasurer, C. H. & D. Ry., Lima, Ohio.

August 31.—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

September 5-8.—Annual convention of the Traveling Engineers' Association at Chicago, Ill. W. O. Thompson, secretary, New York Central Car Shops, E. Buffalo, N. Y.

September 11-16.—Annual convention of the American Foundrymen's Association and the American Institute of Metals, Cleveland, Ohio, in the Cleveland Coliseum. A. O. Backert, secretary-treasurer, American Foundrymen's Association, Cleveland, Ohio.

September 11-16.—Exhibition of machines, equipments and supplies for the foundry and allied industries in conjunction with the annual conventions of the American Foundrymen's Association and American Institute of Metals, at Cleveland, Ohio, in the Coliseum. C. E. Hoyt, manager, 1949 W. Madison St., Chicago, Ill.

September 25-30.—Second National Exposition of Chemical Industries, Grand Central Palace, New York City.

September 28-30.—Meeting of the American Electrochemical Society at Grand Central Palace, New York City. Secretary, J. Malcolm Muir, 239 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

New Mexico State School of Mines, Socorro, N. M. Annual register for 1915-1916 with announcements for 1916-1917.

University of South Carolina, Columbia, S. C. Catalogue 1915-1916 with calendars for 1915-1916 and 1916-1917.

Providence Engineering Society, Providence, R. I., will occupy its new rooms at 29 Waterman St. when it opens for its fall and winter work next September. The whole second floor of the building has been taken over and will be remodeled and equipped in a modern and attractive manner. The society expects to pursue an interesting and useful line of work for the coming year.

NEW BOOKS AND PAMPHLETS

Strength and Other Properties of Concrete as Affected by Materials and Methods of Preparation. By R. J. Wig, G. M. Williams and E. R. Gates. 172 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 58.

The Winnipeg River Power and Storage Investigations. By J. T. Johnson, Chief Hydraulic Engineer. In two volumes: Volume I, 511 pages, 6⅝ by 9¾ inches. Illustrated. Volume II, Charts, 6 by 9¾ inches. Published by the Department of the Interior, Ottawa, Canada.

The growing realization of the importance of water powers makes this voluminous report of much interest and value to mechanical and civil engineers generally. It is claimed that the power available from the Winnipeg River is greater than that now being developed at Niagara Falls. Long-distance electrical transmission will make the power available over a wide area, and the ultimate development will profoundly affect the industrial life of Ontario.

Predetermination of Prices. By Frederick Parkhurst. 96 pages, 6 by 9¼ inches. Illustrated. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $1.25.

The purpose of this book is to present an argument in favor of the possibility of predetermining true costs. To substantiate this argument, the author has entered into a brief consideration of important factors which govern the making of such a determination. The text is divided into eight chapters which cover the following subjects: Importance of Absolute Control of all Sources of Information; Discussion of the Elements Affecting True Costs; Direct Costs; Indirect Costs; Recapitulation of Costs; Estimating; Profit and Relatively True Selling Prices; Conclusions.

Ammunition Manufacture—Processes and Hazards of Artillery and Small Arms Ammunition Manufacture. By W. D. Milne. 28 pages, 6 by 9 inches. Paper covered. Published by the Underwriters' Bureau of New England, 141 Milk St., Boston, Mass.

This report deals with the hazards of munitions manufacture from the standpoint of the insurance companies. It treats of the manufacture of shrapnel, projectile cases, shrapnel shell filling, shrapnel fuse, loading fuse powder trains, artillery cartridge cases, artillery primers, fulminates and primer loading, storage, blending and drying of black powder, small arms ammunition, distribution of manufacture, bullets, cartridge cases, primers, loading cartridge clips, powder houses and hazards of powder and fulminates.

Questions and Answers on Automobile Design, Construction and Repair. By Victor W. Page. 701 pages, 5 by 7½ inches. 387 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $1.50.

This treatise consists of a series of thirty-seven lessons covering over two thousand questions and answers on the motor car, its construction, operation and repair. The modern gasoline car and its principal parts are described in the first lesson, and then follows a description of the action of two- and four-stroke cycle motors, the parts of gasoline motors and their functions, fuels for automobile motors, theory of carburetion and its application, etc. The work is one that should appeal to those who like the catechism style of presenting technical information.

Strength of Webs of I-Beams and Girders. By Herbert F. Moore and W. M. Wilson. 50 pages, 6 by 9 inches. 22 illustrations. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill. Price, 30 cents.

The bulletin records the results of tests made at the Engineering Experiment Station of the University of Illinois on a number of specimens consisting of 12-inch I-beams having the webs planed down to a thin section and 24-inch built-up girders having webs of thin plates. The results of the tests show that in general the shearing stress is a maximum at the neutral axis, but that diagonal stress at the junction of web and flange must be considered. Tests show that stiffeners at supports and under concentrated loads are very necessary. A formula is given for determining the buckling strength of webs.

Safety First for Vocational Schools. Prepared by Lewis A. Wilson. 90 pages, 5¾ by 9 inches. Illustrated. Published by the University of the State of New York, Albany, N. Y.

The bulletin treats on vocational school accidents and their legal aspect; safety precautions for school boards; safety suggestions for vocational teachers; general safety rules for pupils; how to organize a safety campaign in a vocational school; fire drills, instructions and precautions; general safeguarding rules; rules for guarding and operating woodworking machines; rules for guarding and operating machine shop equipment; safeguarding the electrical shop; resuscitation from shock; safety precautions for plumbers, printers, painters, decorators, patternmakers, blacksmiths, etc. The bulletin, although intended primarily for vocational schools, will be found generally serviceable for instructing all classes of workers in industrial establishments.

The Marine Steam Turbine. By J. W. M. Sothern. 561 pages, 6 by 9 inches. Illustrated. Published in America by D. Van Nostrand Co., New York City. Price, $6.

This book is of the fourth edition, revised to include a number of improvements that have developed in marine steam turbine design, especially the introduction of gearing between the propeller driving shaft and the turbine to obtain the maximum efficiency of both turbine and propeller. The contents by chapter heads are as follows: Definitions and General Principles; Workshop Practice; Data from Actual Practice; Torsion Meters; General Notes; Temperature-Entropy Diagrams; General Turbine Data; Impulse Turbines and Combined Impulse and Reaction Turbines; Description of the Curtis Turbine; Geared-down Turbines; Practical Operation of Turbine Machinery; Data from Actual Practice; Shaft Horsepower; Condensers and Auxiliaries; Oil Fuel; and Boilers. The work is illustrated by over 330 diagrams, photographs and detail drawings. The book is suitable for naval and mercantile marine engineers, students and others concerned with the theory of marine steam turbines and their practical application for the propelling of vessels. The author is the principal of Sothern's Marine Engineering College, Glasgow, Scotland. Previous editions have been translated into French, German, Spanish and Dutch, and the work, therefore, has an international reputation.

The Engineer in War. By P. S. Bond. 187 pages, 5 by 7⅜ inches. Illustrated. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $1.50.

Military field engineering is a practical art, and cannot be acquired by study alone; but engineering plays such an important part in all operations of warfare that there is little exaggeration in stating modern warfare to be an application of engineering science to the armed conflicts of states. Those who have considered the military policy of the United States cannot have failed to observe how greatly it depends upon the voluntary service of citizens; in fact, the rights and privileges of citizenship carry with them an obligation of service to the state, but mere tacit recognition of a duty does not insure its efficient discharge. Acknowledgment of a duty involves the necessity of preparing for its performance, and if we do not prepare, we are evading the duty. In such voluntary preparation of citizens to fulfill their obligations to the state, civil engineers play an important part, as it is obviously impossible to train non-professional men to give satisfactory service in military engineering. It is to meet the requirements of such men that the present text has been prepared. The author does not aim to provide a treatise of military field engineering, as he recognizes the existence of a number of excellent manuals and text-books on this subject. The aim has been to present a brief outline of the relation of engineering practice to the conduct of modern warfare, and the adaptation of principles and practices of civil engineering to military requirements.

Power Transmission by Leather Belting. By Robert Thurston Kent. 114 pages, 5¼ by 8¼ inches. Illustrated. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $1.25.

The development of high-speed steel cutting tools and the intensive methods of manufacture which have resulted from their use have placed greater demands upon the drives used for machine tools. Necessary improvements in power transmission systems have been developed, but the change has come so gradually and unobtrusively that many engineers have not realized the improvements that have been made in this branch of engineering practice, and literature of power transmission—especially the transmission of power by belting—has not been kept up to date. Many excellent papers have been read before various engineering societies, and contributions of equal merit have appeared in the technical press, and in his introduction to the present text the author makes acknowledgment to these sources for much of the information that he has presented. The subject is covered in a comprehensive manner, with equal stress laid upon theory and practice. Theoretical discussions and explanation of practical matters are separated, and as a result the shop engineer, master mechanic or man in charge of belts in the shop can readily obtain the necessary information in regard to the selection of the proper size of belt to transmit a given horsepower, the tension at which it should be operated and the length of time which ought to elapse between retightening, together with notes on the proper care and maintenance of belts. In like manner, the engineer will find the subject treated from the standpoint of theory as well as practice, so that his requirements are well taken care of.

Economics of World Trade. By O. P. Austin. 141 pages, 5 by 7½ inches. Illustrated. Published by the Business Training Corporation, 185 Madison Ave., New York City.

This is the first of a series of texts for a course in foreign trade issued under the direction of Dr. Edward Ewing Pratt, Chief of the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce. This first volume contains an "Introduction to the Course in Foreign Trade," written by Dr. Pratt, which discusses the various factors that make foreign trade a dominant factor in American commercial prosperity. Dr. Pratt traces the development of the United States from the time when we were a commercially provincial nation down to the present, when we have assumed the export leadership of the world. The significant increase in the proportion of our manufactured to our raw materials and foodstuffs exports is graphically brought out. During the decade ending with 1889 the proportion was 80 per cent of crude materials and foodstuffs to about 20 per cent of manufactured goods exported. In the period 1890 to 1899 the proportion was 75 per cent of crude materials and foodstuffs to about 25 per cent of manufactures. In the period ending 1909 the proportions were 62 per cent of foodstuffs and raw materials and 38 per cent for manufactures. During the period 1910 to 1914 the proportion of manufactures rose to 47 per cent, as against 53 per cent for foodstuffs and crude materials. Not only has our trade with the European countries increased tremendously since the war, but it has also increased elsewhere, for example: South America, 20 per cent; Africa, 40 per cent; Asia, 40 per cent; Australia, 40 per cent. "Will we and can we retain this increased trade?" is a question that Dr. Pratt both asks and answers. The level of costs after the war, the factors of commercial good will, capital requirements and supply, and labor conditions in Europe after the war, as they bear on our future export trade, are discussed. Following the introduction is the first text, which is written by O. P. Austin, statistician of the National City Bank and formerly chief of the Bureau of Manufactures of the United States government. This part of the volume sets forth the underlying factors which control the world currents of foreign trade. Such subjects as the export of surplus production, the export of capital, the control of transportation, colonization and emigration, trade routes and trade centers, the seasonal movement of commodities, artificial stimuli to trade, protection and free trade, are all discussed thoroughly and interestingly. It is perhaps safe to say that this subject of world trade economics is nowhere else treated with equal clearness and authority.

NEW CATALOGUES AND CIRCULARS

Roller-Smith Co., 233 Broadway, New York City. Bulletin 300 descriptive of portable direct-reading slide wire ohmmeters.

Richards-Wilcox Mfg. Co., Aurora, Ill. Catalogue of overhead trolley and I-beam carrying equipment for loads up to four tons.

Reed Small Tool Works, Worcester, Mass. Leaflet describing the Reed caliper and giving prices for sizes from 1 to 6 inches.

Persons-Arter Machine Co., Worcester, Mass. Catalogue 2 illustrating and describing Model A 8- to 12-inch rotary surface grinders equipped with magnetic chucks.

United States Lathe & Machine Co., Cincinnati, Ohio. Circular of the United States 20-inch, heavy-duty, screw cutting engine lathe with quick-change, five-step cone and single back-gear.

Vulcan Soot Cleaner Co., Dubois, Pa. Catalogue on Vulcan soot cleaners as applied to boilers, superheaters, economizers, garbage destructor boilers, waste heat boilers and similar apparatus.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin 1004 showing panoramic view of the new laboratories of the Massachusetts Institute of Technology which are served by Shepard electric cranes.

Electric Controller & Mfg. Co., Cleveland, Ohio. Price lists for E. C. & M. ventilated controllers, brakes, push buttons, motor starters, rheostats, switches, pressure regulators, safety limit stops and crane switchboards.

Keuffel & Esser Co., Hoboken, N. J. Circular of a new flexible curve rule in 12-, 18-, 24- and 30-inch lengths. It is claimed that the rule embodies all the advantages with none of the drawbacks of the ordinary curve rulers.

S. K. F. Ball Bearing Co., Hartford, Conn. Bulletin entitled "S.K.F. Ball Bearings for Cotton Seed Oil Machinery," describing the construction of S.K.F. ball bearings and the advantages gained by their use in this class of machinery.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin E-41, superseding E-32, illustrating "Duntley" electric track drills, heavy-duty side-spindle and center-spindle drills, electric grinders, spike drivers, etc.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 13 discusses the advantage of large gathering capacity in a forging machine and shows how this applies to the National heavy pattern forging machine.

Chicago Flexible Shaft Co., 149 W. LaSalle St., Chicago, Ill. Catalogue of flexible shafts and tools for grinding, reaming, polishing, drilling, tapping, buffing, boring, sanding, etc. These flexible shafts are of the wire and link core types.

Alexander Milburn Co., 1420 W. Baltimore St., Baltimore, Md. Folder illustrating Milburn oxy-acetylene welding and cutting apparatus, including welding torch, pressure regulators, cutting torch, generators, portable welding outfits, etc.

National Scale Co., 6 Mechanic St., Chicopee Falls, Mass. Circular illustrating "Multi-unit" sectional steel shelving which permits of arrangement in sections by the multiplication of any number of units, which interlock. Units can be added as required.

Day & Zimmermann, 611 Chestnut St., Philadelphia, Pa., has begun the publication of a house organ called "Development," the object of which is "to disperse ideas, advice and information for use in the proper development of industries and public utilities."

Diamond Machine Co., Providence, R. I. Catalogue showing the line of Diamond wet tool grinding machines, which contains sixteen different sizes and types. Specifications are given for wet tool grinding machines of the floor and bench types, belt- and motor-driven.

U. S. Ball Bearing Mfg. Co., Chicago, Ill. Catalogue F describing U. S. ball bearings. The booklet contains information on the hardening and grinding of these bearings and illustrates the standard types of radial bearings, adapter bearings, cone type bearings and thrust bearings.

Montgomery & Co., 104 Fulton St., New York City. Price sheet entitled "Odds and Ends," giving sizes and prices of arbors, bolts, hacksaw blades, blocks, broaches, chucks, cutters, dressers, drills, extinguishers, files, holders, screws, screwdrivers, taps, tapes, carpenters' and woodworkers' tools, and other tools, supplies and machinery made by this company.

Nordberg Mfg. Co., Milwaukee, Wis. Bulletin 28, covering the Nordberg line of poppet valve engines, which includes three types, namely, full poppet, poppet-uniflow and poppet Corliss. The engine best suited for the purpose is recommended in each case. In addition to describing the construction of the different types of engines the book gives results of tests made on these engines.

Draeger Oxygen Apparatus Co., 422 First Ave., Pittsburg, Pa. Folder descriptive of type B pulmotor, a hand-operated resuscitation device, insuring a safe and efficient pressure. This type of pulmotor is equipped with a regulating valve by means of which air is allowed to escape to any degree desired, reducing the inhalation pressure as shown by the indicator gage.

Hub Machine, Welding & Contracting Co., 22nd and Race Sts., Philadelphia, Pa. Circulars illustrating "Acme" metal saw table in two sizes. Table No. 1 is 18 by 18 inches and takes saws up to 6 inches diameter; table No. 2 is 22 by 24 inches and takes saws up to 10 inches diameter. These machines are being used extensively at present for cutting copper cartridges. They are also specially designed for cutting copper shells and tubing, brass tubing, sheet and rod metal, fiber, rubber, etc.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular illustrating Westinghouse reversing motor equipments applied to metal planers. These direct-connected reversing motors have 4 to 1 speed adjustment by field control, and the controller gives fine speed increments. The circular points out the advantages resulting from the use of reversing motors on planers and other machines having reciprocating motion.

Phoenix Mfg. Co., Eau Claire, Wis. Catalogue of Conradson geared-head engine lathes, geared-head projectile lathes and geared-head special lathes, built in 21 inches and 28 inches swing. The spindle drive is effected by means of duplex gears and worm-gears of widely varying ratios. The general construction has been worked out to afford the maximum of rigidity and power so that the heaviest cuts may be taken without excessive vibration.

David McLain, Goldsmith Bldg., Milwaukee, Wis. Booklet on McLain's semi-steel, showing semi-steel castings in wide variety and illustrating the superior physical characteristics of semi-steel consisting of 30 to 50 per cent steel which is claimed to have a tensile strength of 34,000 to 38,000 pounds. Booklet containing synopsis of McLain's System which comprises information and instructions in a set of twelve printed lessons covering gray iron mixtures, cupola practice and the making of semi-steel.

J. T. Slocomb Co., Providence, R. I. Catalogue 15 covering complete line of Slocomb micrometer calipers and center drills. The latter half of this catalogue is called, "The Measuring Book," and contains suggestions in regard to accurate and economical measuring in machine construction by the use of micrometer calipers. This section of the book is illustrated with halftone and line engravings, making the matter very clear, and contains much useful material including tables of decimal equivalents, tap drill sizes, speeds for twist drills, diameters of centers, sizes of center drills and speeds, etc.

Sweet's Catalogue Service, Inc., 115-119 W. 40th St., New York City. Second annual edition of Sweet's engineering catalogue which contains a collection of condensed catalogues, comprising materials of construction, contractors' plant, power plant equipment and allied products, completely indexed with cross references. The catalogues cover 823 pages, 8½ by 12 inches. The index is divided into three parts, the first part containing the manufacturers' names, the second part, classified list of products and the third part, trade names. The catalogue also contains a specification digest for aid in specification writing. This is intended for use in connection with the power plant section and occupies 80 pages.

American Pulley Co., 4208-60 Wissahickon Ave., Philadelphia, Pa. Booklet entitled, "Belt Pulleys," by Charles A. Brinley, a reprint of a paper read before the Engineers Club of Philadelphia, June 20, 1916. This booklet contains valuable pulley information including data of the results of tests on pulleys made at the American Pulley Co.'s plant, under the supervision of William W. Crosby. The company has also issued another booklet entitled, "Belt Pulleys—Report of Tests for Belt Slip," by H. M. Haven and William W. Crosby. The object of the tests was to determine the slip in feet between a belt and the face of a pulley when the belt was transmitting different known horsepowers to the pulley. The apparatus used is illustrated and the results of the tests are tabulated. These booklets will be sent free on request to those interested.

TRADE NOTES

Abbott Ball Co., Hartford, Conn., has let the contract for an addition to its ball bearing plant, two new buildings now being under way.

Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich., has changed its Boston office from 185 Devonshire St. to 445 Tremont Bldg., 73 Tremont St.

Wagner Electric Mfg. Co., St. Louis, Mo., has moved its Detroit office to 1291 Woodward Ave. The office will continue to be in charge of Dean Emerson.

Newman-Andrew Co., American representative of Jno. Hy. Andrew & Co., Ltd., Toledo Steel Works, Sheffield, England, has moved from 107 West St. to larger offices at 26 Cortlandt St., New York City.

Ready Tool Co., 654 Main St., Bridgeport, Conn., has purchased a plot on the corner of Railroad Ave. and Iranistan St., Bridgeport, and has placed a contract for the erection of a brick factory building, to begin at once.

Brown & Sharpe Mfg. Co., Providence, R. I., will close from July 28 to August 8 for the annual vacation. During this time the offices will be open as usual, and orders for machine tools, machinists' tools and cutters will receive the same attention as at any other period of the year.

W. H. Nicholson & Co., 112 Oregon St., Wilkes-barre, Pa., secured an order for 1017 Nicholson compression shaft couplings for 2 7/16-inch shafting from the Remington Arms & Ammunition Co. for the ordnance plant at Ilion, N. Y. The Nicholson couplings are of the four-jaw compression type which is applied without milling keyways in the shafting.

National Twist Drill & Tool Co., Detroit, Mich., is erecting a three-story concrete and brick office building, 42 by 81 feet. A four-story factory addition, 45 by 76 feet, with L-connection to the office building 45 by 73 feet, is also being erected and is nearly completed. The dimensions given in the July number were incorrect in regard to the factory addition and L-connection.

Glidden Varnish Co., Cleveland, Ohio, has built a large addition of concrete, fireproof construction throughout, affording 27,000 square feet of additional floor space. The addition will be equipped throughout with modern machinery for the manufacture of paints and varnishes. The plant occupies an area of 16½ acres, and the total floor space of the buildings is 190,000 square feet. Complete lines of varnishes and paint specialties are manufactured for the requirements of all industries.

G. Hartmann has opened an office in the Tribune Bldg., New York City, where he will act as representative of the following machine firms in Norway, Finland, Sweden and Russia: G. Hartmann, Ltd., Christiania; Finska G. Hartmanns Maskinaffar, Ltd., Helsingfors; G. Hartmanns Maskinaffar, Ltd., Stockholm; and Christian Christiansen, Petrograd and Moscow. He will act as agent for the purchase of metal working machinery, machine tools, metals, tubing, crucibles and other materials required in general manufacture.

Russo-Baltic Car Works Co., Room 242, Metropolitan Tower, 1 Madison Ave., New York City. The company, which was incorporated in Petrograd, Russia, has sent a commission to America for the purpose of purchasing materials and machines for the company's new automobile plant in Russia, and not for the purpose of purchasing materials for the manufacture of railway cars and other railway equipment. The commission invites all concerns offering machinery, etc., for the manufacture of motor cars to send catalogues and printed matter descriptive of their products.

Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., has begun the erection of a complete manufacturing plant on a six-acre tract of land located on Kentucky Ave. The new structure will be of concrete, four stories high, with 150,000 square feet floor space. The main building will be 380 by 60 feet with two L's 100 feet long, making the entire frontage 700 feet. A power plant and auxiliary buildings will be located in the L's. It is expected that the buildings and new equipment will double the present capacity of the plant. Plans, specifications, engineering and construction are in charge of Westinghouse, Church, Kerr & Co.

Cincinnati Milling Machine Co., Cincinnati, Ohio, gave a birthday party to its employes at the Cincinnati Zoological Garden, July 1, in honor of the fiftieth birthday of the president, Frederick A. Geier. About 4200 employes and members of their families accepted the invitation and participated in the events. The program included a shoe race, potato race, three-legged race, sack race, tug of war, ladies' and gentlemen's race, track race around the lake, fifty-yard dash, peanut race for girls, pipe-lighting race for girls and men, flag race, nail-driving contest for women, rolling hoop around the lake (fat men only eligible), donkey driving contest, goat riding pillow contest. The party was voted a great success by all participating.

International Oxygen Co., 115 Broadway, New York City, is installing a new plant at College Point, L. I., for the manufacture of oxygen and hydrogen gas. It is expected that the installation will be completed late in August or early in September. When completed the company's trade in Brooklyn and environs, as well as in Manhattan, will be largely handled from the College Point plant. Heretofore this local business has been supplied by the company's Newark works. About six years ago the company acquired the American rights to manufacture electrolytic gas generating apparatus. An oxygen-hydrogen generating plant was installed to demonstrate the efficiency of the apparatus and the purity of the gases, but the manufacture of apparatus is the main business of the company, this part of its business being concentrated at the Newark factory. The manufacture and distribution of gas in cylinders is a local and secondary matter.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been awarded the contract for furnishing the necessary equipment for the electric propulsion of the U. S. S. "Tennessee," the super-dreadnaught of the largest class, now under construction. The system of propulsion being installed differs from any now in use by battleships. Instead of the propellers being mechanically connected to the driving engines or turbines, there are two steam turbines developing over 33,000 horsepower driving electric generators which furnish current to four 6700-horsepower motors, each motor driving a propeller. Electric drive for battleships has been adopted after a careful investigation by the Navy Department to whom it presented numerous features of structural, operating, and military advantages, among which are that the steam turbines developing the electric energy may be located in any desired portion of the ship, that the propelling machinery may thus be better protected from injury, that full power may be available for reversing, and that greater rapidity in maneuvering is made possible compared with existing mechanical systems of control.

Morse Chain Co., Ithaca, N. Y., has lately increased its capital stock from $400,000 to $1,500,000 for the purpose of increasing the manufacturing facilities. New buildings will be erected and additions made to old ones. The growth of the company has been remarkably rapid; it started with a fair-sized factory at Trumansburg, N. Y., in 1904, just about the time when electric motors came into general commercial use. In 1906 the business was moved to Ithaca, N. Y., to a new factory built especially for the purpose, and twice as large as the former one. In 1912 it was necessary to again enlarge, and the floor space was more than doubled by additions. The present plans contemplate again doubling the size of the plant. A large storage building has been about completed and additions to the steel and wire mills and a new gas producer building are well under way. Another addition to the main building, increasing its total length to more than 900 feet, will soon be started. When the buildings are completed the company will have a total floor space of approximately seven acres, which will be devoted exclusively to the manufacture of the Morse rocker-joint power transmission chain.

CLASSIFIED AND WANT ADVERTISEMENTS

Will be found on page 269 of this issue and will be run in the same relative position in future.

AJAX

(Trade Mark Registered)

Taper Forging Rolls

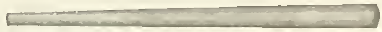
THESE ROLLS are being widely used for producing tapered forgings.

The surface of the pieces can be made smooth and uniform.

They can be produced more rapidly and economically than with hammers, and the expense of repairing damaged hammers is eliminated.

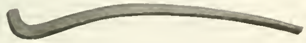
It is impossible to give any complete list of parts or of shops where these rolls might be used. They are successfully employed in hundreds of plants.

If you use tapered forgings at all like those shown, write for an Ajax Engineer. He will tell you whether the rolls will do the work and just what the production would be.



Tapered Tubes

Many manufacturers will see how the tapering of this class of work can be applied to their products.



Brake Shoe Keys

The enormous savings which it was possible to make by the use of the roll method led us to design a special machine for making these brake keys complete, all in one heat and at a single handling.

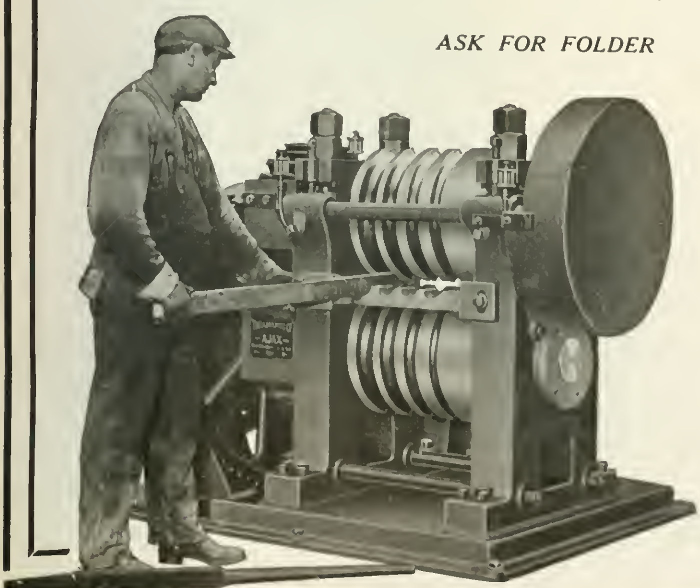
Wedges

In making such pieces, the uniformity of taper and the great speed of the Ajax Rolls give the most satisfactory and economical production possible.

Tongs

These illustrations show the uniform taper and smooth work done on Ajax Machines.

ASK FOR FOLDER



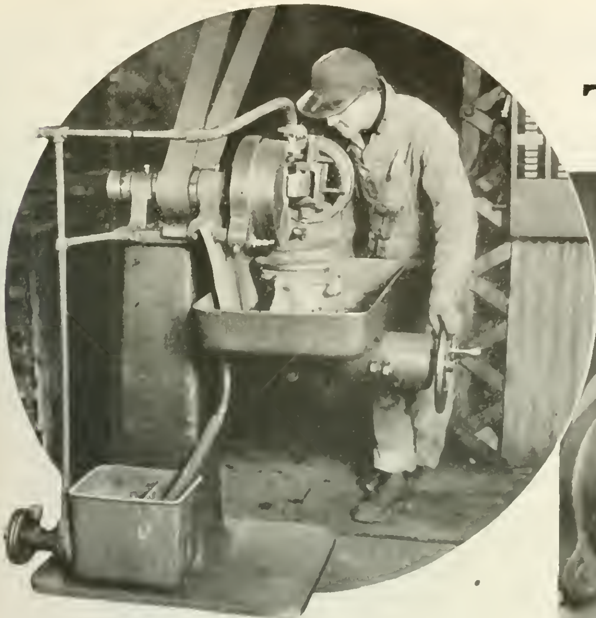
THE AJAX MFG. CO.

CLEVELAND, OHIO

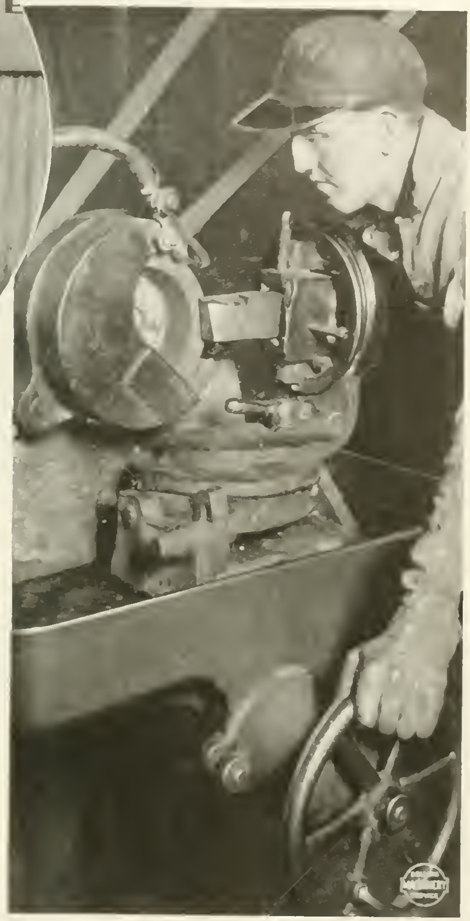
CHICAGO OFFICE:
621 Marquette Building

NEW YORK OFFICE:
1369 Hudson Terminal


"Pioneer"
STEEL HANGER
A Man's Job
Erecting cast-iron hangers is a man's job — and what is more, it doesn't take much of a hanger to require *two or three* men to get it into position.
A "Pioneer" Pressed Steel Hanger weighs only one-third as much as a cast-iron hanger; it has greater strength and costs no more; it can be erected by one man easily.
Why not, therefore, use "Pioneer" Hangers?
Have you a copy of our new booklet "Transmission Data"? It is worth studying. Mailed promptly for the asking.
STANDARD PRESSED STEEL CO.
PHILADELPHIA, U. S. A.



Better Tool Grinding



It is Possible to Grind a Tool Correctly by Hand; But Why make your High Priced Mechanics Do It?

Tool grinding the "Gisholt" way is the correct way—every tool ground to its correct angles and re-sharpened by *grinding the top only.* No guess work about it—the angles are standard, sample tools are furnished for the operator to duplicate and a chart is provided which shows him exactly how to obtain each angle.

The "Gisholt" way is the way of the Browning Engineering Company, Cleveland, Ohio. One Gisholt Tool Grinder and one man grind the tools for the whole shop. Each man has a sharp tool ready and waiting for the moment he needs it.

No machine is held up while its operator is off in some other part of the shop grinding (or waiting his turn to grind) the tool he needs.

Not only is production bettered; but costs are reduced. Tool costs are less; labor is less; waste time is less.

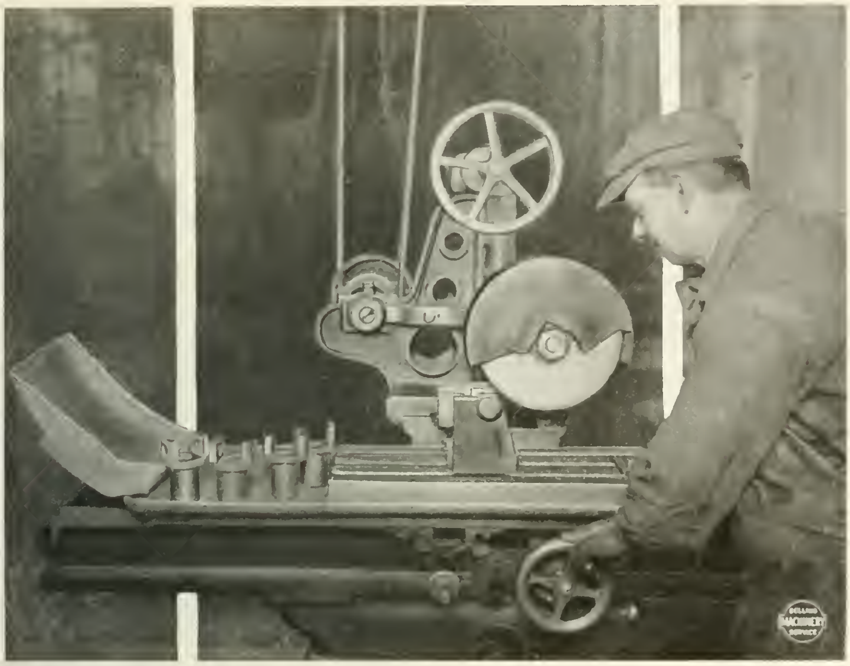
All these advantages and more we offer you in the Gisholt Tool Grinder. May we send the catalogue and more details?

GISHOLT

GISHOLT MACHINE COMPANY

1117 E. Washington Avenue
MADISON WISCONSIN

Diamond Surface Grinder



Universal Joint Grinding
By the International Motor Co.

The Diamond Surface Grinder at the Plainfield, N. J., plant of the International Motor Company is a busy machine. It grinds everything that can be put up to a machine of this type; it has been in service for five years, and it has yet to be out of commission for repairs. The job on hand when our photographer called was grinding nickel-steel universal joints, taking 0.020" of stock from the slot and finishing the bottom at the same time. Not spectacular grinding by any means, but owing to the toughness of the material and the accurate finish required, a pretty good indication of how the Diamond Grinder meets demands on a really stiff job.

Diamond Surface Grinders are made right, and every machine subjected to rigid test before it leaves the factory. Add to "Diamond" accuracy and speed, "Diamond" ability to take such cuts as 0.006" on hardened steel and 0.125" on cast iron, and you have "Some Grinder."

Let us show you some before-and-after production figures.

DIAMOND MACHINE COMPANY, Providence, R. I.

AMERICAN GRINDING WHEELS

And They Continue To Use Them Year After Year

In the whole convincing record of American Grinding Wheel efficiency, there is no more important data than that secured recently at the Elizabethport (N. J.) plant of the American Swiss File & Tool Company. This concern makes a high-grade line of files and employs in every department the best equipment obtainable.

They began using American Grinding Wheels five years ago, and have continued them because they proved absolutely satisfactory for the exacting work demanded. The photograph shows an "American" grinding 12″ x 2″ flat file blanks three at a time. The files are ground first on one side, then turned and ground on the other. The American wheel is 12″ diameter, 4½″ high, cup shaped, grain 46 corundum, grade 1¼—a grade which has proved a winner from the first.

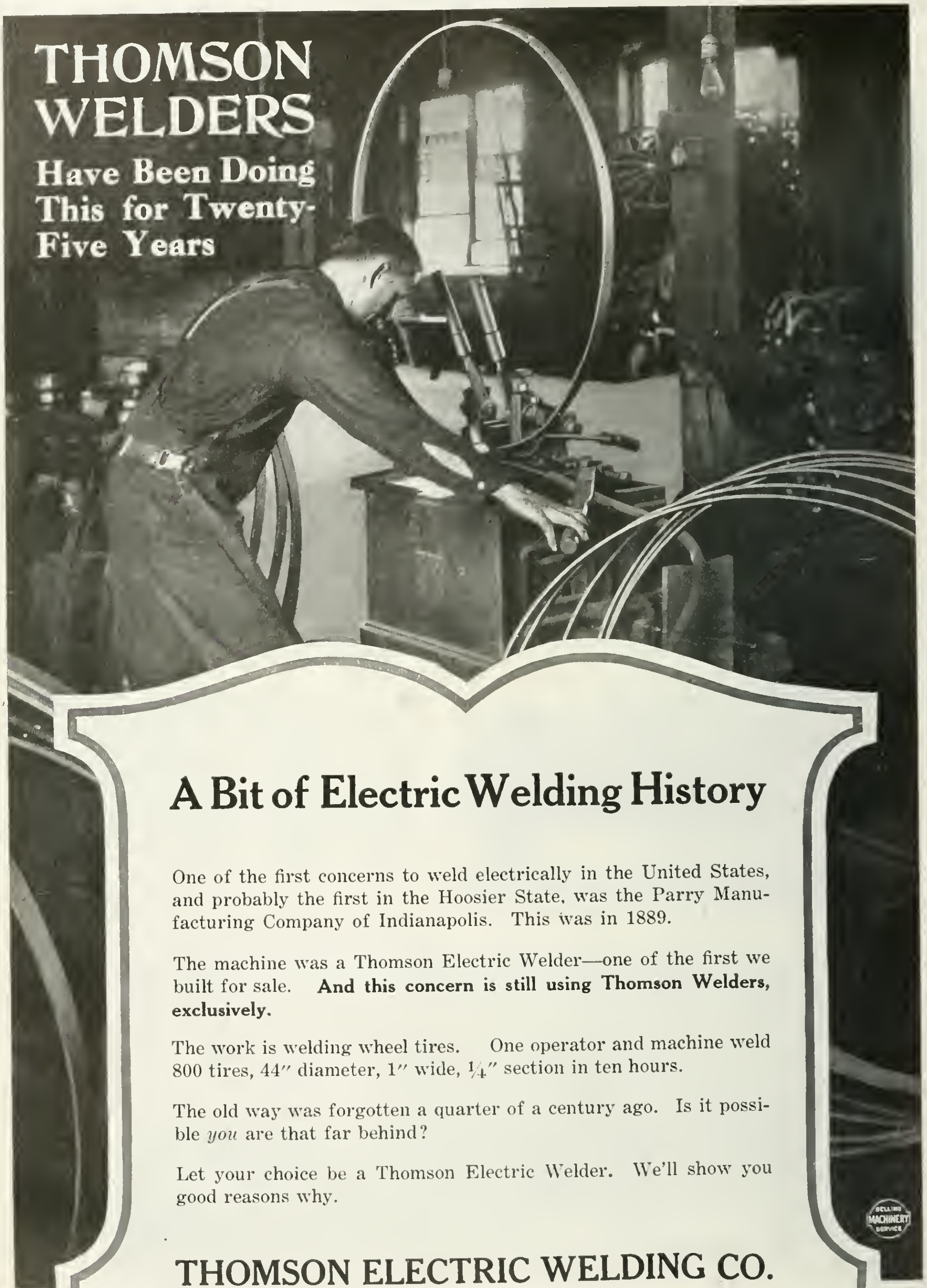
That's American history—the wheel that suits the work today can be duplicated next year—or the year after. American Wheels are adaptable—none more so. They are quality wheels—none better. Used exclusively by many firms who say they have "tried them all." Write us your requirements. We have the wheel.

AMERICAN EMERY WHEEL WORKS

PROVIDENCE, RHODE ISLAND

Buck & Hickman, Ltd., London, Sheffield, Birmingham, Manchester, Glasgow; F. G. Kretschmer & Co., Frankfurt, a/M., Germany; Heinrich Dreyer, Berlin, Germany; Hans Schulze, Vienna, Austria; Kann & Heller, Budapest, Hungary; A. B. V. Lowener, Stockholm, Sweden; V. Lowener, Copenhagen, Denmark; V. Lowener's Maskinforretning, Sverre Mohn, Christiania, Norway; R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland; R. S. Stokvis & Fils, Paris, France, and Brussels, Belgium; Takata & Co., Tokio, Japan; Societa Italiana De Fries & Co., Milan, Italy; La Maquinaria Anglo-Americana, R. D'Aulignac, Barcelona, Spain; Bevan & Edwards Pty., Ltd., Melbourne, Australia; O. R. San Galli, Petrograd, Russia; Murphy & Charles, Inc., Valparaiso, Chile (for Chile, Peru and Bolivia).


SPECTACULAR WORK! Men are on piece-work and doing all they can to fatten up the pay envelope. The steel is 70-point carbon and the elastic limit is high—at least 120,000 pounds to the square inch. Too bad Uncle Sam objects to stating *where*—we can tell only *how* Stellite is used. There's great variation in the shell steel and no specific figures can be given on the number of shells turned between grinds. The cutting speeds, however, run from 50 feet at the tip of the nose to 250 feet on the diameter. This is the finishing operation ,the depth of cut being 1-16".
Stellite tools are the only tools that can stand the pace in this plant without frequent regrinding. The men in the shop want nothing else.
Send $1.00 for two sample Stellite bits, one for turning cast iron, one for steel, and try them out. The things you can do with them will surprise you. Booklet on request.
THE HAYNES STELLITE COMPANY
KOKOMO
Patentees and Sole Manufacturers
INDIANA
Also Sold by THE MIDVALE STEEL COMPANY
WAREHOUSES: PHILADELPHIA CLEVELAND BOSTON CHICAGO NEW YORK SAN FRANCISCO



A Bit of Electric Welding History

One of the first concerns to weld electrically in the United States, and probably the first in the Hoosier State, was the Parry Manufacturing Company of Indianapolis. This was in 1889.

The machine was a Thomson Electric Welder—one of the first we built for sale. **And this concern is still using Thomson Welders, exclusively.**

The work is welding wheel tires. One operator and machine weld 800 tires, 44″ diameter, 1″ wide, ¼″ section in ten hours.

The old way was forgotten a quarter of a century ago. Is it possible *you* are that far behind?

Let your choice be a Thomson Electric Welder. We'll show you good reasons why.

THOMSON ELECTRIC WELDING CO.

LYNN, MASSACHUSETTS, U. S. A.

THE PIONEER MANUFACTURERS

Why Pay Forfeits on Overdue Rifle Contracts?

Use These Machines and Meet Deliveries

The "Victor" Deep Hole Drilling Machine was developed especially to meet the demand for a tool that would handle deep hole work rapidly and accurately. The drill is stationary and solidly supported. The work revolves and is held rigidly in position by a steadyrest. Special drills having oil holes and grooves at the sides are used. Oil is forced through the drill at a pressure of 500 to 1000 pounds, cooling the work and forcing out the chips. Two spindles work independently and produce very accurate holes.

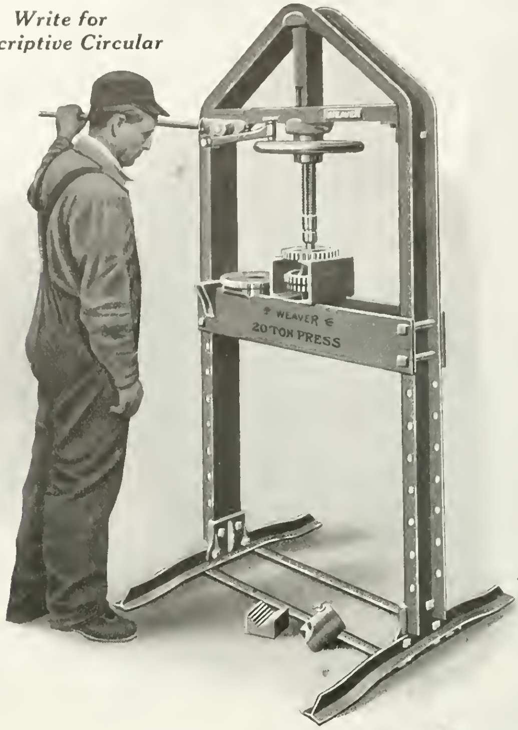
The "Victor" Rifling Machine combines the same advantages of speed and accuracy in rifling operations. An important feature is the interlocking clamp on the work spindle. By this device a barrel may be removed for examination and returned in exact register with the cutting tool. A barrel can be rifled easily in 10 or 15 minutes. There are big production possibilities in these machines. Let us tell you about them.

The International Engineering Co.
CLEVELAND OHIO

Ask for complete specifications.

Prompt Deliveries.

Write for Descriptive Circular



WEAVER

20-Ton Forcing Press

ROOMY—POWERFUL—QUICK ACTING

THE clean, open, roomy construction of this Press permits it to perform a great variety and range of service.

The solid, ONE-PIECE frame of 5-inch, 9-pound channel steel provides abundant strength with the minimum of bulk and weight.

LEVERAGE 1500 to 1—Our compound leverage principle supplies a leverage of 1500 to 1 at the end of a 30-inch lever. One man can develop a pressure of 20 tons with ease. The perpendicular movement of the lever does not necessitate anchoring the Press. THE SCREW DOES NOT REVOLVE.

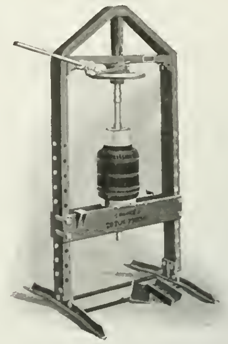
GENERAL SPECIFICATIONS—Ball bearing hand wheel, quick-adjusting; bronze thrust bearing; 2-inch mill-cut screw; length of nut on screw, 5 inches; diameter of hand wheel, 15 inches; width of frame, 32 inches; height of frame, 74 inches; weight, crated for shipment, 450 pounds.

EQUIPMENT—We supply regularly with the Press two sections of 5-inch channel iron blocking, 8 inches long; two extension arms to attach to either end of the bolster, and a vise block equipment for holding awkward pieces against a severe twisting strain.

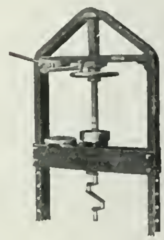
Net Price, Complete with Equipment **$56.00**

EXTRA WIDE PRESS—We are in position to furnish these Presses in greater width than the regular size specified above at a very nominal additional charge.

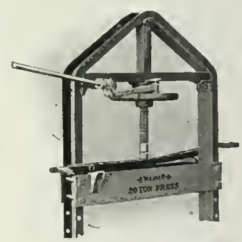
Weaver Manufacturing Co.
Harvard Park - SPRINGFIELD - Illinois



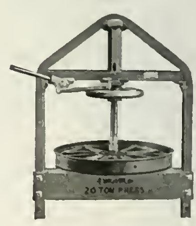
THE GREAT DEPTH ADJUSTMENT will accommodate very large, bulky work.



THERE IS AMPLE ROOM between the bolster plates for all ordinary work.



A VERY WIDE BEARING can be secured for straightening heavy shafts, axles, etc.



THE WIDE FRAME permits large wheels, pulleys, etc., to be handled to advantage.


JOHNSON
BRONZE
BUSHINGS
have been found from years and years of severe service in all conceivable machines to be
the Bushings
that become the standard for all who once use them
Made in one of the most modernly equipped and operated plants in the country specializing on bushings.
Are your bushings giving you the wear they should?
Are you receiving the Delivery?
Do you want our Proposition?
Write today—NOW
JOHNSON BRONZE COMPANY
FORMERLY THE AMERICAN CAR & SHIP HARDWARE MFG CO.
NEW CASTLE, PA.

"I'll Remember that Name 'SPARTAN'

"The trade mark says 'Spartan.' I suppose it was named after those old Spartans—the fellows who could stand 'most everything.

"This belt was on the machine when I started in here three years ago and it has certainly stood some hard service. Doesn't slip, stretch or glaze. Guess the boss knew what he was doing when he picked this belt—why, it's good for years yet. I'll keep that G & K Spartan trade mark in mind—I may be able to use the information some day."

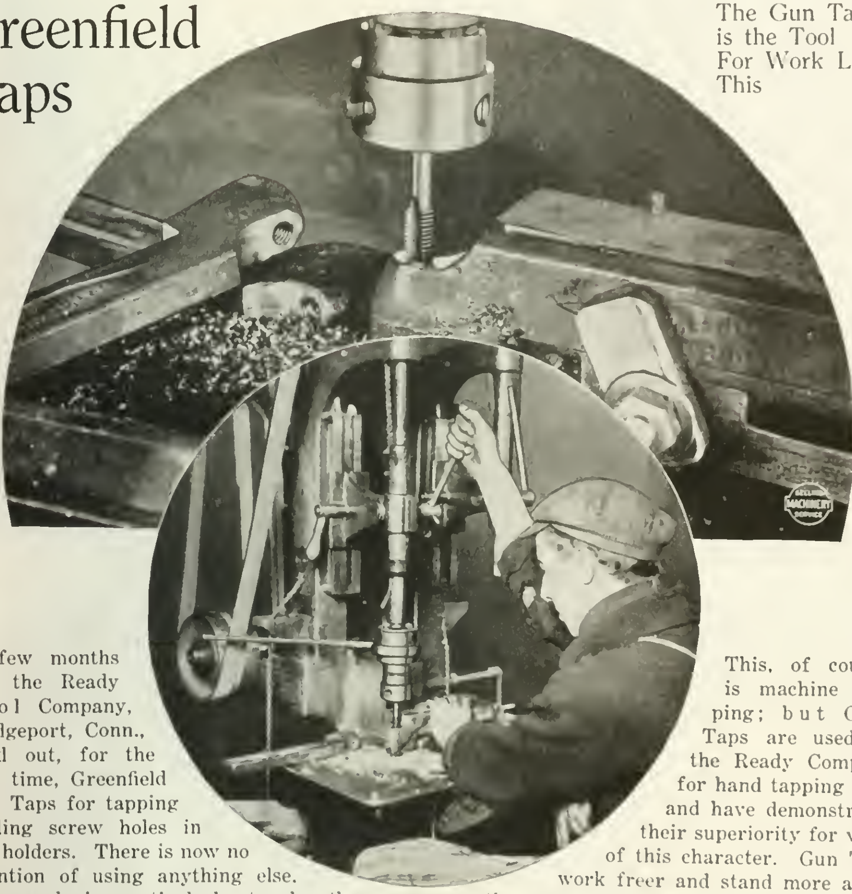
The operator is pretty close to the belt. He appreciates a good one because he is often the loser from a poor one. Any Graton & Knight belt makes good because it is made from selected hides tanned by superior processes. Heat, cold, strain, water, oil, or acid fumes have no ill effect on "Spartan" Belting." It's the belting supreme.

A New G&K catalog is just off the press. Lists our complete and extensive line—belts for all purposes. A postal brings a copy.

The "GUN" TAP

Greenfield Taps

The Gun Tap is the Tool For Work Like This



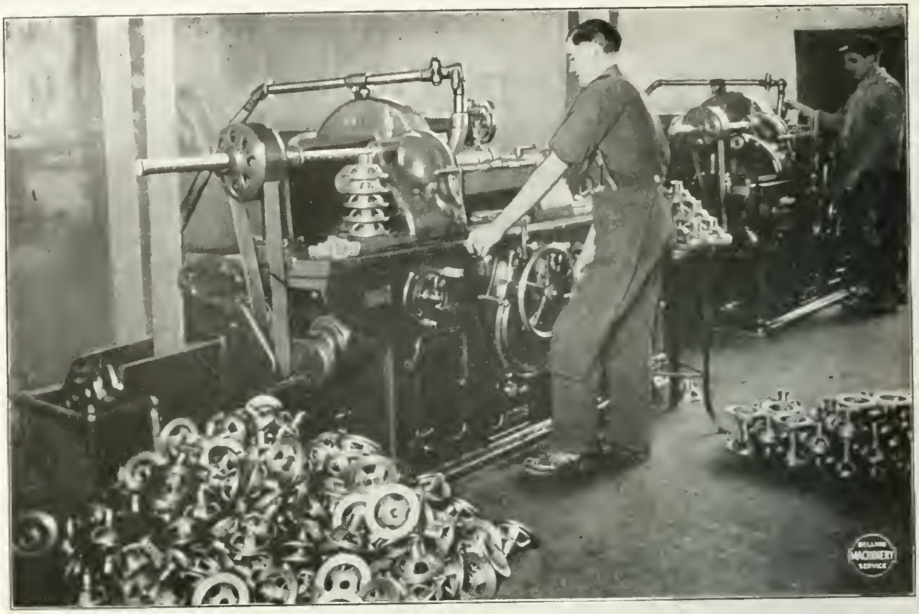
A few months ago the Ready Tool Company, Bridgeport, Conn., tried out, for the first time, Greenfield Gun Taps for tapping binding screw holes in tool holders. There is now no intention of using anything else. This work is particularly tough; the holders are made from chrome nickel steel; the requirements very strict as to accuracy and finish. In the work shown the tap is ½″-13 and the depth of the tapped section ⅞″.

This, of course, is machine tapping; but Gun Taps are used by the Ready Company for hand tapping also, and have demonstrated their superiority for work of this character. Gun Taps work freer and stand more abuse than other taps. We can cite other instances where manufacturers have been stumped on tough jobs on which ordinary taps refused to work—the "Gun" Tap has solved the problem. We recommend Gun Taps for tough work. Try them.

PORATION, Greenfield, Mass., U. S. A.

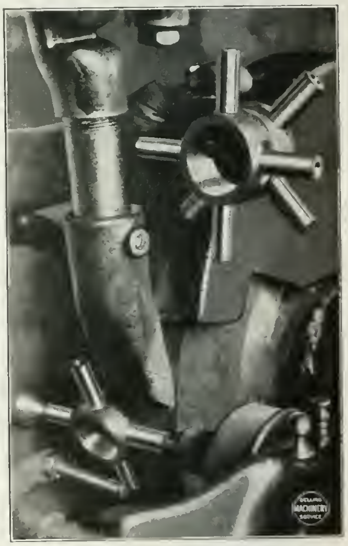
MFG. CO. Division A. J. SMART MFG. CO. Division

DETROIT, 55, 57, 59 Wayne St. LONDON, 149 Queen Victoria St. CANADA, Wells Bros. Co. of Canada, Ltd., Galt, Ont



Two Recently Installed LANDIS GRINDERS

and Some of the Work They Handle



This pair of Landis Grinding Machines has been installed six months—and you can judge for yourself what they are doing and how well they are doing it by the work they happened to be on when the photographs were snapped.

The machine in the foreground is grinding hubs, 3-16″ wide by 1.5745″ diameter, on malleable iron differential parts; the limits being nothing over and only 0.0005″ under size. The second machine is grinding differential gear crosses, four ground sections, 5/8″ diameter by 1 5/8″ long, within limits of 0.001″.

This work is produced in big quantities, by one of the foremost manufacturers of automobile parts of this character, and you can rest assured that the Landis is the most economical Grinding Machine for the purpose or these two never would have been installed.

Let us send the Bulletin and more details on this new Landis Self-Contained Grinding Machine—the grinder in which all overhead works are done away with, in which gearless drive, centralized control and many other features contribute to speed and efficiency.

LANDIS

LANDIS TOOL COMPANY, Main Office and Works: **WAYNESBORO, PA.**

NEW YORK OFFICE: 50 CHURCH STREET

AGENTS: Dewstoe Machine Co., Birmingham, Ala. Harron, Rickard & McCone, San Francisco and Los Angeles.

UNIVERSAL GRINDING MACHINES
INTERNAL GRINDING MACHINES
PLAIN GRINDING MACHINES
CRANK GRINDING MACHINES
ROLL GRINDING MACHINES
CAM GRINDING MACHINES

RED-E
Roughing Tools
Heavy Turning

ROUGH-TURNING shrapnel and high-explosive shells is stiff work on which Red-E Tool Holders have proved highly efficient.

The engraving shows a Red-E roughing tool at work on a 3″ high-explosive shell removing from 3-16″ to 1-4″ total on the diameter. Feed is 1-16″ per revolution and cutting speed from 60′ to 70′ per minute.

Red-E Tools take heavy cuts, stand high speeds and dig into costs. If you have heavy turning that is causing trouble, give them a trial.

Complete line listed in catalogue—write for your copy

THE READY TOOL COMPANY
BRIDGEPORT CONN., U. S. A.

Detroit Grinding Wheels

Are made from natural or artificial abrasives and in grades to meet all grinding requirements. They wear well and are as lasting as modern methods can make them. Since Detroit quality never varies, duplicates, accurate to a hair, can be had at all times.

More particulars on request

DETROIT GRINDING WHEEL COMPANY
DETROIT, MICH.

$60.00 Buys This Waterbury Grinder

Ask for Catalog

And a very brief trial will be enough to prove how good the investment is. Simple design and extra strong construction combine to insure rapid and accurate operation and the greatest durability.

FULLY GUARANTEED

THE BLAKE & JOHNSON CO.
WATERBURY CONN.

Your men do not like to grind drills on a machine with complicated adjustments —they'd rather grind by hand. Hand grinding results in inaccurate tools, oversize holes and loss through breakage. Put a "Yankee" Drill Grinder in your tool-room — your men will *use* the "Yankee" because it is simple, requires only two adjustments to finish from *three to four drills a minute*, and the quality of its work is absolutely beyond question.

Circular tells more—ask for it.

Wilmarth & Morman Co.
1180 Monroe Ave., N.W. GRAND RAPIDS, MICH.

There's Nothing Much Harder on a Grinding Wheel Than Rough Steel Castings

If you have ever tried grinding of this kind you know what the sand and scale do to a wheel. It is just about as tough a proposition as ever was.

One of our large customers knows, for a great deal of work of this character goes through their plant—and grinding wheels were a source of more or less trouble (generally more) until Abrasive Wheels were adopted.

The cast steel pinion shown, for a sugar refining machine, is typical of the work. The teeth are cast, then ground. It is rough, tough grinding, and an Abrasive Wheel, 10″ by 1″ at 1400 R. P. M., *outlasts anything this customer ever used before.*

An ABRASIVE WHEEL Does the Trick

Try Abrasive Wheels—for any grinding purpose. You'll find them good wheels—always.

BESLY FORGED NUT TAPS

(PATENTED)

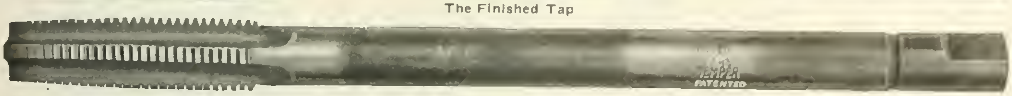
Unequaled for ACCURACY and LONG LIFE

Flutes are Forged—Not milled **Forging Refines, Compacts and Improves the steel**

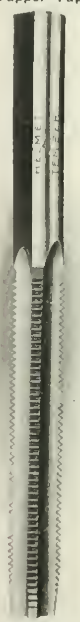
The Shank Size, Unannealed Blank

The Forging

The Finished Tap

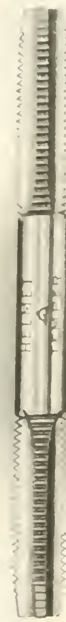


Single End Automatic Tapper Tap



Bent Shank Automatic Tapper Tap

Double End Automatic Tapper Tap



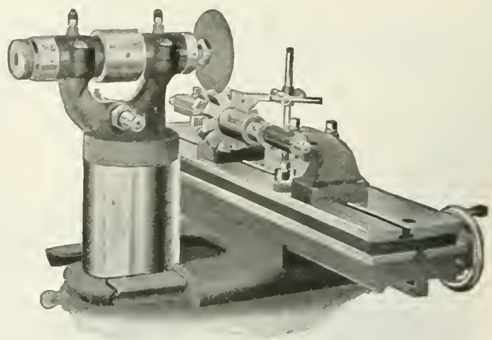
BESLY FORGED NUT TAPS have won their way on sheer ability to tap nuts at the minimum tap cost; and today are used exclusively by more large nut manufacturers than all other makes of nut taps combined. A trial will convince you.

Besly Hand, Pipe and Boiler Taps are just as good as Besly Nut Taps. Give them a trial and be convinced.

Ask for 1916 Besly Tap Catalogue

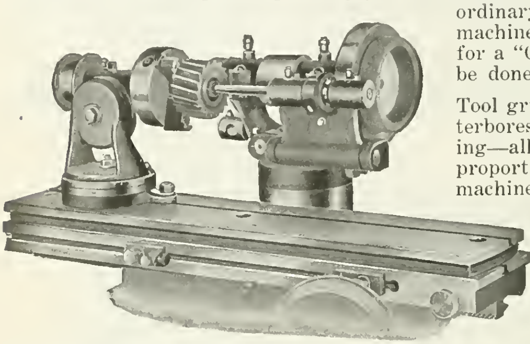
CHARLES H. BESLY & COMPANY
120 B North Clinton Street CHICAGO

For Tool Room or Shop—a Good All 'Round Grinder



The *Greenfield* Universal Grinder

There is hardly a shop where this versatile machine will not fit in and turn out good work economically. It is difficult to imagine a grinding job, such as the ordinary shop would have, that could not be handled on this machine. We show two commonplace jobs that are easy for a "Greenfield"; they give but a suggestion of what can be done.



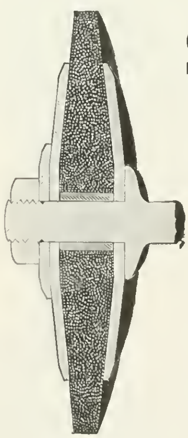
Tool grinding of every kind—cutters, reamers, taps, counterbores, gages, etc.; surface, cylindrical and internal grinding—all can be done quickly and accurately. A heavy well proportioned knee supporting stiff, ribbed slides gives the machine unusual rigidity for its size.

If you need a tool room grinder, don't fail to investigate this.

Greenfield Machine Company

Greenfield, Mass., U. S. A.

Safety Wheels, Safety Collars, Safety Machines



A combination that permits high speed production with safety both to your work and to your workmen.

Safety Wheels stand tests of speeds 50 per cent higher than would be required in regular practice, and if equipped with Safety Collars are absolutely safe.

Safety Grinding Machines possess that balance, rigidity and strength which permit operation of Safety Emery Wheels at maximum capacity.

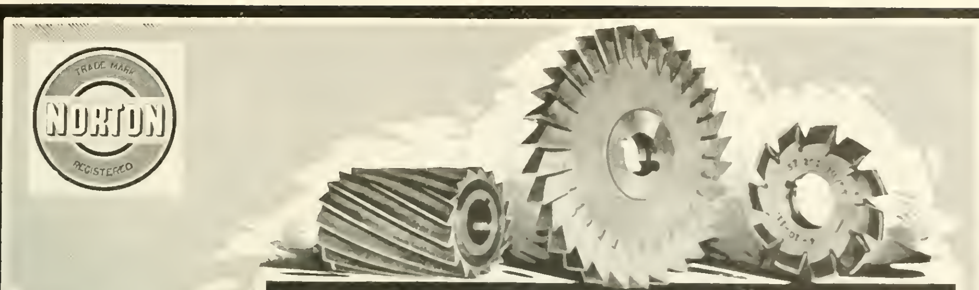
All Safety products are made of the best material by up-to-the-minute methods, and are furnished for a wide range of service.

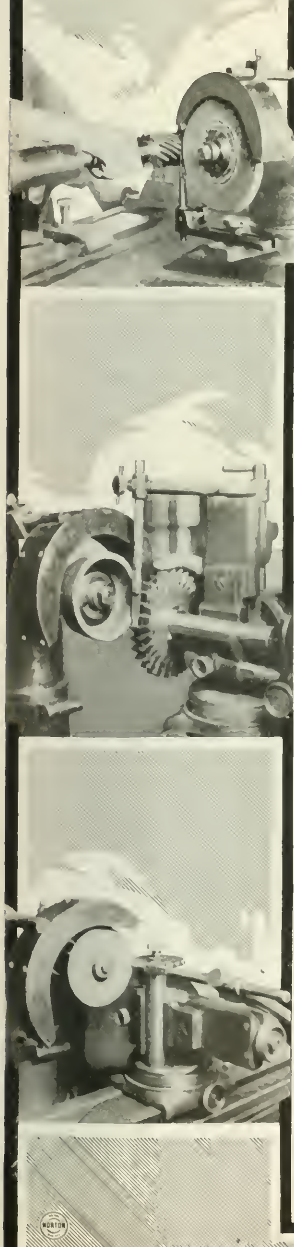
Send for catalog for complete information.

The Safety Emery Wheel Company

SPRINGFIELD, OHIO

FOREIGN REPRESENTATIVES: Farmer & Co., London. Adler & Eisenschitz, Milan. Allied Machinery Co. of America, Paris.





Tool Grinding Series—No. 2

CUTTERS

Here are a few simple facts about cutter grinding

The wheel must be of a soft, free-cutting grade; the cut must be light, and never forced.

The wheels most commonly used are about 46 grain, grades J and K; the coolest cutting abrasive is Alundum. Wheels finer than 60 grain should never be used for cutter grinding of either high speed or carbon steel. Fine wheels are more likely to burn the work than coarser wheels.

Some operators prefer to use a cup wheel whenever possible, since the periphery of a regular wheel leaves a clearance of the teeth slightly concaved or hollow. This may be overcome by swinging the machine table so that the work passes across the wheel at an angle instead of parallel to the wheel face, as shown in the set-up for the spiral cutter.

Practice varies as to the direction the wheel is run. It is safer to run the wheel off of the cutting edge. Some more experienced and skilled men in this work run the wheel toward the cutting edge, as there is slightly less danger of burning, and this method produces a keener cutting edge, free from burr. If the tooth is not held firmly against the tooth-rest by this method, the edge of the tooth may be carried into the wheel, causing it to be ground away.

We show here three general types of cutters and a practical set-up for grinding each. Note the first illustration—the tooth-rest must be set to give the clearance desired, it should be against the tooth being ground. Pass the cutter back and forth, merely touching one of the teeth, and watch carefully to be sure the machine is properly set to follow the "old clearance." When grinding, move the cutter past the wheel with a steady motion, taking light cuts, and use special care that the cutting edges are kept radially equal. The most difficult problem is to keep the cutter a true cylinder.

The average cut should not be more than from 0.001" to 0.002". Ordinarily, twice around will put the average cutter in condition.

The "setting" of the machine to obtain the correct angle of clearance is important. Too much clearance is better than too little; common practice is to allow four or five degrees for cutters. Cutters of the side mill type are ground on the top in exactly the same manner as the plain cutter. A cup wheel is employed for grinding the sides, the cutter being held on the edge of a special arbor, as shown in the illustration.

Form cutters are usually ground with a saucer or dish wheel. They are held on a short arbor, as illustrated here, and ground on the face only. It is important that the operator keeps the cutting edge in a radial line to retain the shape. In this particular type of cutter, it is necessary to do the grinding with the tooth-rest on the back of the cutting tooth instead of on the face.

For plain milling cutters, the wheels most used are Alundum 3846 J and K, although 3860 I, vitrified and silicate, is a popular grain and grade in saucer shapes, such as Brown & Sharpe No. 60.

One of the most popular wheels for grinding gear cutters is saucer shape Alundum 3846 K. Another good wheel is Alundum 3870 J. In the smaller diameters, 3860 K is commonly used.

On inserted tooth milling cutters, 3846 J and K are the most popular wheels, and under certain conditions 2836 I meets the requirements.

Other points to be kept in mind in connection with cutter grinding are:

The grinding wheel should run true.

The wheel should be kept clean—a glazed or dirty wheel will draw the temper quicker than one whose cutting surface is clean and true.

A diamond should be used for truing the wheel face.

Tool-room wheels should not be carelessly left lying around to collect oil and dirt, but should be kept in racks or cupboards designed for this purpose.

NORTON COMPANY

WORCESTER, MASS.

New York Store
151 Chambers Street

Electric Furnace Plants
Niagara Falls, N. Y.
Chippawa, Ont., Can.

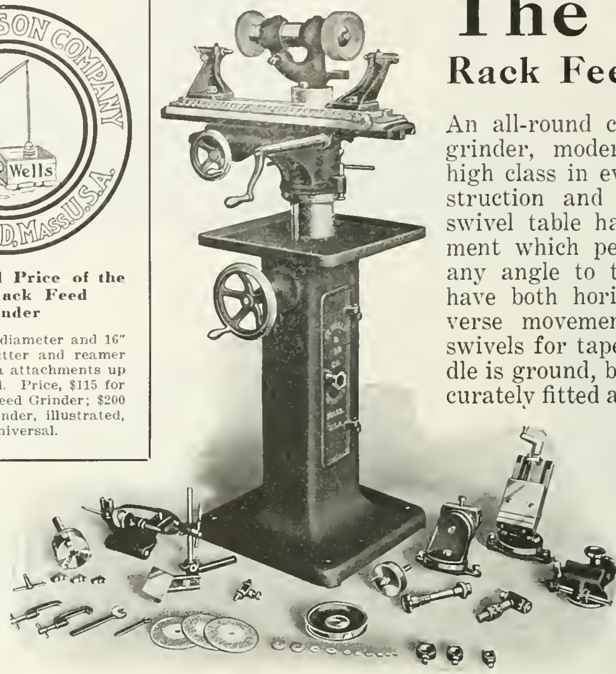
Chicago Store
11 N. Jefferson Street

S-2

The Wells
Rack Feed Grinder

Capacity and Price of the Wells Rack Feed Grinder

Work up to 8" diameter and 16" long. Plain cutter and reamer grinder or extra attachments up to full universal. Price, \$115 for No. 184 Rack Feed Grinder; \$200 for No. 190 Grinder, illustrated, which is full universal.



An all-round cutter and reamer grinder, moderate in price yet high class in every detail of construction and in service. The swivel table has vertical adjustment which permits working at any angle to the wheel. Slides have both horizontal and transverse movement, and top slide swivels for taper grinding. Spindle is ground, boxes and slides accurately fitted and dust-proof, and new spring-take-up compensates for end-thrust.

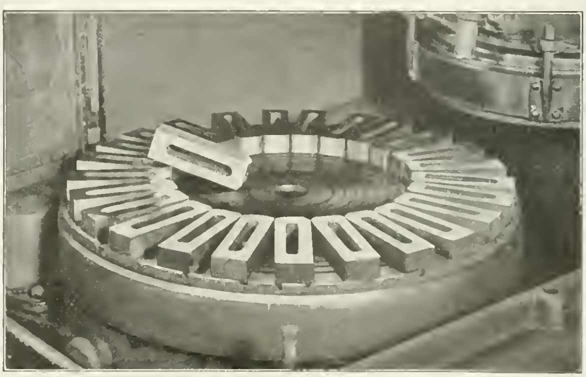
Complete details on request.

F. E. Wells & Son Company

Greenfield, Mass. U. S. A.

The Blanchard Grinder Saves Time and Money on these Castings

These jaws for lathe steady rests are 5¾" long, 1¾" wide, 1⅛" thick. About 1-32" is allowed on each surface for grinding. They are first ground on two sides parallel and to limits of ± .0015" of size (this is the operation illustrated), then clamped in a simple squaring fixture holding 24 pieces where one edge is ground square, then put directly on the magnetic chuck again and the other edge ground parallel with the first and of course square with the two sides.



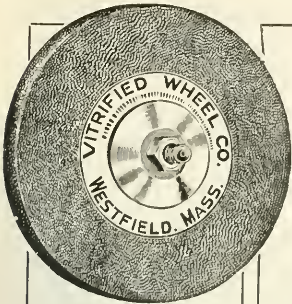
The production, grinding 4 surfaces square, parallel and to size limits of ± .0015" is *25 castings per hour* (100 surfaces).

Compare the above with your practice. Wouldn't you like Blanchard production figures on your work? Write today.

The BLANCHARD MACHINE CO.

64 State St. Cambridge, Mass.

DOMESTIC AGENTS: Prentiss Tool & Supply Co., Motch & Merryweather Machinery Co., Marshall & Huschart Machinery Co., W. E. Shipley Machinery Co., Kemp Machinery Co., Robinson, Cary & Sands Co., Pacific Tool & Supply Co. **CANADA:** Williams & Wilson, Ltd., A. R. Williams Machinery Co., Ltd. **GREAT BRITAIN:** C. W. Burton, Griffiths & Co. **FRANCE:** Aux Forges de Vulcain.



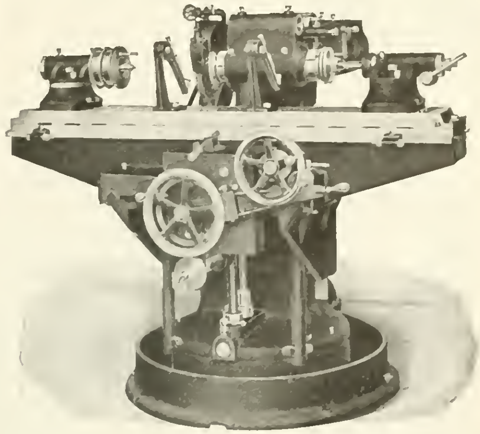
Use the Wheel You Can Depend On

VITRIFIED GRINDING WHEELS

are tested under speeds that are more than three times greater than ordinary work requires. This practically makes it an impossibility for a defective wheel to leave our shops. Properly selected, Vitrified Wheels give unequaled service wherever used. All standard sizes, shapes and grades.

Catalog No. 8 for complete information.

VITRIFIED WHEEL CO.
WESTFIELD, MASS.



An Ideal Grinder for the Small Shop

For the shop that has varied types of grinding to do and only a limited amount of each kind

The Thompson Grinder

is unsurpassed. Handles all kinds of grinding—plain, taper, surface, disk, die, tool and cutter—quickly and economically. Strong, sturdy and accurate. A machine you can always keep busy. An investment that will pay big dividends. Write for full details.

The Thompson Grinder Co.
Springfield, Ohio, U. S. A.

Blount Improved Wet Tool Grinder

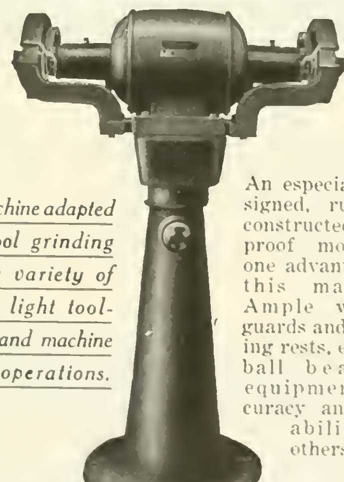
Blount Grinders of every style are high grade throughout.

HERE is a grinding machine which can be run constantly if desired. It is exceptionally rigid and strong, has long, self-oiling bearings and a vertical centrifugal pump which guarantees a continuous and positively controlled supply of water. Overflow bowl is ample; safety hood protects the operator.

Ask your dealer or write for complete catalog.

J. G. BLOUNT COMPANY
EVERETT, MASSACHUSETTS

The Dillon Electric Grinder



A machine adapted for tool grinding and a variety of other light tool-room and machine shop operations.

An especially designed, ruggedly constructed, dust-proof motor is one advantage of this machine. Ample wheel guards and grinding rests, efficient ball bearing equipment, accuracy and durability are others.

FULL DETAILS ON REQUEST.

The Dillon Electric Company
CANTON, OHIO, U. S. A.

The Farwell Gear Hobber

This One We Believe Has Established a Record

FIVE years ago the Albaugh-Dover Company, Chicago, installed a No. 1 Farwell Gear Hobber. This machine has never been down for repairs—and much of the time it is run continuously from 12 o'clock midnight Sunday till 12 o'clock midnight Saturday. Mr. Navotny, General Foreman, estimates this machine has hobbed 175,000 gears, and today it is one of the smoothest running little mechanisms you ever saw. The work is 12 pitch, double thread, brass worm wheels; $4\frac{1}{2}''$ diameter, $\frac{5}{8}''$ face, 52 teeth. Output is 14 per hour, *every hour.*

There are several other Farwell Gear Hobbers in this plant. Do you wonder why?

THE ADAMS COMPANY, 1901 MARKET STREET DUBUQUE, IOWA

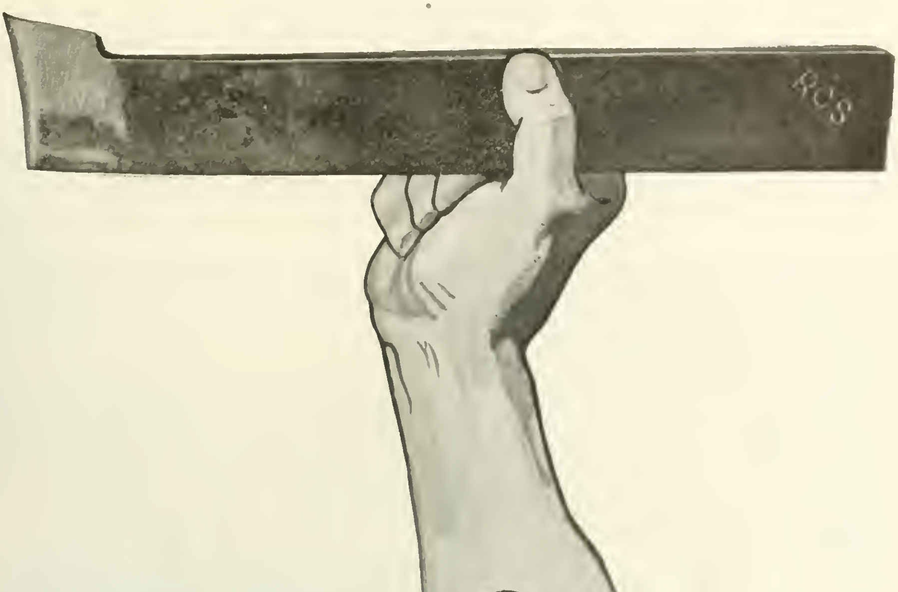
The Inimitable Bearing

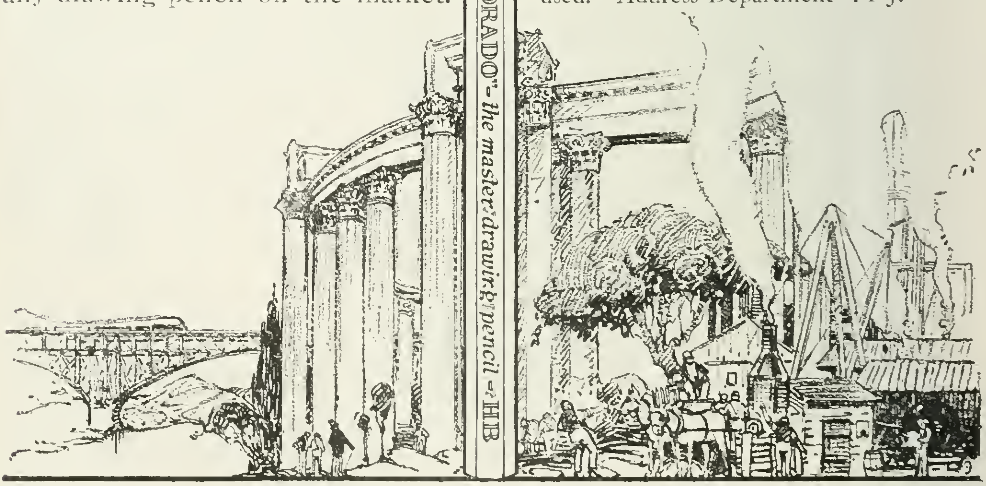
It would be possible to double the output of this grinding department—not, however, without sacrificing the quality of its output. In race grinding, close accuracy is extremely important—the ten-thousandth part of an inch is a lot; enough, in fact, to make or mar the bearing. The highest skill and the finest machinery are none too good to grind the races of "The Inimitable Bearing." Let us tell you more about them.

Hess-Bright's Conrad Patents are Thoroughly Adjudicated.

Hess-Bright Mfg. Co.
Front St. and Erie Ave. Philadelphia, Pa.

TRADE MARK
HB DWF
HESS-BRIGHT
THE INIMITABLE BEARING




DIXON'S "ELDORADO" the master drawing pencil HB

WOLFRAM

TRADE **HIGH SPEED STEEL** MARK

WOLFRAM—a Standard High Speed Steel
CONTAINS 18% TUNGSTEN

All the elements entering into its manufacture are produced in America. It contains definite percentages of Tungsten, Chromium and Vanadium to give it the maximum cutting power with the fewest grindings.

WOLFRAM costs no more than other brands containing lower percentages of Tungsten.

VULCAN CRUCIBLE STEEL COMPANY

ALIQUIPPA, PA., U. S. A.

The Height of Efficiency in Tapping

This operator is using an 8″ Murchey Collapsible Tap for boring out and tapping one end of a drain tee. He places the tee on the boring mill table, centralizes it carefully, clamps it down and starts the mill table. He then brings the Murchey Tap down to the work and throws in the downward feed.

This tap is equipped with a set of boring cutters placed in advance of the tapping inserts; the rough casting is carefully brought to size just ahead of the tapping operation, yet simultaneous with it. This method of handling a job of this nature is the height of efficiency. The boring and tapping is accomplished at the same time and the very best kind of thread is secured.

The length of the threaded portion is $1\frac{5}{8}$″ and one tee is completed every six minutes—ten per hour. This includes setting up the work and taking it down. Six-inch tees, same length of thread, same conditions, are threaded at the rate of nineteen per hour.

A Big 8″ Murchey Tap

Fitted with a Set of Boring Cutters

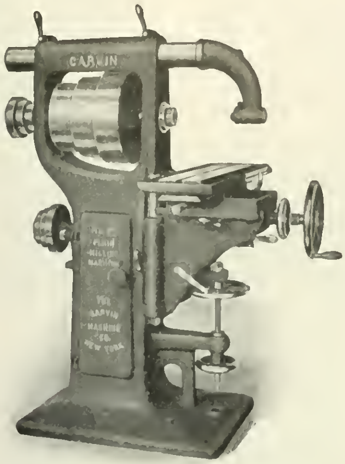
We'll send the catalogue and show you just what Murchey Tools—Collapsing Taps and Die Heads—can do to lower costs or better the quality of your threaded work, whenever you say the word. Why not write us now?

MURCHEY MACHINE & TOOL COMPANY

34 PORTER STREET, DETROIT, MICHIGAN

Great Britain, Ireland and British Colonies, Coats Machine Tool Company, [illegible] LONDON—NEWCASTLE-ON-TYNE—GLASGOW. France: Fenwick Freres & Company, 8 Rue de Rocroy, PARIS.

A GARVIN MILLING MACHINE FOR EVERY NEED



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Again, a less expensive operator can be used.

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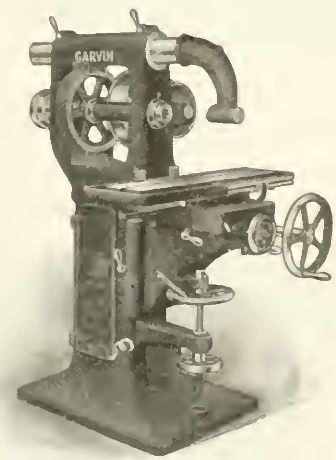
Machines are simple and accurate, having lots of power, and enough feed and speed changes to take care of the work they are intended for.



GARVIN No. 21 Plain Milling Machine, Back-Geared. Use Code - - Abject

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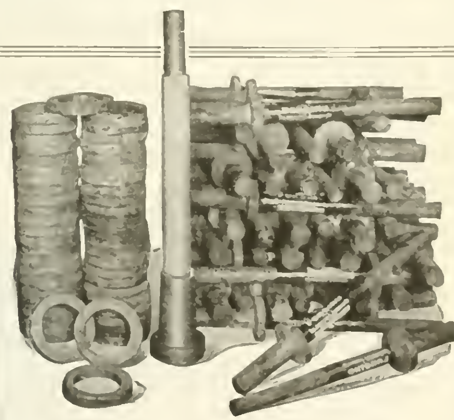

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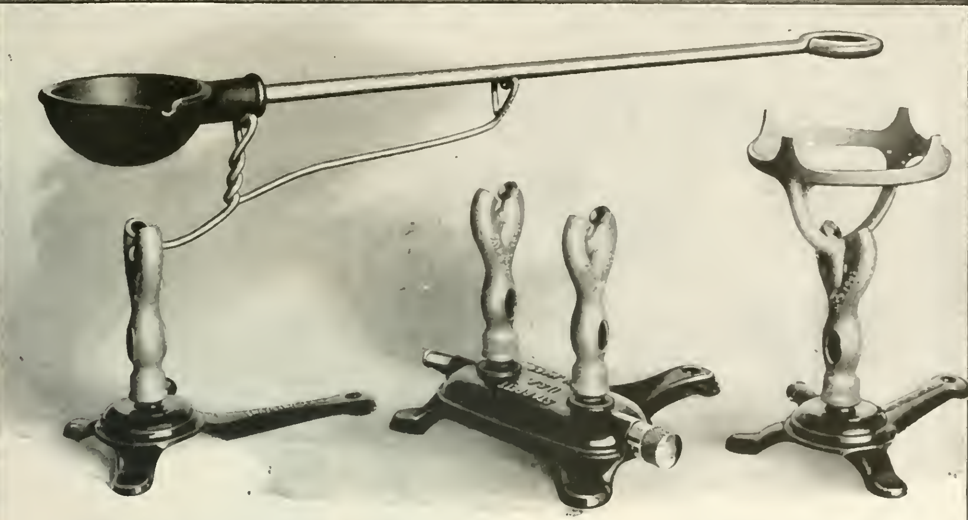

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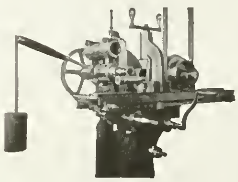

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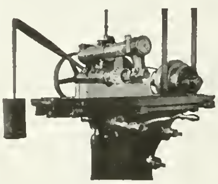

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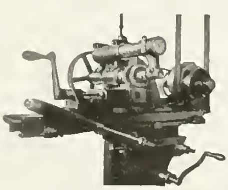

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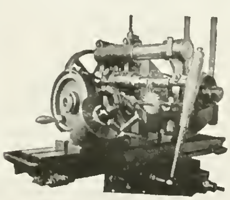

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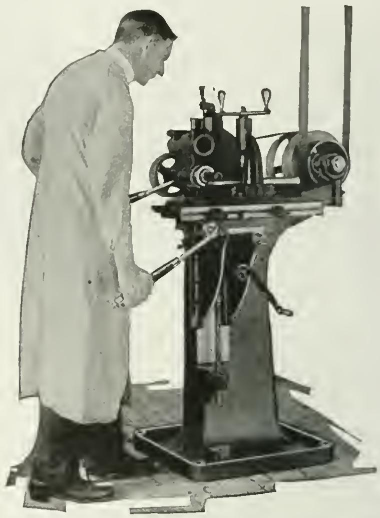

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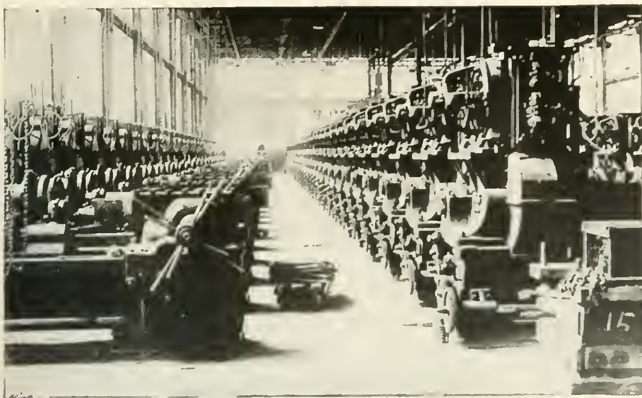

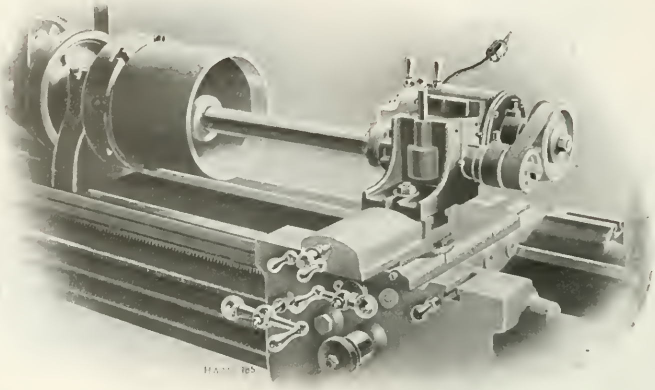

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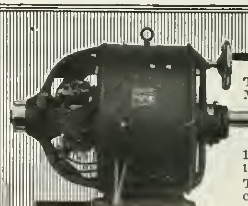

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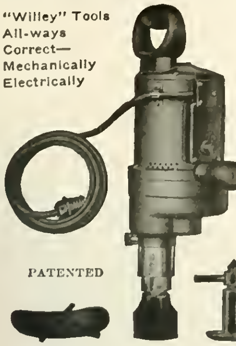

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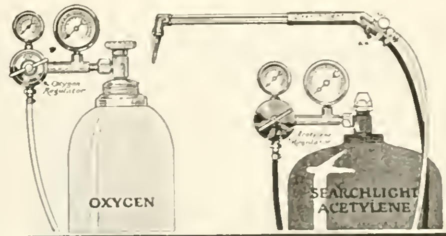

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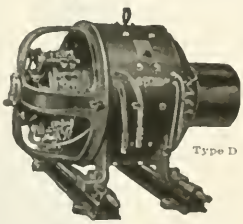

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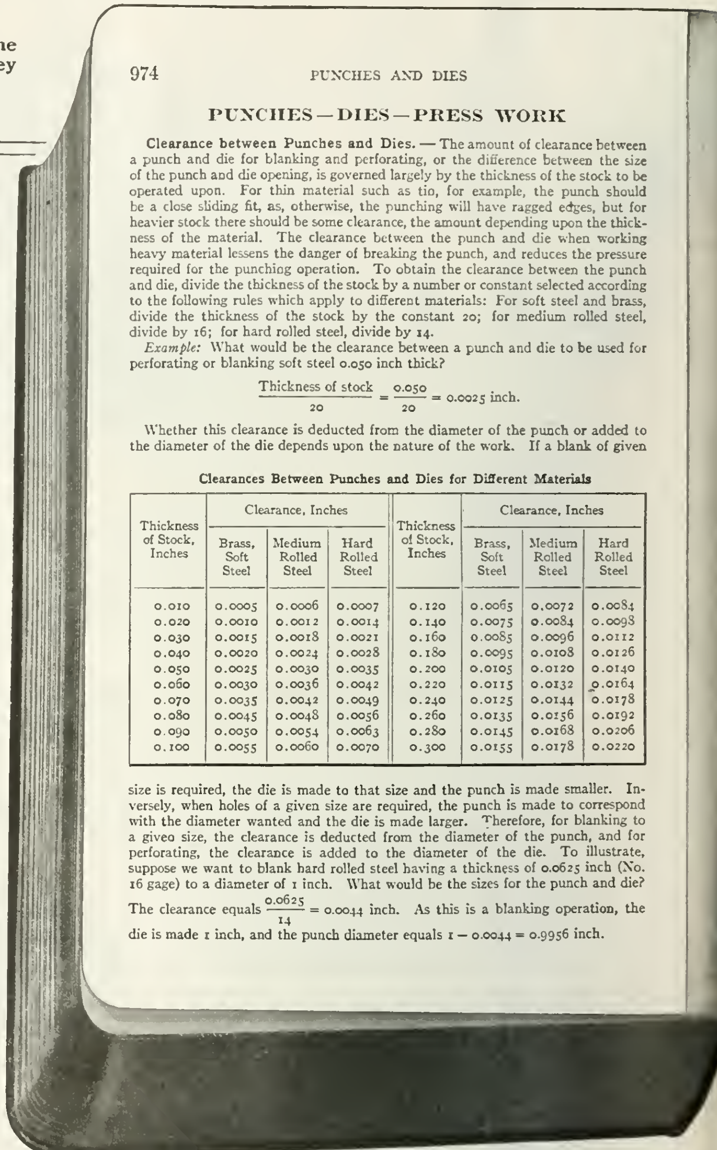
This Handbook is notable for the information it furnishes which cannot be found in other handbooks because it is exceedingly difficult to obtain.



974 PUNCHES AND DIES

PUNCHES—DIES—PRESS WORK

Clearance between Punches and Dies. — The amount of clearance between a punch and die for blanking and perforating, or the difference between the size of the punch and die opening, is governed largely by the thickness of the stock to be operated upon. For thin material such as tin, for example, the punch should be a close sliding fit, as, otherwise, the punching will have ragged edges, but for heavier stock there should be some clearance, the amount depending upon the thickness of the material. The clearance between the punch and die when working heavy material lessens the danger of breaking the punch, and reduces the pressure required for the punching operation. To obtain the clearance between the punch and die, divide the thickness of the stock by a number or constant selected according to the following rules which apply to different materials: For soft steel and brass, divide the thickness of the stock by the constant 20; for medium rolled steel, divide by 16; for hard rolled steel, divide by 14.

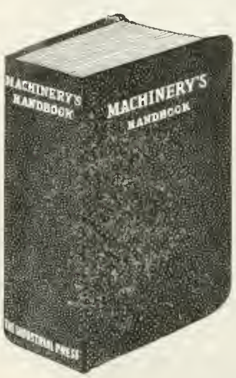
Example: What would be the clearance between a punch and die to be used for perforating or blanking soft steel 0.050 inch thick?

$$\frac{\text{Thickness of stock}}{20} = \frac{0.050}{20} = 0.0025 \text{ inch.}$$

Whether this clearance is deducted from the diameter of the punch or added to the diameter of the die depends upon the nature of the work. If a blank of given size is required, the die is made to that size and the punch is made smaller. Inversely, when holes of a given size are required, the punch is made to correspond with the diameter wanted and the die is made larger. Therefore, for blanking to a giveo size, the clearance is deducted from the diameter of the punch, and for perforating, the clearance is added to the diameter of the die. To illustrate, suppose we want to blank hard rolled steel having a thickness of 0.0625 inch (No. 16 gage) to a diameter of 1 inch. What would be the sizes for the punch and die? The clearance equals $\frac{0.0625}{14} = 0.0044$ inch. As this is a blanking operation, the die is made 1 inch, and the punch diameter equals $1 - 0.0044 = 0.9956$ inch.

Clearances Between Punches and Dies for Different Materials

Thickness of Stock, Inches	Clearance, Inches			Thickness of Stock, Inches	Clearance, Inches		
	Brass, Soft Steel	Medium Rolled Steel	Hard Rolled Steel		Brass, Soft Steel	Medium Rolled Steel	Hard Rolled Steel
0.010	0.0005	0.0006	0.0007	0.120	0.0065	0.0072	0.0084
0.020	0.0010	0.0012	0.0014	0.140	0.0075	0.0084	0.0098
0.030	0.0015	0.0018	0.0021	0.160	0.0085	0.0096	0.0112
0.040	0.0020	0.0024	0.0028	0.180	0.0095	0.0108	0.0126
0.050	0.0025	0.0030	0.0035	0.200	0.0105	0.0120	0.0140
0.060	0.0030	0.0036	0.0042	0.220	0.0115	0.0132	0.0164
0.070	0.0035	0.0042	0.0049	0.240	0.0125	0.0144	0.0178
0.080	0.0045	0.0048	0.0056	0.260	0.0135	0.0156	0.0192
0.090	0.0050	0.0054	0.0063	0.280	0.0145	0.0168	0.0206
0.100	0.0055	0.0060	0.0070	0.300	0.0155	0.0178	0.0220



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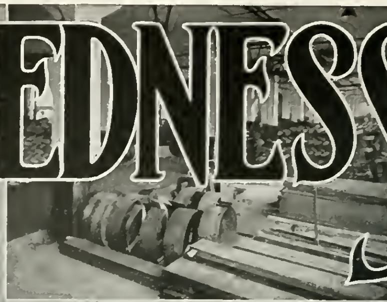

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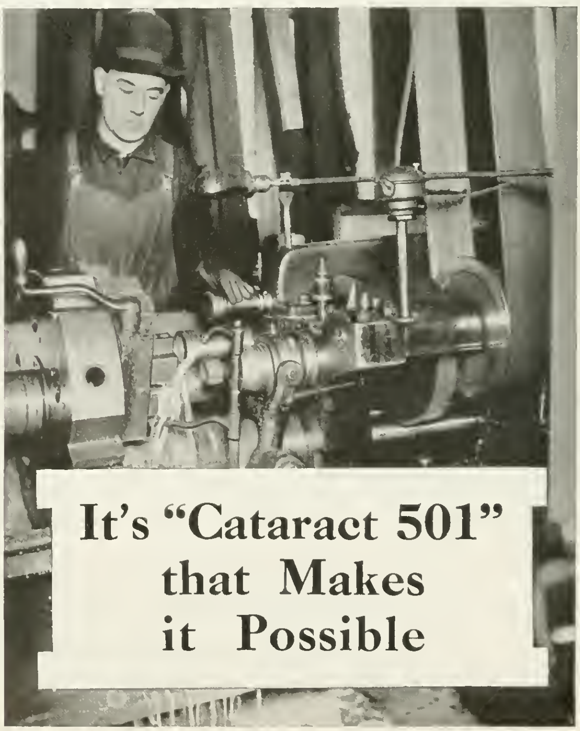

THIS automatic chucking machine is one of a battery of eight that runs twenty-four hours a day machining hot-forged brass parts, one of the toughest brass turning jobs in the shop. In spite of its being difficult work, production is high, and, what is still better, it is secured at the minimum cost for tools. "Cataract 501" is the reason. From the day "Cataract 501" was put in service as the cutting lubricant, production increased and tools made fewer trips to the grinding wheel. Try it out in your shop on hard jobs, long runs and high speeds.

We will furnish sample free if you will tell us where to send it.

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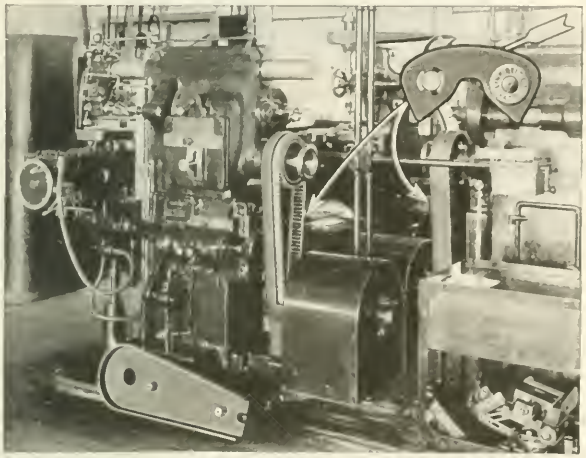
Here is a milling machine drive, the center-to-center distance of which is too long for a practicable gear drive, yet too short for a belt transmission. It is a typical drive for Link-Belt Silent Chain—the transmission that is equally good on long or short centers.

Flexible as a Belt. Positive as a Gear.
More efficient than either.



Link-Belt Silent Chains Driving Brown & Sharpe Milling Machines, Plant of Western Electric Co., Chicago.

Link-Belt Silent Chain

in machine shop duty doesn't stop at convenience of application. It is efficient (98.2 per cent on actual test), so positive that it will pull anything that motor and machine can carry. It cannot slip.

Look for the name on the washers; look for the liners in the joints.

The success of Link-Belt Silent Chain is due to its patented Pin-Bushed-Joint construction—a round pin and two case-hardened semi-circular bushings—found in no other chain.

Write for Data Book No. 125 which shows how to figure machine tool drives and determine prices.

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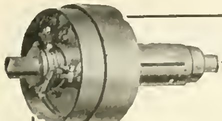
Charlotte, N. C., J. S. Cothran, Com'l Bk. Bldg.
Toronto ... Canadian Link-Belt Co., Ltd.

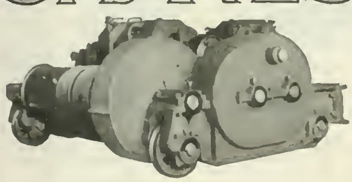


MANY employees dislike to shift belts. The result is considerable power wasted through running idle shafting. Put Moore & White Friction Clutches on those machines and each operator has individual control of his machine; he can *stop it instantly in the event of accident*, machines can be operated in groups and a saving in the cost of belting and shafting can be effected.

The correctness of Moore & White design and the thoroughness of Moore & White construction have been demonstrated by years of service. *Our Circular "M" will give all details.*

The Moore & White Co.
Philadelphia, U. S. A.

NORTHERN CRANES



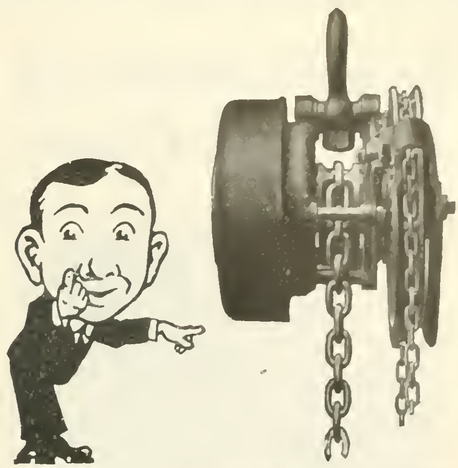
Has your crane a modern ship-shape safety trolley like this? This is our

"Type E" Crane Trolley

Made along up-to-the-present lines with all features of safety and efficiency demanded by good engineering practice. Learn more—get our catalogs. We also make

ELECTRIC HOISTS
Air Hoists, Foundry Equipment, etc.

Northern Engineering Works
6 Chene Street Detroit, Mich.



Yes, That's the Hoist

that the big railroads and machine shops are buying. Meeting the demand is keeping us hustling every day, and nights too, sometimes. It's the

FORD TRIBLOC CHAIN HOIST

the hoist with steel parts, planetary gears and the highest kind of efficiency.

It's the Hoist that has the famous Ford Loop Hand Chain Guide that keeps the chain from gagging, enables you to operate it at any angle and at any speed you may wish to.

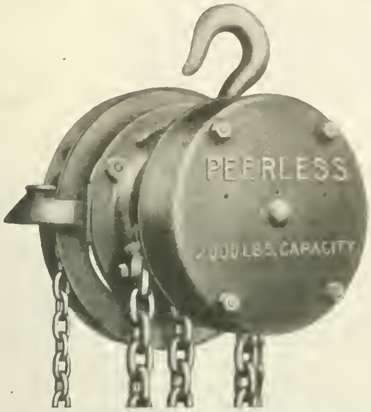
The Loop Hand Chain Guide makes the Ford Tribloc superior in both speed and safety. We back our faith in it with a five years' guarantee.

Catalogue? Surely.
You will be glad to have it and we will be glad to send it.

Ford of Philadelphia

FORD CHAIN BLOCK & MANUFACTURING CO.
137 Oxford Street PHILADELPHIA, PA.

PEERLESS

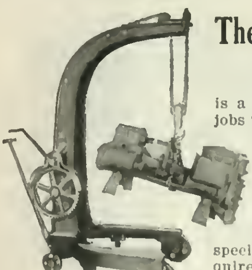


HOISTS

SUPREME IN ENDURANCE

Edwin Harrington, Son & Co., Inc.
Philadelphia, Pa.

The Canton Portable Floor Crane



is a one-man tool for lifting-jobs that usually require 4 or 5 men; is easily operated, economical, and strongly constructed. Invaluable in large shops, a necessity in smaller ones. Furnished in a variety of styles and sizes, and specials built for unusual requirements.

Booklet E-10 for more informotion

THE CANTON FOUNDRY & MACHINE CO.
CANTON, OHIO, U. S. A.

"TOLEDO CRANES"

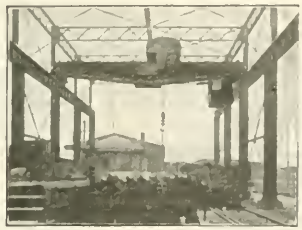
FOR EVERY SERVICE

They are quite
R e l i a b l e

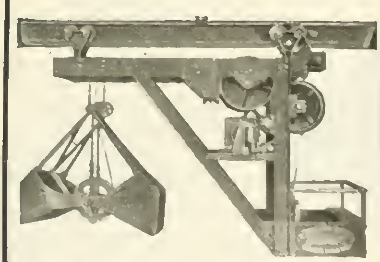
The Toledo Bridge & Crane Co.
2950 Dorr St. TOLEDO, OHIO

For All Parts of Your Plant

For Every Service
Nothing Too Severe
Hand Power or
Electric—
D. C. and A. C.



CRANES
HOISTS



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Track Systems and
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Write for catalogues

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in stock and to order

For Block, Roller and High Speed Silent Chains. New Catalogue.

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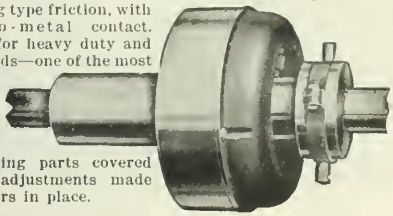
No Safer Clutch than the "Edgemont"

The Edgemont Enclosed Friction Clutch has patented expanding type friction, with metal-to-metal contact. Adapted for heavy duty and high speeds—one of the most powerful hard-service clutches made. All working parts covered and all adjustments made with covers in place.



Full line of Clutches. Ask for Catalog E.

THE EDGEMONT MACHINE COMPANY
2700 National Ave. DAYTON, OHIO

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BANTAM, CONN.

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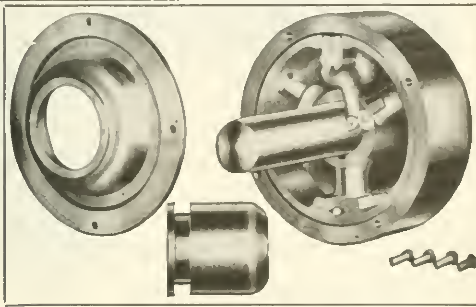

The Cleveland Clutch

is built and designed to give *dependable* and *efficient service*

Our increased manufacturing facilities guarantee prompt *delivery.*

Let us mail you literature.

THE RELIANCE GAUGE COLUMN CO.
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F. BROWN'S PATENT FRICTION CLUTCH COUPLINGS AND PULLEYS

FRICTION CLUTCH PULLEY

FOR HIGH SPEED

ENGINEERS — ESTABLISHED 1854 — FOUNDERS

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FOR HEAVY DUTY

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GEARS

FOR MOTOR, MACHINE, MILL OR POWER PLANT

ROPE DRIVES A SPECIALTY

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We lay out, make the drawings, furnish the material and erect it. Special machinery built to drawings and specifications

WORKS:—ELIZABETHPORT, N. J.

"How can we speed up the work on our Shell Contract?"

"How can we handle the forgings faster and route them through the plant without waste of time and labor?"
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These problems are being put up to us every day, and many prominent concerns having war contracts can testify that we have solved them. If you are still struggling along in the old expensive way, let us install a system of

Mathews Gravity Conveyers

Designed to fit your needs

Gravity Roller Conveyer Delivering Shell Forgings from cars into plant

Gravity Roller Conveyer and Automatic Inclined Elevator Conveying Boxes of Shells from packing room to cars

There's a MATHEWS CONVEYER for Every Handling Requirement—

MISCELLANEOUS MERCHANDISE in boxes, barrels, crates, cartons, cans, sacks, etc.

BRICK, Tile, Slate, Building Blocks, etc.

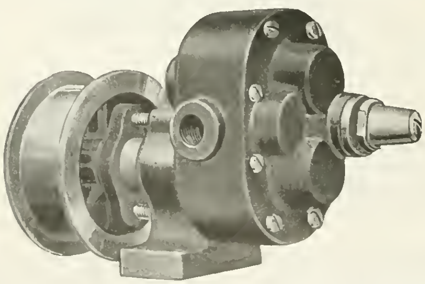
LUMBER, Lath, Shingles, Flooring, Staves, R. R. Ties, etc.

PIG IRON, Fire Brick, Billets, Bars, Angles, Sheets, etc.

Ask for Catalog "L" and tell us what you want to handle.

MATHEWS GRAVITY CARRIER CO., Main Office and Factory: ELLWOOD CITY, PA. Branch Factories: Toronto, Ont. London, Eng.

Trahern Circulating Pumps



Simple, efficient, easily attached and adapted for the lightest water solution or for the heaviest oils. *Trahern Pumps fully cover every requirement for dependable and economical lubrication.* Flow is steady and free from vibration; automatic cut-off at supply without stopping pump a valuable feature; no expense for maintenance.

The correct pump for every type of machine is included in the Trahern line of service pumps.

Write us your requirements

Trahern Pump Company

Rockford *Dept. 10* **Illinois**

SPRINGS, WIRE & STEEL — THE WALLACE BARNES CO. — ESTABLISHED 1857 — BRISTOL, CONN. U.S.A. — SCREW MACHINE PRODUCTS

"BARNES-MADE" PRODUCTS

Whatever your requirements for

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our Service Department can design them properly for you, and our springs will give unexcelled service.

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THE WALLACE BARNES CO.
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Mfrs of Small Springs of every description Screw Machine Products Spring Washers Stampings etc Dealers in Spring Steel and Wire.

NEW DEPARTURE BALL BEARINGS

American Made for American Trade
QUALITY FIRST
THE NEW DEPARTURE MFG. CO.
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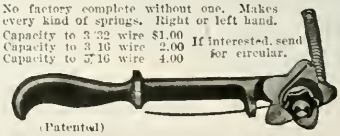
Hjorth Perfection Spring Winder

No factory complete without one. Makes every kind of springs. Right or left hand.

Capacity to 3/32 wire $1.00
Capacity to 3/16 wire 2.00
Capacity to 5/16 wire 4.00

If interested, send for circular.

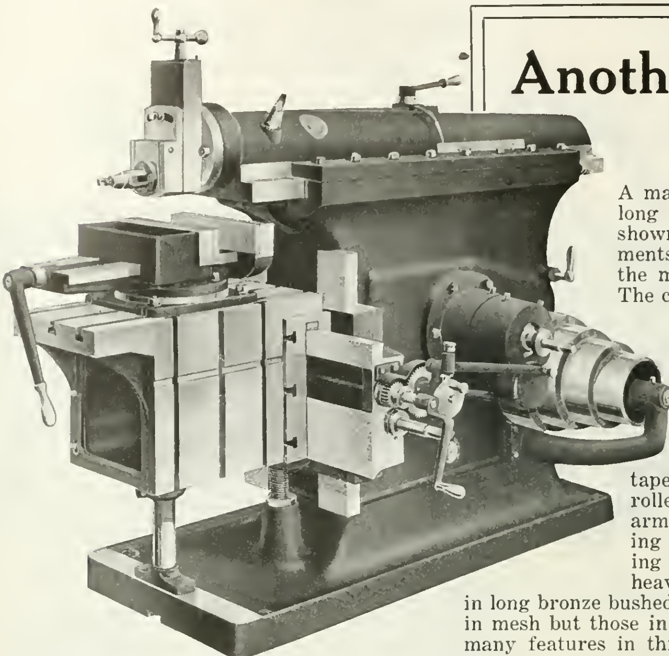


(Patented)

Hjorth Lathe & Tool Company
27 School St., Boston, Mass.
Works: Woburn, Mass.

THE TILTED TURRET

Turret Lathe and Screw Machine



Another Rockford Success

A machine that will add many to the long list of Rockford enthusiasts is shown herewith. All the new improvements are embodied—everything up to the minute for modern requirements. The compact, sturdy lines of the

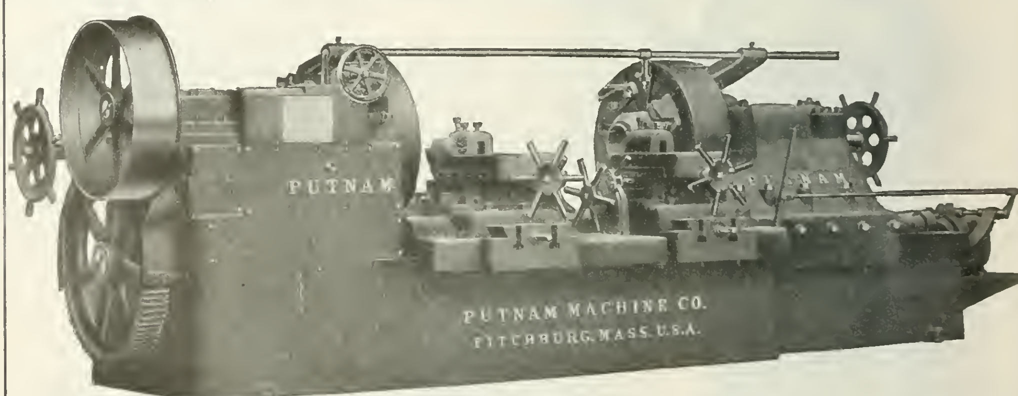
Rockford 24-inch Back Geared Crank Shaper

tell the story of rugged power and the ability to get heavy work out on time. Full length taper gibs, heavy arched ram with roller bearing on new style rocker arm, staunch outer support for driving pulley to prevent belt pull springing shaft, square bearings on ram, heavy shafts of high carbon steel run in long bronze bushed bearings, steel pinions, no gears in mesh but those in use—these are but a few of the many features in this efficient shaper. For shop or tool room you couldn't make a wiser investment.

Send for descriptive circulars.

Rockford Machine Tool Co., Rockford, Ill.

PUTNAM
Latest Pattern 42" Coach Wheel Lathe



All Steel Gearing. Heaviest and strongest built. Belt or motor driven, as desired. Combination Tool Holders. Putnam Driving Dogs. Automatic Tailstock Binding Device. Calipering Device.

Machine Shop and Foundry Equipment of Every Description

MANNING, MAXWELL & MOORE, Inc.

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Boston Buffalo Chicago Cincinnati Cleveland Detroit Milwaukee
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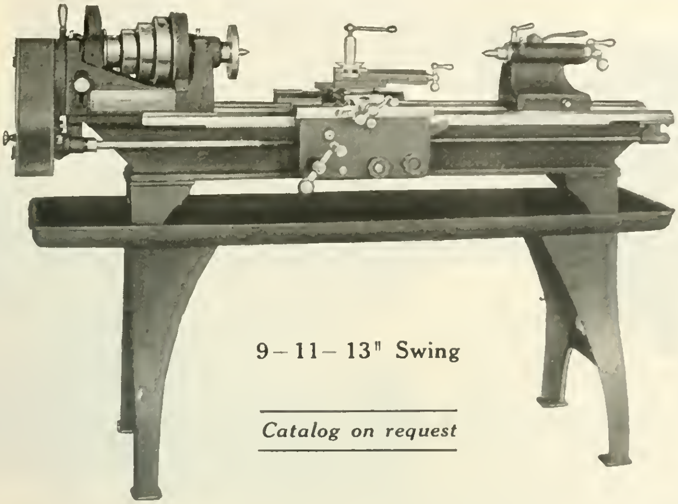


Tool Room "Stars"

9 – 11 – 13" Swing

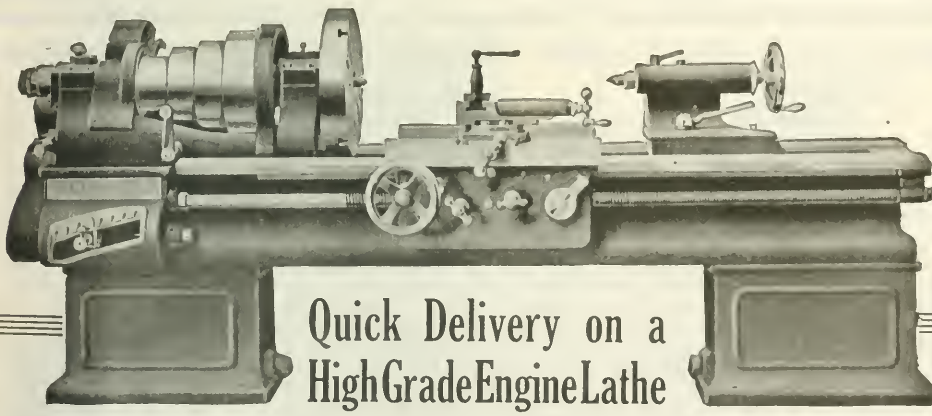
Catalog on request

"Star" Lathes are built for business, no fancy finishings or superfluous parts; but great care is taken in emphasizing those features that produce results. The work they turn out leaves nothing to be desired, and proves the soundness of the principles of "Star" construction. They are well adapted for tool room purposes, where they can be depended upon for consistent service. "Star" Lathes are rapid, rigid, accurate, low-cost machines which give lasting service. Many big concerns in all the prominent lines of manufacture use them, both for tool room and manufacturing purposes. Let us tell you where you may see them in operation.

THE SENECA FALLS MANUFACTURING COMPANY

330 WATER STREET **SENECA FALLS, NEW YORK**

Canadian Sales Agents: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, St. Johns, N. B., Calgary, Saskatoon, Winnipeg, Vancouver, Edmonton, Fort William, Hamilton, Ottawa, Quebec, Regina, Victoria.



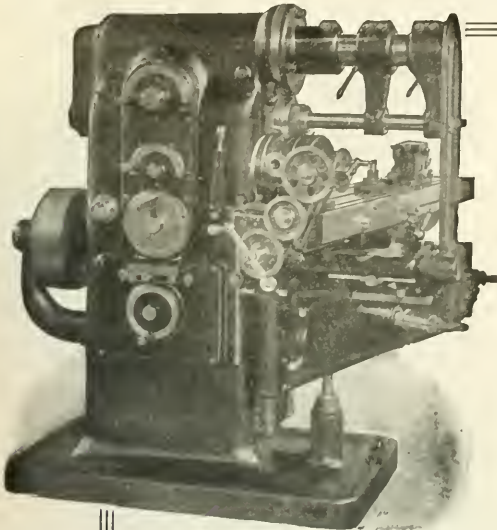
Quick Delivery on a High Grade Engine Lathe

GOOD lathes are hard to get in these busy days. So when we are able, through large facilities, to offer August and September deliveries on this Davis 22" x 10" Quick Change Engine Lathe, manufacturers in need of lathe equipment should be prompt to take advantage. The Davis is a well-known high-grade engine lathe with positive feed and double back gears—a stocky, powerful machine that will turn 9" shells successfully. Orders are coming in fast.

Better get in touch with us at once.

BUFFALO CONTRACTORS' PLANT CORPORATION, Buffalo, N. Y.

NEW YORK OFFICE, Hudson Terminal Building, 30 Church Street, C. E. FORSYTH, Manager, Phone 340 Cortlandt



For *Your* Tool Room

Would you be interested in a milling machine that would enable your toolmakers to do better work and more of it—a machine that was accurate enough for the finest tool work and powerful enough for general manufacturing? Naturally you would, and

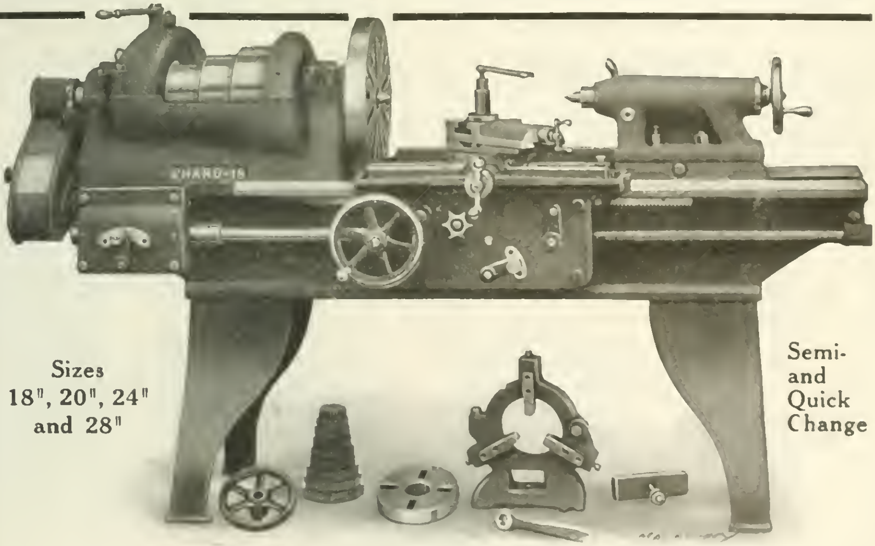
No. 2 Rockford Universal Miller

is the machine to investigate. This sturdily designed miller has a powerful constant speed drive, from which an abundance of power is transmitted to the spindle. Knee, saddle and table are of generous proportions, and are solidly supported. Back gears located inside frame at the front, giving a drive of immense power and preventing vibration and chatter. A wide range of independent speeds and feeds is quickly obtainable through simple quick-change gear mechanism conveniently located at the side of the machine. Write for further details.

ROCKFORD MILLING MACHINE CO., Rockford, Ill.

CHARD

The Lathe Unusual



Sizes 18", 20", 24" and 28"

Semi- and Quick Change

IN designing this machine we made a number of important departures from standard lathe design. It is the heaviest lathe of its size on the market—a stronger machine throughout. We believe we have the best lathe spindle possible to produce. The ways of the bed are chilled $\frac{5}{8}$" below the surface—longer wear, permanent alignment. No gears in apron running on fixed studs. Three-point suspension for bed, no warping or springing. Handles revolve on fixed studs, not in operator's hands. *Let us tell you all about them.*

CHARD LATHE COMPANY, New Castle, Ind., U.S.A.

AGENTS: Vonnegut Machinery Co., Indianapolis, Ind. English and Miller Machinery Co., Detroit, Mich. The W. M. Pattison Supply Co., Cleveland, Ohio. M. S. Zortman Machinery Co., Pittsburgh, Pa. The E. A. Kinsey Co., Cincinnati, Ohio. Federal Machinery Sales Co., Chicago, Ill.

Send For This New Illustrated Catalogue-M. Just off the Press.

NATIONAL COUNTING MACHINES

NATIONAL-CHAPMAN ELEVATING TRUCKS

A 500-Foot Haul—Then What?

Well, That Depends on the Kind of Truck

If it's a National-Chapman, the operator simply presses the handle release—the loaded platform gently sinks to the floor—the truck rolls smoothly from underneath and the trucker is off to pick up another load. His business is hauling—only.

But what a different story if it's a platform truck that must be unloaded, so that the operator can use it again. He made the 500-foot distance in 2 minutes—but now he spends 10 minutes or more unloading—time wasted

It is perfectly obvious that the trucking system which involves hauling only will save the biggest part of your trucking expense.

That's why it will pay you to investigate the powerful, handy National-Chapman Elevating Truck.

NATIONAL SCALE COMPANY
6 Mechanic Street CHICOPEE FALLS, MASS.

Hyatt Roller Bearings Used Exclusively on Trucks

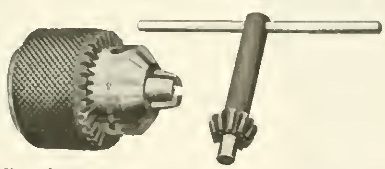
Getting Capacity Out of your Tools?

If you are not, it's time you investigated the Millholland Quick-change Chuck. It is designed especially for speeding up drilling, reaming, boring and tapping operations by permitting the rapid change of drills, reamers, taps, etc., while the machine is running. It is very easy to operate, is simply constructed, dirt-proof, and practically indestructible. Furnished in nickel or vanadium steel.

Folder for details.

W. K. Millholland Machine Co.
Indianapolis, Indiana, U. S. A.

Our Customers Know Why!



Why have our first customers, without solicitation, continuously and increasingly purchased **Jacobs Improved Drill Chucks?**

Our Illustrated Catalog M sent upon request

THE JACOBS MANUFACTURING CO.
HARTFORD CONN., U. S. A.

The Chuck You Need for Driving High Speed Drills

The Pratt Positive Drive Drill Chuck is especially adapted for this class of drilling. It holds the drill securely, drives it at high speed without danger to work or tool, and leaves the drill shank clean and free from scar

Specify Pratt Chucks in your next order.

THE PRATT CHUCK COMPANY
FRANKFORT, N. Y.

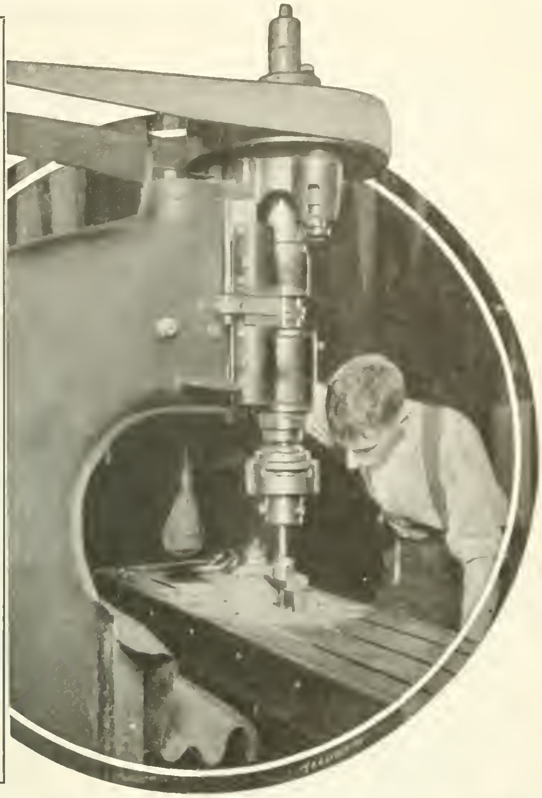
EUROPEAN AGENTS Selson Engineering Co. L'td 85 Queen Victoria Street, London, England

Dependable Boring Heads

Holes in Jigs, Tools and Fixtures are now bored accurately to size by clamping the tool or fixture on the milling machine table and rotating the boring tool in the Casler Offset Boring Head. The new way enables you to save time and make use of the vertical and horizontal adjustment provided on the machine. The Casler Offset Boring Head allows quick and accurate adjustment of the boring tool.

Send for our Treatise on Boring, then order a Head and save time and money on your jig and fixture work.

MARVIN & CASLER CO.
CANASTOTA, N. Y.



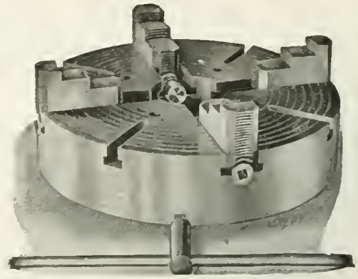
Sweetland –the Chuck with the Bull Dog Grip

YOU ARE familiar with the proverbial grip of the bull dog. Perhaps you are also familiar with the reputation of Sweetland Chucks in this respect. If not it will pay you to learn. Their positive holding power has made them famous. No matter how heavy the cut, they never fail. Strong construction, deep, heavy jaws and perfect balance make the Sweetland a safe and dependable chuck. When you stop to consider the enormous strain to which a chuck is subject you will realize why so many manufacturers specify the sure chuck—the Sweetland.

Our booklet "Chucking for Profit" mailed on request

HOGGSON & PETTIS MANUFACTURING COMPANY
New Haven, Connecticut, U. S. A.

The Horton Habit



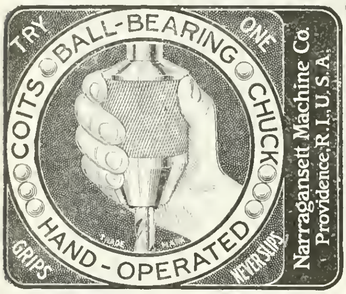
Not an accident, nor a coincidence, but a habit. The Horton habit of leading in chuck manufacture was formed 65 years ago with eyes wide open to future demands, and the way increasing requirements have been met proves that the Horton pioneers not only builded well, but that the original high standard has been maintained ever since. The "Horton" stamp on a chuck is a guarantee of reliability.

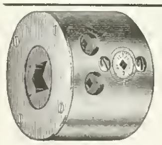
It's *always* safe to specify Horton's

We carry a full line of standard chucks and are prepared to furnish specials upon receipt of specifications.

Catalog for details

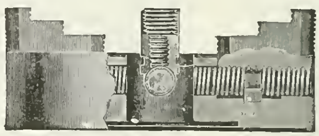
THE E. HORTON & SON CO., Windsor Locks, Conn.





Micrometer Offset Boring Heads to do your accurate boring. These boring heads take up very little room on your milling machines and have great range for boring. Send for catalog.

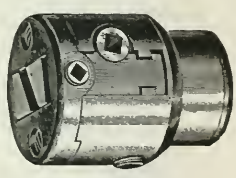
J. T. Flynn Mfg. Co.
DETROIT, MICH.



Solid Steel Rings Reenforce these Independent Lathe Chucks

making them strong where other chucks are weak, providing for tensile stresses and screw thrusts, insuring greater durability and better service.

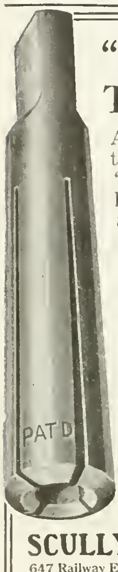
"National" Round Body Drill Chuck



Made with three distinct grips which can be applied at the same time when necessary—a positive gripping chuck—all sizes up to 2 inches.

Catalog?

Oneida National Chuck Co.
ONEIDA, N. Y., U. S. A.

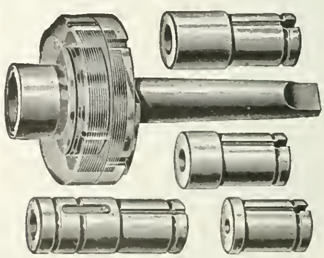


"WEAR-EVER" Tap Chuck

At last—a *practical* tap chuck. The "Wear-Ever" will hold and drive a tap *true* no matter what variation in the shank. As fully 90 per cent of tap breakage is due to taps not running true, the advantage of the "Wear-Ever" is strikingly apparent. No screws to adjust. A few seconds all that is necessary to change taps.

Circular and prices on request.

SCULLY-JONES & CO.
647 Railway Exchange Bldg., CHICAGO, ILL



The Safety Drill & Tap Holder

is the only attachment for the purpose that gives universal satisfaction and is

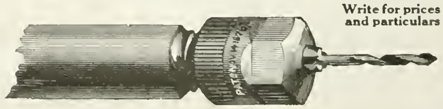
UNEQUALED in Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

Nothing to break or get out of order. Made in 4 sizes, covering from 0 to 2½ inches diameter.

The Beaman & Smith Co., Providence, R. I.

1874 TRUMP DRILL CHUCK 1916

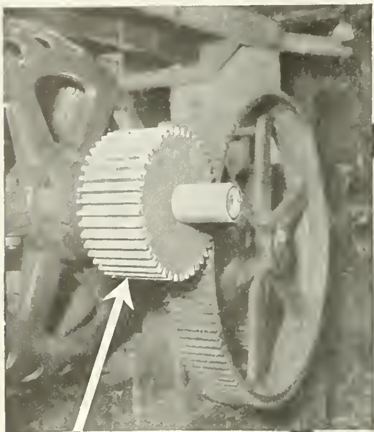
Write for prices and particulars



We have been making it for 42 years; it is still the BIG Chuck at the SMALL price; for Straight or Taper Shank Drills.

Three Sizes: No. 1 0 to ⅛" No. 2 0 to ¼" No. 3 0 to ⅜"

TRUMP BROS. MACHINE COMPANY, Wilmington, Delaware



This is a Micarta-D Pinion

Westinghouse
Bakelite
Micarta-D Gears

have all the good qualities of steel, none of the bad qualities of other non-metallic gears.

They Are Noiseless

Waterproof—Oil proof—Proof against acid fumes

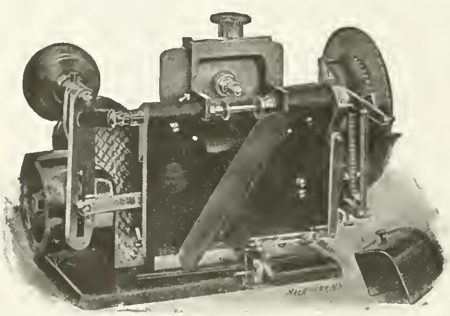
They are self-supporting; not held under compression. They can be stocked indefinitely without deterioration. They are the only non-metallic gears that will not warp, shrink or swell.

They can be advantageously substituted for steel, bronze, rawhide or other non-metallic materials used for gearing.

Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.
Sales Offices in All Large American Cities

W
WESTINGHOUSE ELECTRIC

Westinghouse



The Waltham Gear Cutting Machine

A serviceable machine for cutting small brass and steel gears and fine pitch pinions. The Waltham is entirely correct, capable of fine adjustment and entirely automatic in operation. Cutter is lifted from the work after cut is taken and indexing starts on return stroke without loss of time. All working parts protected from chips. 4 inch capacity.

Write for full description.

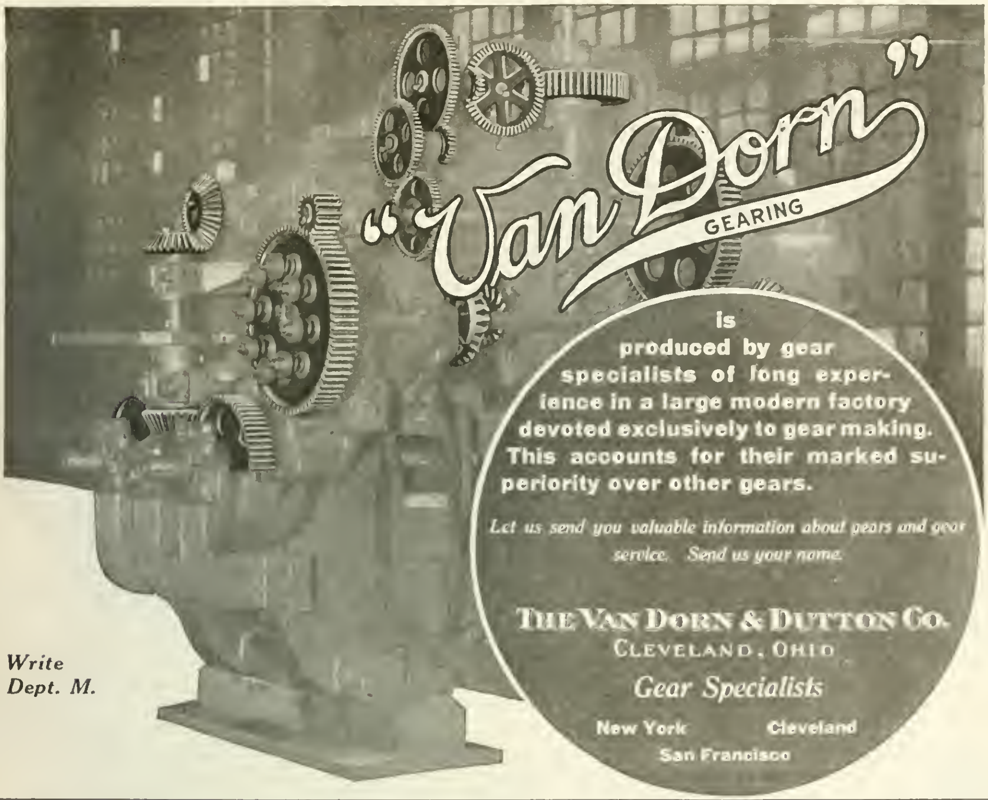
Waltham Machine Works
Makers of Precision Bench Lathes and Machinery
NEWTON STREET, WALTHAM, MASS., U. S. A.

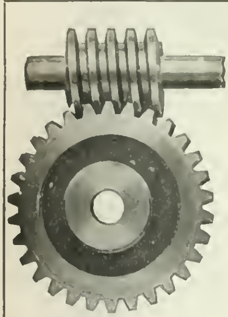
FORGED GEAR BLANKS

¶ The way you want them—when you want them. Gear blanks of open-hearth steel of any carbon, nickel, chrome-nickel, chrome vanadium, etc., furnished in any quantities for prompt delivery. Our product is guaranteed to follow specifications to the letter—our service is one that can be depended upon in the emergency as well as for ordinary demands.

Try us on your next order.

The
MACHINERY FORGING CO.
Hamilton Ave. and Marquette St. CLEVELAND, OHIO





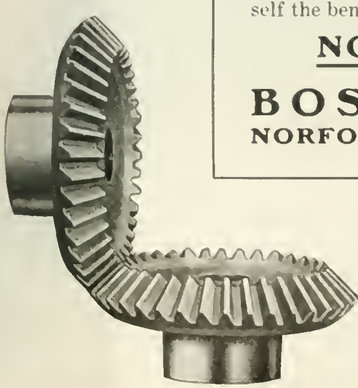
IMMEDIATE DELIVERY

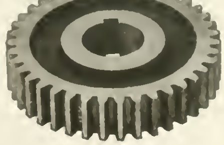
Nothing eats into your surplus so quickly as idle wheels. A few small gears may not seem much in themselves, but the operation of your entire plant may depend upon them. No use worrying over breakdowns, with their expense and inconvenience, when Boston Stock Gears provide the remedy.

We'll carry your gear stock for you, giving you the added advantages of **interchangeable gears, immediate deliveries, lower prices,** and less tied-up capital. **Our stock is complete,** our facilities practically unlimited, and material we use only the best. Begin *now* to give yourself the benefit of Boston Stock Gears. Send for catalog.

NOTE! WE ARE IN A POSITION TO CUT YOUR BLANKS PROMPTLY

BOSTON GEAR WORKS
NORFOLK DOWNS (QUINCY), MASS.

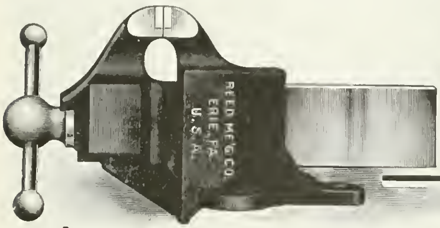




"W&B" DROP FORGINGS

¶ We make a specialty of the highest grade Drop Forgings. Our exceptional capacity and equipment insure accurate forgings and prompt delivery. Send us models or blueprints and permit us to estimate on your requirements.

The
Whitman & Barnes Manufacturing Co.
Established 1854
120th Street CHICAGO, ILL.

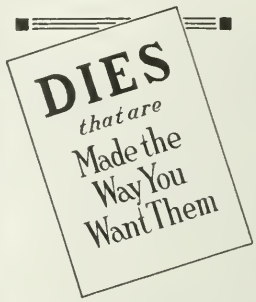


A "Reed" on Your Bench

Don't be satisfied to buy "any old vise"—demand a "Reed" and get 100 per cent value for every dollar spent. Reed Vises are as unbreakable as a vise can be made. One on your work-bench will insure the best vise service possible.

Reed Vises hold work rigidly, do not get out of order, and stand the strains of severe service. Catalogue H is a reference book for use when buying vises. May we mail you a copy today?

REED MANUFACTURING COMPANY
Erie, Pa., U. S. A.

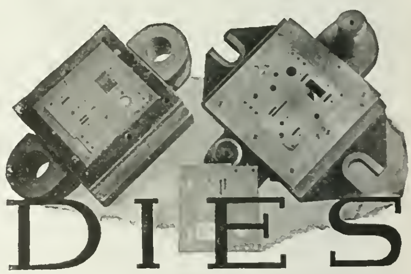


We manufacture high-grade punches and dies of various kinds for use in connection with sheet metal work and described as follows:

Blanking, Piercing, Forming, Trimming, Drawing, and Sub-press work.

We pay particular attention to see that the dies are made according to the desires of our customers. Write us.

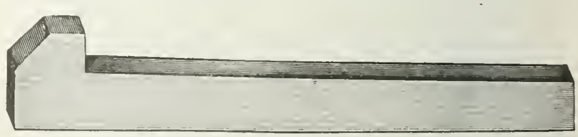
The Columbus Die, Tool & Machine Co.
COLUMBUS, OHIO, U. S. A.



It pays to use Nelson Dies. Highest grade workmanship. Prices right. Consult us.

NELSON TOOL COMPANY, Inc.
781-783 East 142nd St. New York City

Nothing to Do but Drive



You are not put to the trouble of filing and fitting when you use our Finished Machine Key. We finish them *complete*—all ready to drive, and you can always depend upon accurate machining and true size. We have special facilities for making Machine Keys any length, width, depth, style or taper. If your keys are costing too much—get our prices.

Our specialties include: Machine Racks, Cold Drawn Shafting, Screw Stock, Flats, Squares, Hexagons and Special Shapes. Send for interesting Catalog.

STANDARD GAUGE STEEL COMPANY, Beaver Falls, Pa., U. S. A.

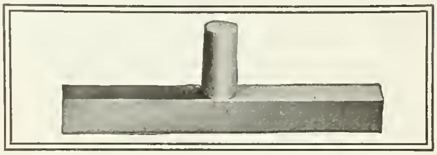
BRANCH OFFICES: Chicago, Ill., and Philadelphia, Pa. Pacific Tool and Supply Co., San Francisco, Cal. Dilworth Lockwood & Co., New York. R. B. Ridgley, Detroit, Mich. A. L. Maeder Co., Portland, Ore. Hall & Pickles, 64 Port St., Manchester, England.

MOLTRUP

The name is your guarantee of highest quality

Over 20 years' experience in Key making at your service. Gib Head—Plain Taper—Round End Feathers—Special Keys for every manufacturing purpose.

May we make yours?



Moltrup Steel Products Co.
BEAVER FALLS, PA.

Agencies: Allison & Co., Chester, Pa.; Geo. W. House, Detroit, Mich. 1081 Continental & Commercial Bank Bldg., Chicago, Ill.

1816 *One Century in Business* 1916

FRASSE-ELECTRIC STEEL

TOOL AND SPRING STEEL
NICKEL, CHROME SILICO MANGANESE
CHROME NICKEL, SILICO MANGANESE

NEW FRASSE ELECTRIC STEEL WORKS, Hartford, Ct.
In Operation September 1st.

PETER A. FRASSE & CO., Inc.
TUBING—STEEL—TOOLS—SUPPLIES
417-421 CANAL STREET, NEW YORK
PHILADELPHIA BUFFALO HARTFORD

WEDELL & BOERS
157 Jefferson Ave., Detroit, Mich.

TOOL CARE REQUIRES A TOOL CASE

The ideal tool case for the practical mechanic is the W. & B. It is compact and strong, has stationary tray for heavy tools, and drawers are fitted in lengths and depths to take tools of all sizes. W. & B. Cases are covered with Seal Grain Cowhide or Karatol, as preferred, and are handsomely finished.

Write for booklet and prices.

Lower Your Tapping Costs with a

Sizes 1" to 12". Circular on request.

VICTOR COLLAPSIBLE TAP

Save the time now *wasted* in backing out a solid tap. Even if it is only a few seconds each time, those seconds total a substantial amount in a week's work. Victor Taps are strong, durable and simple. No complicated parts to get out of order. Body of machine steel, chasers high-speed steel. Set screw adjustment from front maintains setting. Automatic trip prevents spoiled work. Ideal for tapping shells.

VICTOR TOOL COMPANY
WAYNESBORO, PA., U. S. A.

They're Good Tools

Bay State Taps and Dies

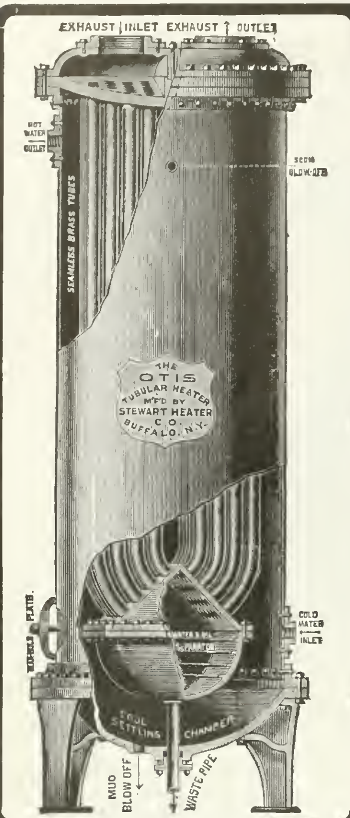
meet every requirement for clean cut, accurate threads and cost saving service. They are made from best grade steel, hardened according to the Bay State special process, tested before being put in stock and guaranteed to be free from imperfections.

Bay State Taps and Dies cut the cost of high-grade threading to low figures. Why not give them a trial? Taps, Dies, Screw Plates, etc.

WRITE FOR THE CATALOG

Bay State Tap & Die Co.
MANSFIELD MASS., U. S. A.

Representatives for England: Geo. W. Goodchild & Macnab, 56-58 Eagle St., Southampton Row, London, W. C. Representatives for Scandinavia: Wilh. Sonesson & Co., Ltd., Malmo, Sweden.



THE OTIS

Tubular Feed Water Heater, Oil Separator and Purifier

is not an experiment, but a tried and trusted appliance that the makers are not afraid to

GUARANTEE

To heat the feed water to the *boiling point* (210 to 212 degrees) with the exhaust steam without causing any back pressure; *also to extract the oil from the exhaust*, so that the exhaust steam, after being passed through the heater, can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the *additional expense* of an *eliminator*.

We are so sure of the OTIS that we agree to pay all costs of a trial—freight, cartage, piping, etc.—if it fails to do all we claim for it.

Catalogue and Prices at your Service

The Stewart Heater Company
79-99 East Delevan Avenue BUFFALO, N. Y.

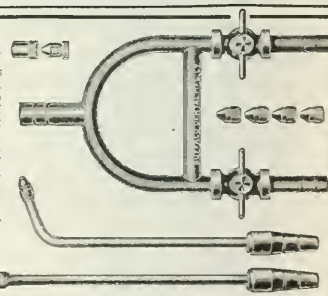
Screw Machine Products

OF ALL KINDS

We have recently equipped with new machinery for making all kinds of screw products. Send in blue prints or samples for prices. Deliveries will be prompt and quality right up to the top notch, for which our reputation is well known. *Prices will please you, too.*

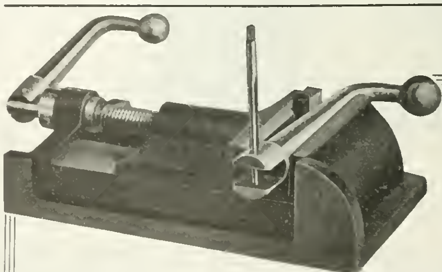
Toledo Screw & Stamping Co.
170 SMEAD AVENUE TOLEDO, OHIO

FOR LEAD BURNING



Our No. 28 Oxy-Hydrogen Lead Burner is most complete. Equipped with taps that are ground to a seat, making them easy to manipulate—safety gauzes in the throat of the yoke to prevent accident by a flashing back of flame—a series of jet tips with varying sized orifices, and a wind shield adjustment to permit its use in draughty places. A straight and curved burner shaft that will meet every possible condition. Price, complete with 5 feet rubber connecting tubing, $7.00. Ask for catalog "B. M.," illustrating and describing this and all our chemical laboratory apparatus.

BUFFALO DENTAL MANUFACTURING CO.
BUFFALO, N. Y., U. S. A.



The MOHN VISE Can Be Used At Any Angle

A feature which makes it particularly handy in drilling and milling at angles. Quickly adjusted. Grips with an ungivable hold. Strong and powerful. Unique handle which can be turned in, out of the way, once vise is adjusted.

Three sizes. Circular and prices on request.

W. D. MOHN & CO., Reading, Pa.

A. G. BUTLER, Inc.

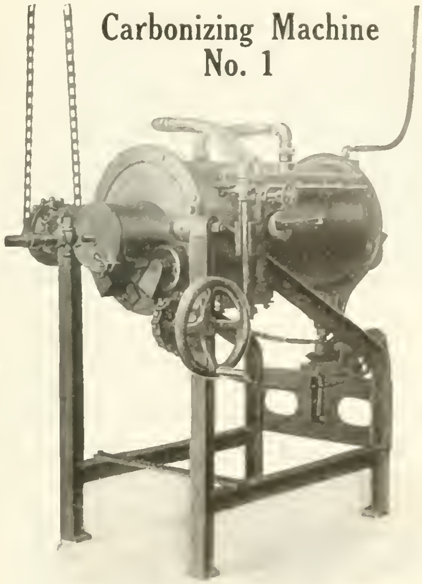
PATTERN LETTERS

For Iron and Brass Castings. Various styles and sizes. For Machines, Bridges, Tablets, etc.

Leather Fillet. All sizes in stock.

Postal Telegraph Bldg., 253 Broadway, New York

Keep Case Hardening Costs Uniform and Low



This **"American"** Carbonizing Machine will enable you to do it. Built to take work up to 6″ diameter and 20″ long, it occupies only 42″ x 69″ of floor space. It uses gas with marked economy, meets exacting demands for service, and produces uniformly high-grade work at low cost.

This is but one of the many furnaces and heating machines in the **"American"** line. All are built to meet the demands of manufacturers who require heat-treating equipment of unusual exactness, control and economy.

Special Book on "Case Hardening with Gas" and Catalogue of the full line of American Furnaces on request.

AMERICAN GAS FURNACE CO., 24 John St., New York

ENGINEERS AND MANUFACTURERS

One Product Only—
FORGINGS

We concentrate all our efforts on making just one thing—Forgings. And following that policy strictly, we are enabled to turn out work that, for reliability and wide range of service, is unsurpassed.

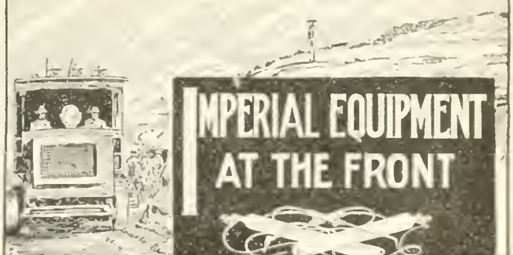
We carry a large stock of material, our shop facilities are unequaled, workmen experts in their line, and last—and all-important—*our methods are right.*

Prompt deliveries on all orders, large or small. Send blueprints or drawings for quotation.

THE MACHINERY FORGING CO.

Hamilton Ave. and Marquette St.

CLEVELAND OHIO, U. S. A.



Somewhere in Mexico

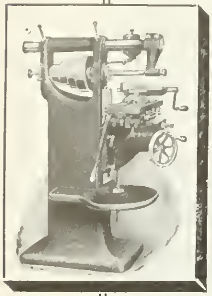
Uncle Sam is using a number of *Imperial Oxy-Acetylene Welding and Cutting Equipments* as FIRST AID to repair breakdowns of the big fleet of transportation trucks and other army equipment on the border.

The government, when seeking *quality of work* and *speed of accomplishment*, chose Imperial—it's a safe lead for you to follow.

Write today for big illustrated catalog showing work actually done, savings made, cost of operation, and other valuable data.

Imperial Brass Mfg. Co.

1224 W. Harrison St. CHICAGO



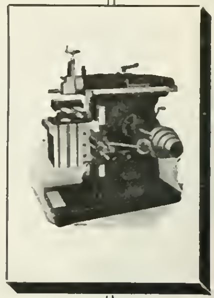
Cut Your Shop Costs

Nobody would think of putting 16-inch lathe work on a 30-inch lathe; then why leave small parts on a large Milling Machine? A Steptoe Hand Miller or small power feed can be handled quicker and will cut your production cost. You will have less money invested in your Milling Machines and have more machines to do the work.

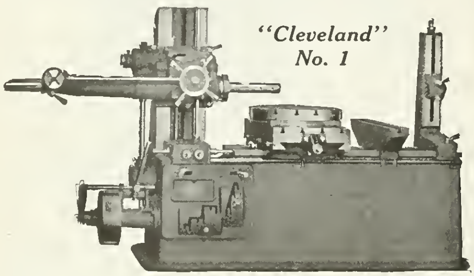
That same principle applied to your small planer work will cut the cost of planer work.

A Steptoe Shaper will do the work faster because it can be handled quicker.

THE JOHN STEPTOE COMPANY
BRIGHTON CINCINNATI, O.



The Cleveland Horizontal Boring, Drilling and Milling Machine

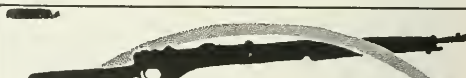


Unusual Range — Exceptional Speed

Bore, mill, drill, tap, etc., on the Cleveland "Horizontal." It's the machine to handle work at low cost. Strength and rigidity insure accurate output, and the system of centralized controls reduces the operating effort to the minimum.

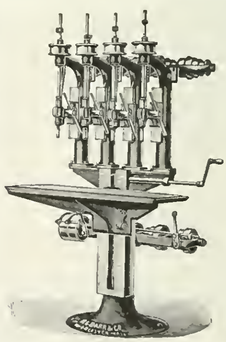
In Cleveland Machines all gears are covered, all feed changes made by one handle, all changes of speed and feed made, without interference, while machine is running. Many other advantageous features. Write for complete description.

CLEVELAND MACHINE TOOL WORKS
Cleveland, Ohio, U. S. A.



Sloan & Chace Mfg. Co.
LIMITED
NEWARK NEW JERSEY

Manufacturers of
Precision Machinery and
Makers of Dies, Tools, Fixtures
and
Special Machines
for Gun Makers.

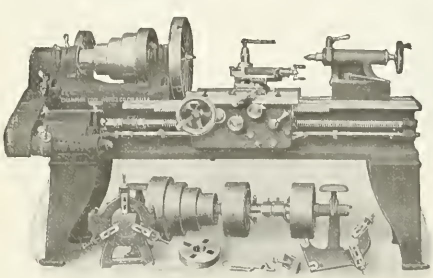


Barr Sensitive Drills

One to 6 Spindles

Lever or Power Feed

MADE BY
FRANCIS REED COMPANY
43 Hammond Street
WORCESTER, MASS., U.S.A.



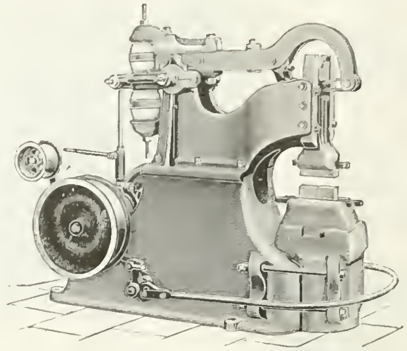
CARE

In their alignment, in the selection of first-grade material, in machining to jigs, in the use of modern, practical equipment, and no special hurry to put through other than good work is the main reason why CHAMPION LATHES are a standard for accurate boring, turning, facing and screw-cutting lathe operations.

Designed with extra weight and every convenience makes them the ideal machine for Tool Room and Factory.

Four Sizes: 12-14-16- and 18-inch.

CHAMPION TOOL WORKS CO.
2422 Spring Grove Avenue CINCINNATI, OHIO, U. S. A.



Bradley Upright Hammers

Are made with heads weighing 15 to 500 pounds. Each contains one-third to one-half more material than those of any other make of the same rating.

Their anvil blocks weigh nearly or quite double those of other hammers.

Their output is guaranteed 25 per cent greater than is possible with other hammers of same rating, or no sale.

More Bradley Hammers are sold each year than all other power hammers combined.

WE MAKE

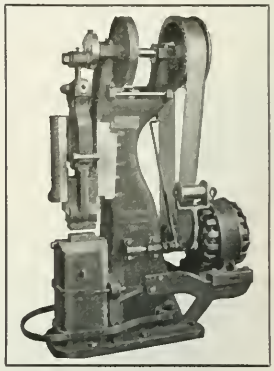
The Bradley Cushioned Helve Hammer — The Bradley Upright Helve Hammer
The Bradley Upright Strap Hammer — The Bradley Compact Hammer
Forges for Hard Coal or Coke

SEND FOR CIRCULARS

C. C. BRADLEY & SON, Syracuse, New York

FOREIGN AGENTS: Schuchardt & Schutte, Berlin, Vienna, Stockholm, Petrograd. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. Buck & Hickman, Ltd., Whitechapel Road, London.

Beaudry Hammers
FOR GENERAL FORGING



Save Fuel, Time and Labor.
Cut Forging Costs in Two.

Belt or Motor Driven

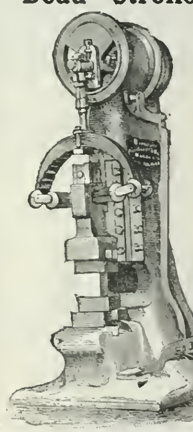
BEAUDRY & CO., Inc.
141 Milk Street BOSTON, MASS.

CHAMBERSBURG STEAM-HAMMERS
"ALL SIZES FOR EVERY CLASS OF WORK"

Our hammers are double acting, have simple valve gear and give the operator perfect control. *Write us for details.*

CHAMBERSBURG ENGINEERING COMPANY, Chambersburg, Pa.
HYDRAULIC MACHINERY

"Dead Stroke" Power Hammers



Strike a square, true blow at all times and can be safely run at high speed.

The peculiar feature is the spring, to which the ram is attached by a flexible belt, permitting a far more effective blow than can be given by any other hammer of the same weight and stroke, and requiring less power.

Built in 7 sizes.

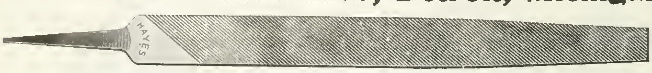
Write for circulars.

MANUFACTURED BY

Dienelt & Eisenhardt, Inc.
1304 No. Howard Street
PHILADELPHIA, PA., U. S. A.

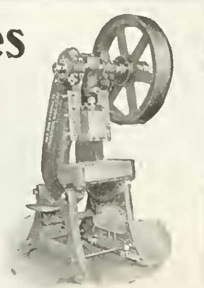
NOT IN A TRUST

HAYES FILE COMPANY, Detroit, Michigan



USE OUR SPECIAL LATHE-CUT FILE FOR LATHE WORK
PRICES ON APPLICATION

Ams Presses



We spare no money nor pains to make our Presses the best that money can buy. Let us quote you on your next Press.

Address Dept. P 3

MAX AMS MACHINE CO., Bridgeport, Conn.

DROP PRESSES
for All Purposes Our Specialty

The Peck Drop Lifter
can be readily applied to foot or hand drops.

MINER & PECK MFG. CO.
Proprietors of the PECK DROP PRESS WORKS
NEW HAVEN CONN., U. S. A.

Genuine Armstrong Stocks and Dies

PIPE CUTTERS

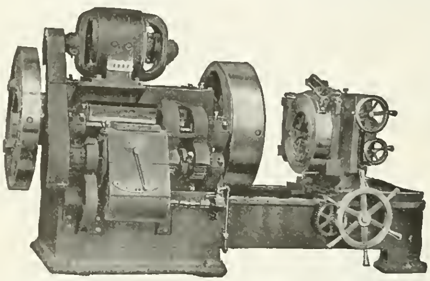
Malleable Iron Hinged Pipe Vises

PIPE MACHINES

MANUFACTURED BY

THE ARMSTRONG MFG. CO., 297 KNOWLTON STREET BRIDGEPORT, CONN.

The Method of Drive is an Important Thing in a Pipe Machine



Because a lot of time is wasted if the speed is not just right for every size and material of pipe.

The "Stoever" Pipe Machine

has a single-pulley drive with gear speed variation. This means that **the belt speed is constant,** not lowest when it should be highest. **The belt tension is always proportional to the power** transmitted—economy of power. **The belt contact is constant and always adequate.**

The "Stoever" has a friction countershaft which eliminates shifting belts and saves at least one-third in belting cost.

The gear speed variation affords a speed exactly right for every size of pipe, and for iron or steel. **This means maximum cutting and threading speed.**

Write for the "Economy" Booklets.

TREADWELL ENGINEERING CO.

Sales Office: 140 Cedar Street, New York

Works: Easton, Pa. TE 10

For Heavy Pipe Cutting and Threading

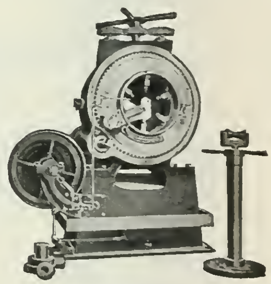
Catalog gives full description.

Curtis & Curtis Co.

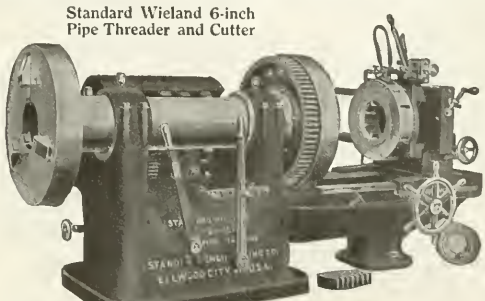
8 Garden Street

BRIDGEPORT CONN., U.S.A.

THIS power-driven Forbes Pipe Cutting and Threading Machine is especially heavy in design, and built for hard service. It is equipped with four speed changes, oil pump and revolving dies, and is particularly compact—requiring five feet less floor space for working a length of pipe than any overhung spindle type machine. It is an economical, one-man machine for work up to 15″ in diameter. Furnished for hand use if desired.



Standard Wieland 6-inch Pipe Threader and Cutter



Thread Pipe Do You? How?

The modern, efficient way is the Standard Wieland way, with a heavy, sturdy, durable machine, simple and positive in operation, fast and accurate in production. This machine costs more and is worth it; character and quantity of output prove it.

A few features: One-piece bed; single-speed pulleys; gear speed changes through semi-steel cut gears; deep chasers, cutting long taper threads in one cut perfectly, steel as well as iron pipe.

Send for the circular.

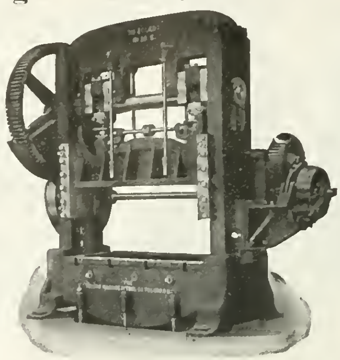
Standard Engineering Company

Ellwood City Pennsylvania

San Francisco Office: 1801 Claus Spreckels Bldg.

"TOLEDO" Prestige Steadily Widens

among manufacturers who seek durable, efficient presses of consistent economy.



"TOLEDO"
Double Crank Presses

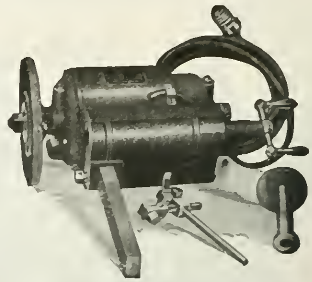
embody exclusive improvements and new features of the greatest advantage.

It is unnecessary to go into the details of the construction of these presses after half a century of tried and proven success.

They are furnished in over 150 sizes and adapted to every requirement of sheet-metal and drop-forging work.

Prompt Deliveries.

The Toledo Machine & Tool Company
TOLEDO, OHIO, U. S. A.



Tool Post Grinder

Hand Feed and Plain

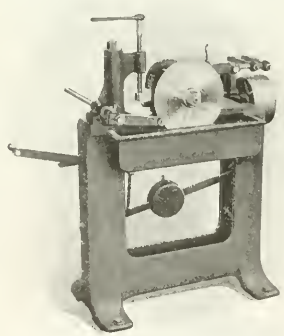
For grinding Centers, Dies, Cutters, etc.

Does both Internal and Surface Grinding.

Supplied with 3/8 x 6" wheel internal grinding attachment.

Ten-foot flexible cord and plug to fit any standard lamp socket.

STOW MANUFACTURING CO.
BINGHAMTON, N. Y.
CHICAGO OFFICE:
106 So. Jefferson Street



It's the Burr "No. 1"

A cold saw fitted with a 10-inch saw blade, 3/32 inch thick, of uniform hardness throughout — a machine that cuts any round stock up to 3½ inches diameter, accurately and fast.

Simple design and substantial construction are distinctive features. Drive is through a steel worm gear provided with ball thrust bearings and a steel pinion; automatic trip shifts belt to loose pulley at finish of cut.

Circular gives full description. Write us.

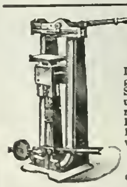
JOHN T. BURR & SON
429 KENT AVENUE, BROOKLYN, N. Y.

Combination FILING Cabinets and Drawing Tables

Thoroughly well made and finished in Grand Rapids best style. Our Cabinets and Drawing Tables never fail to please the purchaser. Table and cabinet combination here shown is one of the most popular pieces.

Send today for descriptive matter and prices on our entire line of Drafting Room Furniture.

FRITZ MANUFACTURING COMPANY
60 Alabama Street GRAND RAPIDS, MICH.



The Cost of Your Marking Reduced and the Quality Improved

Do you want your trade mark to look good on your work? If so, use a Dwight Slate Marking Machine manufactured by us. They are especially designed for marking. Send for Book No. 8 IMPROVED QUALITY OF MARKING—Free. We also have a department devoted to Steel Die Engraving.

Noble & Westbrook Mfg. Co.
0 Asylum Street, Hartford, Conn.

A SIGN OF PROGRESS

It's taking a step in the right direction to replace castings with Acklin Metal Stampings. A trial will convince you that Acklin Stampings are cheaper, and more satisfactory in every respect. *Write for details.*

THE ACKLIN STAMPING COMPANY, 1657 Dorr St., Toledo, O.

AUTOMATIC BAIRD MACHINERY

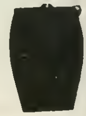
PRESSES—Foot and power.
WIRE FORMING MACHINES —Standard or special.
TUMBLERS—All kinds.
BALL BURNISHING EQUIPMENT.

BAIRD MACHINE CO., Bridgeport, Conn.

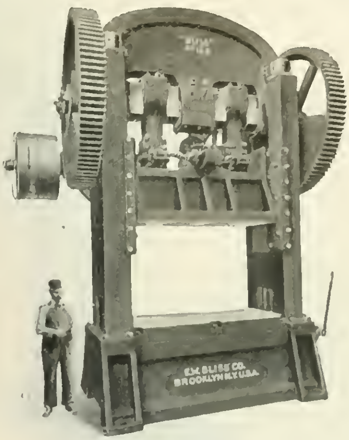
CRUCIBLES STOPPERS COVERS
PHOSPHORIZERS SLEEVES

and other articles for use in melting and refining metals
THE BEST IS TRUE ECONOMY

McCULLOUGH-DALZELL CRUCIBLE CO. Pittsburgh, Pa.



There is a Size that Will Successfully Meet your Exact Requirements



Presses with correct proportions for use in the manufacture of large sheet iron and steel goods. The large diameter shafts and well-gibbed sides allow quantity production that's profitable.

Bliss Double-Crank Presses

Adapted for the economical production of vapor stoves, wrought iron ranges, agricultural implements, automobile stampings, steel car parts, ceilings, sidings, metal doors, window frames and sashes, metal furniture and similar goods.

Built in over 150 sizes, there is one adapted to your special requirements. Write today for descriptive matter.

Talk to us about presses for any and every requirement.

E. W. Bliss Co., 5 Adams Street BROOKLYN, N.Y.

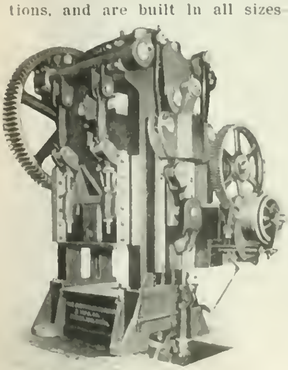
CHICAGO OFFICE: 622 West Washington Boulevard
DETROIT OFFICE: - - - Dime Bank Building

Offices in Europe: 100 Boulevard Victor Hugo, St. Ouen, Paris. Pocock St., Blackfriars Road, London, S. E.

BLISS

"CLEVELAND"
TOGGLE DRAWING PRESSES

Perfect dwell and perfect timing—"Cleveland" Toggle Presses are unusually heavy in their proportions, and are built in all sizes both single and double crank, for the production of all classes of drawn sheet metal parts. They are equipped with automatic or hand operated multiple disc friction clutches. Yokes, rock shafts, cranks and links are steel castings. All pin bearings are bronze bushed.



Patent Applied For.

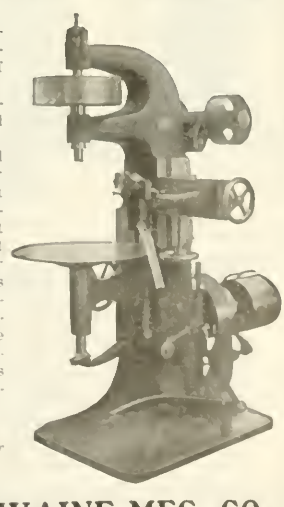
We are prepared to furnish complete equipments of Presses, Shears and Dies for the production of large or small sheet metal articles of every description.

Send us your inquiries.

THE CLEVELAND MACHINE & MFG. CO.
4944 Hamilton Avenue
CLEVELAND OHIO, U. S. A.

SWAINE
No. 4 Double Seamer

A thoroughly dependable machine for accuracy in this line of work, and particularly adapted for high-speed production and quick adjustment. Vibration is reduced to a minimum by running the belt close to base of machine, and any lost motion that might occur can be readily taken up. This "SWAINE" has hardened tool-steel wearing parts, adjustable bed, two-speed arrangement, and is very strongly constructed.



200-page Catalog for complete details

FRED J. SWAINE MFG. CO.
7th and O'Fallon Sts. ST. LOUIS, MO.
LARGEST PRESS BUILDERS IN THE WEST

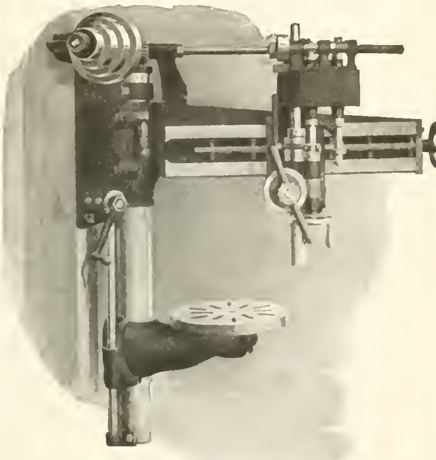
A High Class "Radial" at Low Cost

Production is often limited because of the absence of a radial drill, high investment cost preventing its installation. The No. 51 Canedy-Otto Self-Feed, Wall Type Radial Drilling Machine relieves the pressure. Reasonably priced—within the reach of any manufacturer—and handles a wide range of work just as satisfactorily as higher priced drills.

It is equipped with quick-return lever, serving as pilot wheel to move spindle, four instantaneous speed changes and automatic cut-off. Furnished with $2\frac{1}{2}'$ and $3\frac{1}{2}'$ arms; is powerful and accurate, fully guarded and easily operated. Capacity up to $1\frac{1}{4}''$ holes.

Write for complete details.

CANEDY-OTTO MFG. COMPANY
CHICAGO HEIGHTS ILLINOIS, U. S. A.



PRICES

No. 51—$2\frac{1}{2}$ ft. Arm - - - - $175.00
No. 51—$3\frac{1}{2}$ ft. Arm - - - - $185.00
F. O. B. Chicago Heights

Carried in stock by leading jobbers and machinery dealers everywhere. Send us your name and we will give you the name of our dealer in your locality.

The "NAZEL"

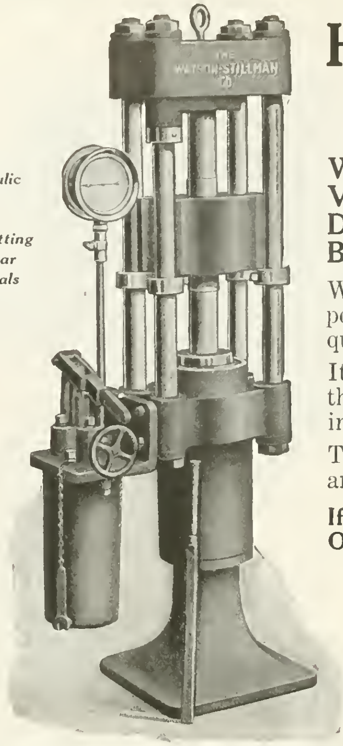
A One-Man Hammer

The "Nazel" is a one-man hammer. In most cases a second operator wouldn't increase the amount of work nor the accuracy with which it is handled. The foot control is perfect and adequate for all except work too heavy for one man to handle and run the hammer at the same time.

This matter of control was one of the things considered most important by the National Transit Pump & Machine Co., Oil City, Pa.—and largely influenced the purchase of the Nazel Hammer we furnished this concern six months ago.

Let us tell you more about "Nazel" control, "Nazel" economy in power, "Nazel" efficiency. You should know.

Nazel Engineering Works
4043 N. 5th St., Philadelphia, Pa.



50-ton Hydraulic Press for Briquetting Granular Materials

Hydraulic Briquetting Presses

We Build Briquetting Presses For a Great Variety of Purposes From Briquetting Coal Dust, Sugar, Salt, etc., to Making Concrete Building Blocks.

We show here a small press for experimental purposes, to determine the pressures, volumes, etc., required for briquetting granular materials.

It is equipped with hand pump and gauge so that the pressure applied can be accurately controlled and indicated.

The briquetting mould can be made in various shapes and sizes.

If you need presses for any purpose, write to us. Our line of over 4000 complete machines probably offers a press to meet your needs. If not, our 60 years' experience is at your disposal.

The Watson-Stillman Co.

192 Fulton Street New York, U. S. A.

CHICAGO, McCormick Building

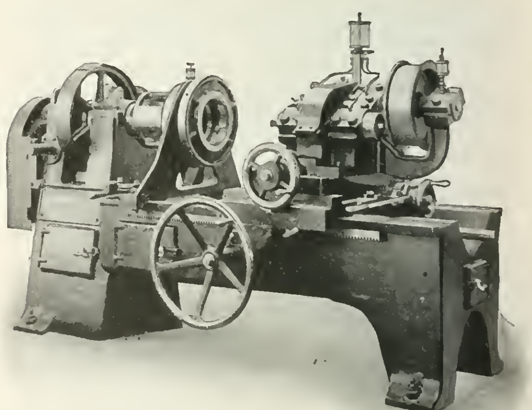
295

Thread Millers

Do You Need Them?

We are filling rush orders for Smalley-General Thread Milling Machines fitted for eight, nine and two-tenths and twelve inch shells, and making good delivery on all sizes. The Smalley-General line includes Thread Millers in sizes to handle shells up to 16 inches. Belt or motor drive.

Full description and prices on request



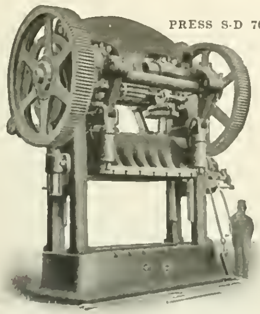
Smalley-General Co.

BAY CITY, MICH., U.S.A.

FERRACUTE PRESSES

FOR CUTTING, FORMING AND DRAWING METAL

PRESS S-D 705



Double-action Toggle Drawing Presses, all widths, giving pressures of 100, 150, 200, 300, 400, 500, 700, 1000, 1500 and 2000 tons.

The press shown exerts 700 tons pressure. Ram stroke up to 18 inches and plunger stroke up to 36 inches. Distance between columns, 124 inches. Friction clutch.

Photographs and full information for the asking.

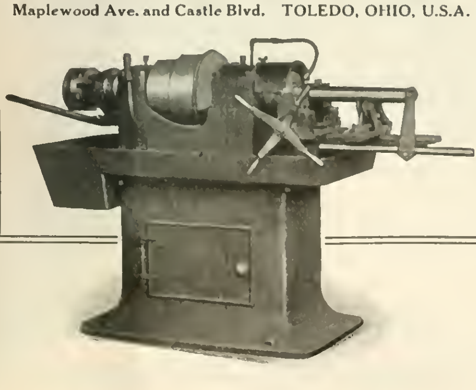
FERRACUTE MACHINE CO.
BRIDGETON NEW JERSEY

The Etna Cutting-Off Machine

Equipped with features heretofore found only in high priced machines, and possesses all their advantages with lower investment and operating costs. The double cut-off insures a square, true cut, while the centering attachment, correct to within .005″ is available, if desired. Etna construction is strong and rigid; these machines are built to withstand heavy cuts and hard service. Made in 2″, 3″, 4″ and 6″ sizes.

Full information on request

THE ETNA MACHINE COMPANY
Maplewood Ave. and Castle Blvd. TOLEDO, OHIO, U.S.A.



HYDRAULIC MG MACHINERY

Every Shop Has Use for This Hydraulic Straightening Press

EVERY medium or large machine, automobile, repair or railroad shop has use for this 250-ton Inverted Hydraulic Forcing Press for Bending, Straightening, Broaching and Miscellaneous Forcing work which is sure to come up daily. Its adaptability to a wide range of such work is unsurpassed, two of its features being a large pressing bed and an adjustable daylight space.

For small shops and smaller work we have hydraulic presses of the same type in smaller designs and lighter pressure capacities.

Just ask us about any type of hydraulic bending or straightening press—we have it. Shall we send you catalogs and bulletins?

Whatever Your Pressing Problems May Be—We Have the Press

No matter what or how intricate your pressing problems may be, we have a design to exactly fit your requirements. We have been building hydraulic equipment exclusively for 40 years. Here is only a partial list of our products:

Abrasive Wheel Presses
Arbor Presses
Auto Wheel Rim Presses
Baling Presses
Bending Presses
Broaching Presses
Die Presses
Drawing Presses
Electrode Presses
Flanging Presses
Forcing Presses
Forging Presses
Forming Presses
General Purpose Presses
Powder Presses
Rubber Presses
Salt Block Presses
Shell Banding Presses
Shell Drawing Presses
Shell Forging Presses
Shell Nosing Presses
Special Presses
Straightening Presses
Wheel Presses
Wood Veneer Presses
Hydraulic Pumps
Hydraulic Intensifiers
Hydraulic Accumulators
Hydraulic Valves

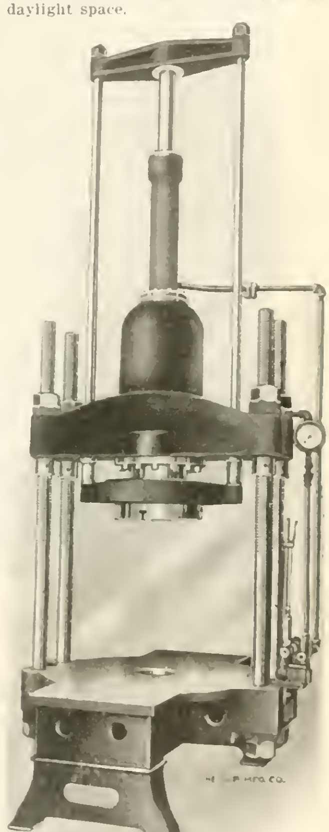


FIG. 1151.

Shall we send you bulletins on any of this equipment?

The Hydraulic Press Mfg. Co.

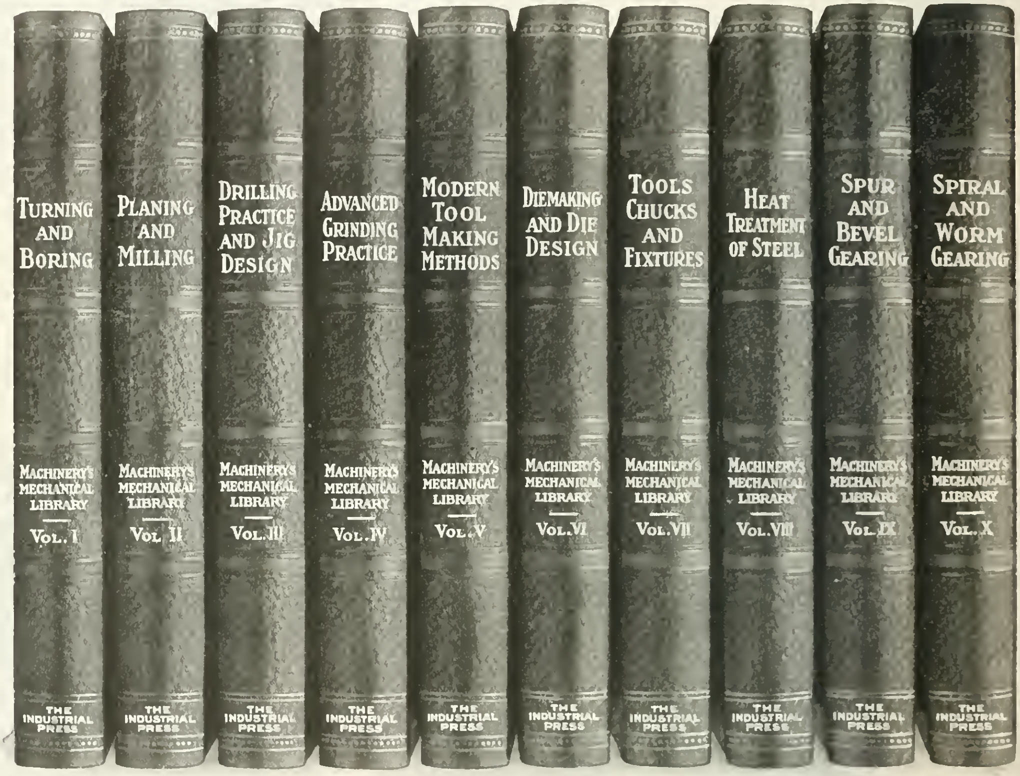
84 Lincoln Avenue MOUNT GILEAD, OHIO

Branch Offices:

Eastern Office: Room 1105-1, 39-41 Cortlandt St., New York City; 414-D Citizens Bank Bldg., Cleveland, Ohio; Division D, 22 N. Clinton St., Chicago, Ill.

"FOR YOUR MG PRESSING NEEDS"

THE NEW SHOP



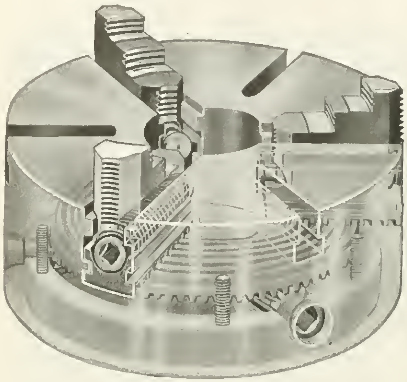
MACHINERY'S MECHANICAL LIBRARY

is an investment which will return you many hundred per cent.

THE mechanic primarily interested in machine construction and design should acquaint himself in particular with the tools and methods in modern machine construction and with the mechanics and mathematics of the machine shop. It is useless for him to study abstract mathematics which have no application in ordinary shop work; but he should study to become generally well-informed, and should endeavor to gain a knowledge of the basic principles of the various processes of manufacture in the works where he is employed. The practical and theoretical should go hand in hand. It should always be remembered that the man whose training is along purely theoretical lines is worth but little in practical life. The man whose training is entirely along practical lines is worth more, yet he seldom occupies a responsible position. The man who combines a well-balanced training in both theory and practice is the man who takes the leadership and holds it.

Every foreman, draftsman, machinist and toolmaker conscious of his inability to fill any responsible position should resolve to secure the knowledge he needs to qualify himself. We can assure him that openings at the top are always available.

This Chuck for All Purposes



UNION No. 83
Geared Scroll Combination Chuck

Operating Universally the jaws give that united strength that is found only in well-made scroll chucks.

Operating Independently the jaws in this chuck will hold just as rigid as those of any Iron Independent Chuck.

This Chuck is Substantially and Carefully constructed with the expertness that characterizes the **Union Standard.**

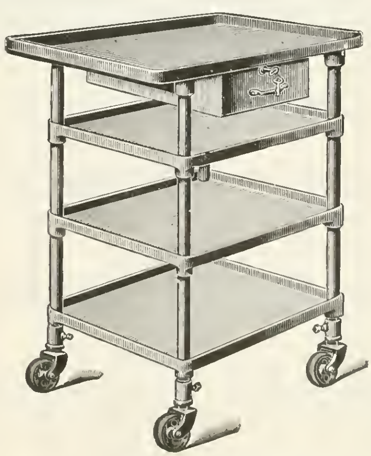
Profit by Our Experience.

UNION MANUFACTURING CO.

New York Office:
26 Cortlandt Street

NEW BRITAIN, CONN.

Makers of a Complete Line of Chucks



Catalog of the Champion line of Tools and Shop Equipment on request.

"Champions" That Deserve the Title

Champion products did not win their reputation without competition; it took a stiff fight to show they would produce better results than the other fellow's—and win the decision.

Champion Tool Holders

Are good examples of the Champion line. A big advantage is the heavy support under the cutting edge which prevents mashing down under continued strains. These holders use cutters close up, are strong, durable and make heavy cuts possible with rapid operation.

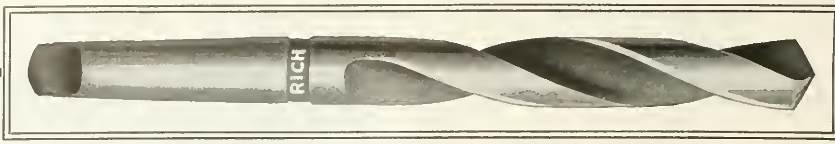
Champion Tool Stands

A typical piece of Champion Shop Furniture. Made of cast iron or sheet metal, with or without drawer. Strongly built and easily moved. A real economy in any shop.

THE WESTERN TOOL & MANUFACTURING CO.

SPRINGFIELD, OHIO, U. S. A.

FOREIGN AGENTS: Alfred Herbert, Ltd., Great Britain, Italy, France, etc. A. B. V. Lowener, Copenhagen, Stockholm. LOCAL AGENTS: Any first-class Hardware House.



REAL DRILLING STAMINA

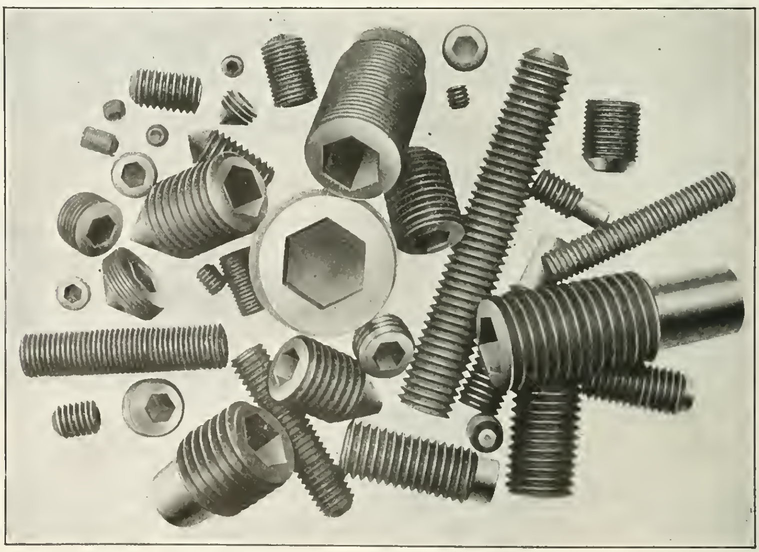
There's a quality in Rich Drills that enables them to stand a hard production pace in a manner truly surprising. Don't take our word for it, just watch one of them at work. No burning or binding. A clean cut right through. No frequent trip to the grinder, either—Rich Drills stay on the job. The kind of drill service you want is in Rich Drills. Look for that name on the shank—it means profitable results.

Send for Catalog describing the full line of

RICH TOOLS

THE RICH TOOL CO., 410-A Railway Exchange, Chicago, Ill.

ALLEN
Socket Cap
Screw



ALLEN
Socket Cap
Screw

Allen Safety Set Screws—Every Diameter, All Lengths

Allen Safety Set Screws are made in every diameter, every length and every shaped point for any purpose to which a safety set screw can be put. The diameters range from ¼ inch up to 1½ inches.

All "Allen" Screws are made by a Patent process which produces a clean socket and adds 30% more strength to the screw.

Write for Catalog No. 12 and free sample screws.

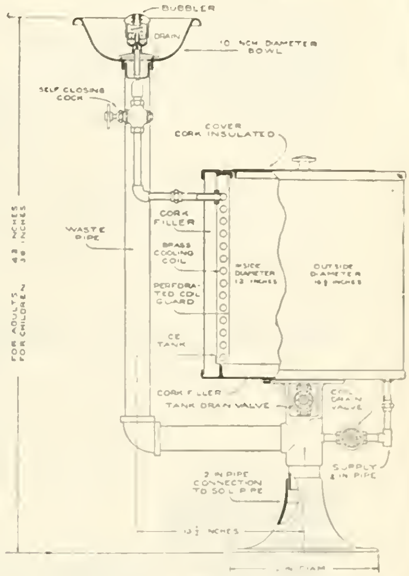
The Allen Manufacturing Company, 135 Sheldon St., Hartford, Conn., U. S. A.

Peoples Life Insurance Bldg., Chicago, Ill. 173 Princess Street, Manchester, Eng.

What It Does

M. E. & E.
Ice-Cooled Bubbling Drinking Fountain

What It Is



Holds 75 pounds ice; 15½ coils brass pipe; supplies 150 persons; to be attached to municipal water supply; sanitary throughout, and economical of both ice and water. Write us your requirements.

Our line includes Wash Bowls, Metal Lockers, All Steel Stools and Chairs with Inset Wood Seats, Stock and Storage Racks, Metal Shelving, Metal Vault Fixtures, Improved Soda Kettles, 40 and 60 gallons, Water Heaters and Instantaneous Mixers, Bubbling Drinking Fountains, Work Benches and Bench Legs, Drawing Stands, etc.

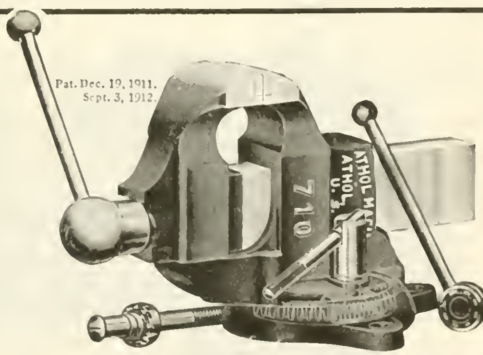
MANUFACTURING EQUIPMENT AND ENGINEERING COMPANY

136 Federal Street BOSTON, MASS.

IT NEVER MOVED

The Swivel Base of the Athol Vise Can't be Started this Way

Pat. Dec. 19, 1911.
Sept. 3, 1912.

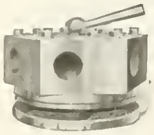


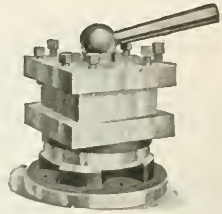
You have used the old types of Swivel Base Vises—one with the pin that drops in a hole, or the one that clamps on a bench with the lever underneath. The one with the pin either becomes loose from wear or sticks tight when you wish to move it—the ones which depend upon friction alone slip when you need them most. It is different with the "Athol." You turn the lever and loosen a taper block having corrugated sides that mesh in the corrugated slot just as the phantom view shows. We're proud of this construction. It doesn't wear loose—it won't stick nor can it be "started" by any strain, no matter how severe.

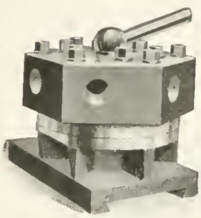
The "Athol" line comprises vises from the simplest to the new Starrett improved vise shown above—vises for every purpose—and *all* good. We want to acquaint you with the line and send a catalogue for your files. Ask for it.

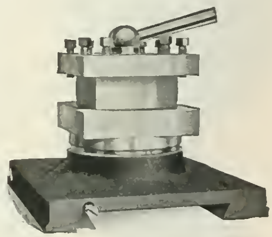
ATHOL MACHINE COMPANY

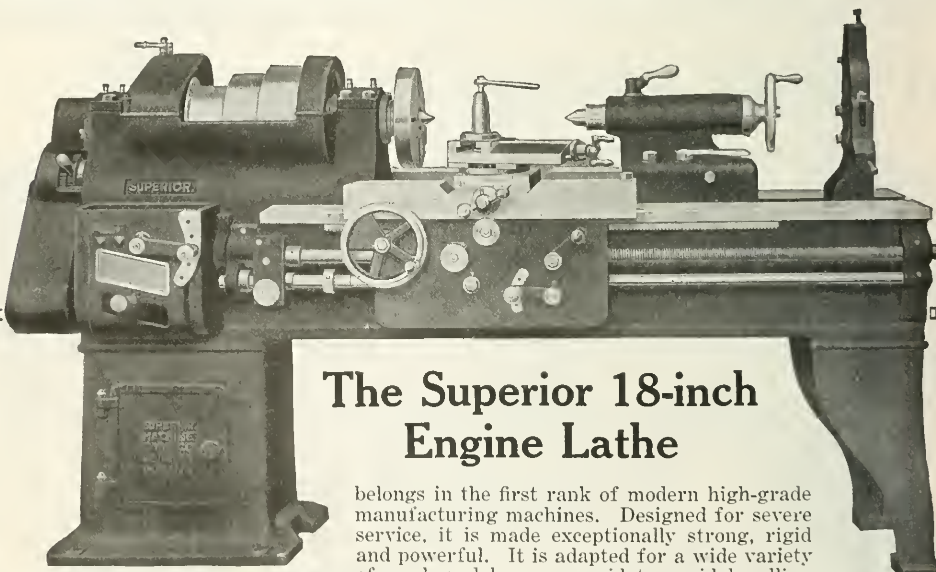
ATHOL, MASSACHUSETTS, U. S. A.



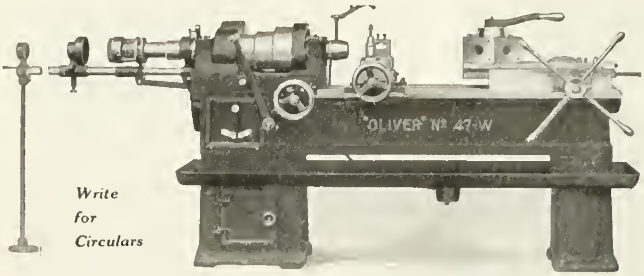








SUPERIOR



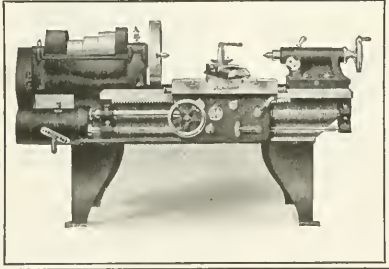
Write for Circulars

"OLIVER"
ENGINE LATHES
16"--18"--26"
TURRET LATHES
SCREW MACHINES

Early Deliveries

Oliver Machinery Co.
Coldbrook and Clancy Sts.
GRAND RAPIDS, MICH., U. S. A.

Sidney Lathes
19-inch and 21-inch Swing



Sidney Lathes have been worked out along better than average lines, with the result that service values have more to recommend themselves than is true of less carefully constructed lathes. Sidney Lathes are particularly strong in the wearing parts, and are extra heavily ribbed and braced to maintain accurate alignment and balance under all conditions.

The carriage "V" is larger than usually provided in this type of lathe; the quick-change gear mechanism is of high-carbon steel throughout, and the headstock of the closed type pattern that adapts it especially for high duty.

Complete details on request.

THE SIDNEY TOOL COMPANY
SIDNEY OHIO, U.S.A.

We Build Them To Wear

For that reason there are more square inches of wearing surface on the crank bearing of a Kelly Shaper than any other shaper made. You can realize the importance of this point. KELLY SHAPERS are built throughout in the same way.

They give uncommon service, because they are designed and built with modern shop requirements in view. We have been making good shapers for over a quarter of a century. Catalog describing full line of these efficient cost reducers on request.

THE R. A. KELLY COMPANY
XENIA, OHIO, U. S. A.

Send for circular

NATIONAL LATHES

Meet the demand for a standard quick-change lathe embodying improvements that render it adaptable to a wide range of work in shops where production demands are heavy. Staunchly built, accurately finished. 17" swing.

THE NATIONAL LATHE CO., 15 W. 2d St., Cincinnati, O.

Hercules Shears and Rod Cutters
Bring the Work to the Tool or the Tool to the Work

Nos. 1, 2 and 5

MADE IN 6 SIZES

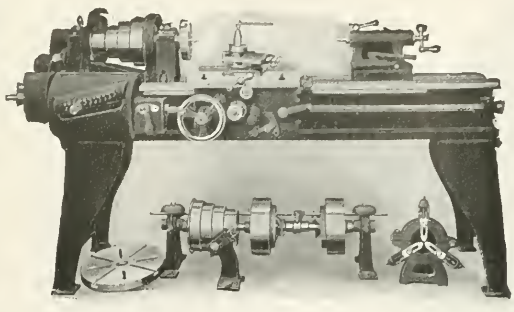
No. 0 cuts 1-4" iron rod and under, 1-16" flat iron.
No. 1 cuts 1-2" iron rod and under, 3-16" flat iron.
No. 2 cuts 5-8" iron rod and under, 1-4" flat iron.
No. 5 cuts 3-4" iron rod and under, 5-16" flat iron.
No. 3 cuts flat sheets or bar 1-4" or under only.
No. 4 cuts flat sheets or bar 5-16" or under only.

The shear blades have a drawn-in cut, with no tendency to crowd work out of the shear. Note that leverage is directly over the cutting point, also the steel band that raises the jaw, dispensing with all springs.

Send for Shear Catalogue

Nos. 3 and 4

Manufactured and for sale by **W. M. & C. F. TUCKER** HARTFORD, CONN., U. S. A.



Read Our Specifications

Before going ahead get a copy of our specifications of this 14″ engine lathe. It's a

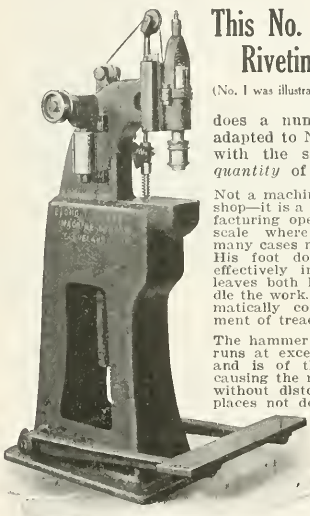
CARROLL-JAMIESON Screw Cutting Lathe

It has double back gears, quick-change gears giving thirty-two changes of feed without removing a gear, nine spindle speeds, 2½″ belt drive from three-step cone.

Drop a line now for a set of specifications.

The Carroll-Jamieson Machine Tool Company
257 Davis Street Batavia, Ohio

A Little Brother of its Big Brother —a Money Saver, Too



This No. 2 Pneumatic Riveting Machine

(No. 1 was illustrated in May *Machinery*)

does a number of jobs not adapted to No. 1 Machine and with the same *quality* and *quantity* of production.

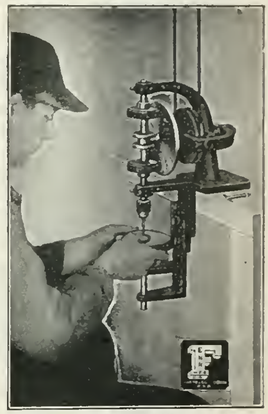
Not a machine for the little job shop—it is a producer for manufacturing operations on a large scale where the operator in many cases needs another hand. His foot does the trick very effectively in this design and leaves both hands free to handle the work. Air valve is automatically controlled by movement of treadle.

The hammer of standard make, runs at exceedingly high speed and is of the revolving type, causing the metal to flow easily without distorting the work in places not desired.

Send us blueprints or samples of those parts which you have had in mind for months but for which you could not find the right machine—our production estimate and proposal will surely interest you. Let us tell you more about it. Write us Today!

Blomquist-Eck Machine & Manufacturing Co.
203 ST. CLAIR AVENUE, N. E. CLEVELAND, OHIO
AGENTS: E. E. Minard, 516 Free Press Bldg., Detroit, Michigan.

The Fenn Tapping Machine



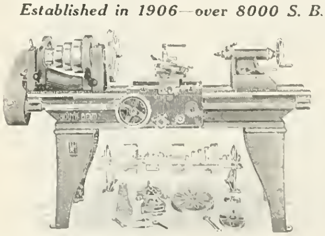
Do your tapping on this machine and save your drilling machines for the work they were built to handle. We can show you it will pay.

A little machine that wins its O. K. on the very first job. Very easy to operate; turns out a large quantity of work economically and with minimum tap breakage. The Fenn has adjustable friction rolls that permit quick speed changes, and can be reversed at higher speed than the forward drive. Capacity 3/16″ holes and under. *Write for full information.*

FENN MANUFACTURING CO.
HARTFORD, CONNECTICUT, U. S. A.
W. L. FENN and W. A. FENN, formerly of Taylor & Fenn Co.
Cable Address: "Fenn"—Western Union Code.

South Bend Lathes

Established in 1906—over 8000 S. B. Lathes in use.



13-inch Lathe
14-inch Lathe
15-inch Lathe
16-inch Lathe
18-inch Lathe

Straight or Gap Beds. For the machine or repair shop.

A low price lathe without expensive fads. Send for catalog and prices.

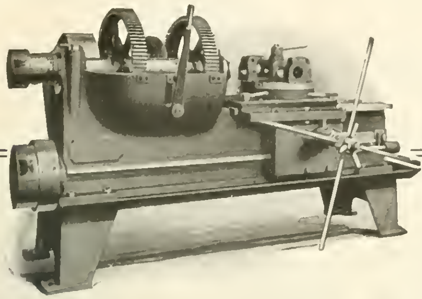
SOUTH BEND LATHE WORKS
426 E. Madison St. South Bend, Ind.

STAMPINGS

Dies, Jigs, Tools, Pressed Metal Parts

turned out by us have quality, accuracy, suitable price and positively prompt delivery to recommend them. We furnish estimates from blue prints or samples and solicit trial orders.

Lansing Stamping & Tool Co.
LANSING Dept. D MICHIGAN



The Cleveland Chucking Lathe

Does One Thing—Does It Well

This machine was developed for the express purpose of handling the turning, drilling, boring and forming operations on 3″ to 6″ shrapnel and high-explosive shells. Powerful, rigid and surprisingly simple in operation, it can be relied upon to produce maximum output with an unskilled operator. Just the machine to help catch up on those overdue projectile orders. We can make prompt deliveries. Send for circular.

The Cleveland Crane & Engineering Company
WICKLIFFE, OHIO, U. S. A.

ENGINE LATHES

"N.E.A.T."

PRECISION GRINDING

MACHINERY.

TOOLS, JIGS AND FIXTURES

National Engineering And Tool Works
OAK PARK ILLINOIS

Save Handling Expense

Let one man take the place of five. He can do the same amount of trucking with less effort. An actual saving of from 20% to 80% if you use the

Barrett Multi-Truck

Send for our trial offer. We'll demonstrate in your plant that we can save money.

BARRETT-CRAVENS CO.
750 FEDERAL ST. CHICAGO, ILL.

If you tap nuts for automobile construction, or any service demanding good quality, accurately tapped nuts, investigate the

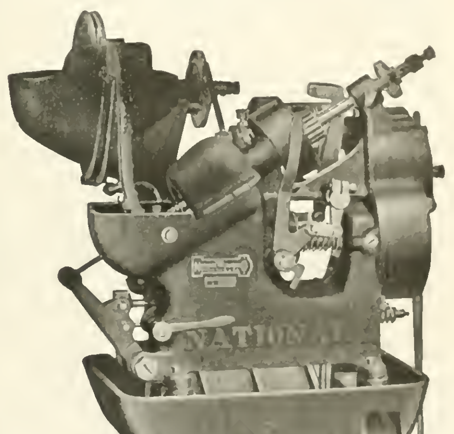
NATIONAL AUTOMATIC (Bent Tap) NUT TAPPER

(PATENTED)

This design embodies radical departures, which greatly improve the tendency to tap nuts "square"—a requisite in good quality nuts.

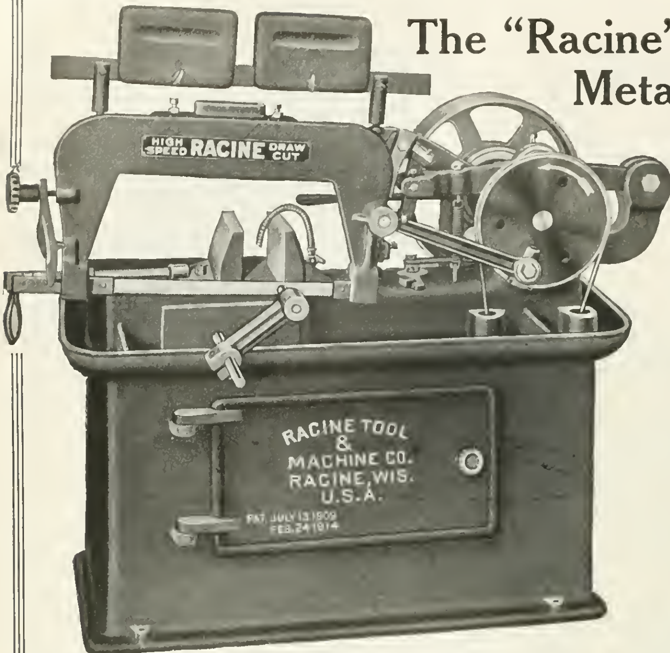
Also, you get bigger outputs; there is less tap breakage; and longer tap life. And, there is decided freedom from trouble and petty repair common in Automatic Tappers heretofore.

We welcome investigation. If you will send samples, we'll advise the possibilities of this tapper on your work, or arrange a test run if you desire. A card will open negotiations.



THE NATIONAL MACHINERY CO.
TIFFIN, OHIO, U. S. A.

National Tapper Talks, illustrating in detail the construction and operation of this tapper, will be sent on request.

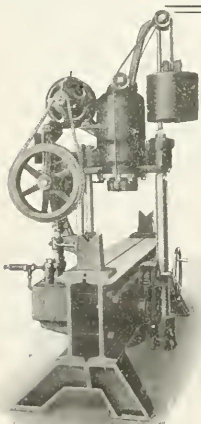


The "Racine" for Economical Metal Cutting

The "Racine" is the original automatic, positive lift, draw-cut metal cutting machine, with patented lifting device which lifts the blade clear of the work on the non-cutting stroke, thereby increasing output as well as the life of the blades.

It cuts faster, truer and more economically than any other machine of this kind. A broad statement, but one we prove with every sale. We can convince *you*. The machine is compact, rigidly built and stands hard service. Circular on request.

RACINE TOOL & MACHINE CO., 250 15th Street, Racine, Wis.



"Metalwood" Shaft or Axle Bending Press

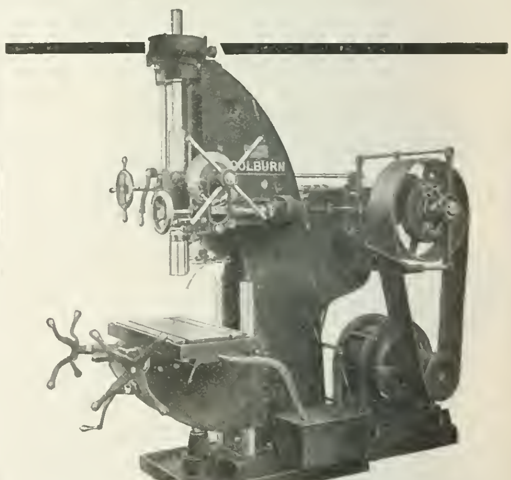
This ruggedly built, well balanced machine has capacity for straightening work up to 6″ diameter on 36″ centers. It is compact and convenient and handles the heaviest work quickly and easily.

Equipped with "Metalwood" Duplex Pump operated by 5 H. P. Motor through a "Link-Belt Silent Chain" drive. The traveling head is carried on roller bearings packed in grease. Operated through compound gearing and so nicely balanced that little effort is required to move it.

Metalwood Straightening Presses are also built in 60- and 90-ton sizes. Furnished with hand-operated, two-pressure, two-plunger pumps when desired. Descriptive circulars on request.

METALWOOD MFG. CO. DETROIT, MICHIGAN

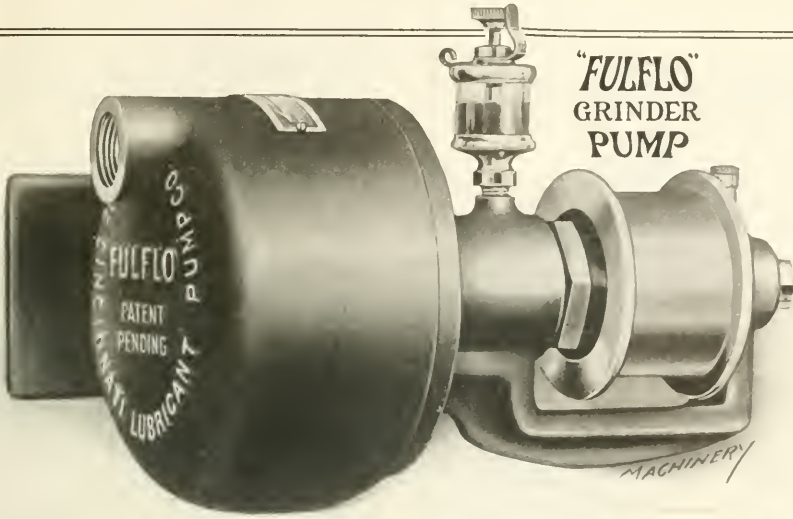
Eastern Office:
PAUL R. KETZER, Eastern Manager, Bourse Bldg., Philadelphia, Pa.



THE "COLBURN"

A heavy-duty drill press of remarkable power, strength and rigidity. Developed to meet the demands of heavy, difficult work, it has unusual range, and can be handled with the ease and speed that plainly spell—profit. It will pay you to write for further details.

COLBURN MACHINE TOOL CO., Franklin, Pa.



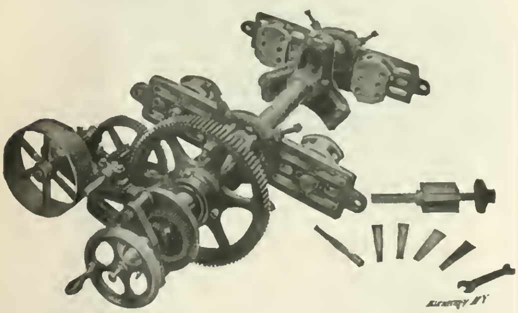
"FULFLO" GRINDER PUMP

The Pump with the Full Easy Flow

That is one way a "Fulflo" Grinder Pump differs from the ordinary pump—*it doesn't squirt and splash all over the machine and surrounding floor.* Instead, it delivers a large volume of cool lubricant at the point it is needed—the cutting point. Force enough to wash all chips and grit away, but no splash.

The "Fulflo" is centrifugal in action; can be mounted in any convenient position because, on account of its positive trap feature, it will retain its prime regardless of whether it is above or below the level of the liquid. Grit cannot reach bearings nor interfere with action of pump. Complete description on request.

THE CINCINNATI LUBRICANT PUMP CO., 126 Opera Place, Cincinnati, Ohio



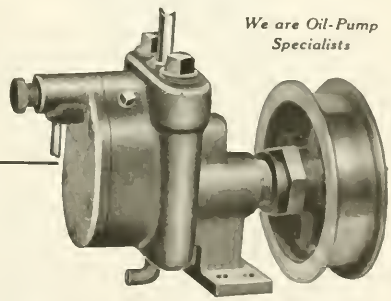
Don't Shut Down Your Plant

Even if you must have the engine cylinders re-bored it is not necessary to dismantle the engine and declare a protracted shut-down. If you have an Underwood Portable Boring Bar Outfit, it is an easy matter to refinish the cylinder. Simply take out the piston and start the tool at work and the job is quickly finished. Why have a costly plant stand idle when a small investment will avoid it. There are other profitable uses for the outfit also. We will gladly explain them in detail. Write us.

H. B. UNDERWOOD & CO.

PHILADELPHIA Established 1870 PENNSYLVANIA

We are Oil-Pump Specialists



A Good Flow of Cool Lubricant

is always assured with a Roper Pump. The flow can be varied to meet the requirements of different jobs by the simple method of regulating the cock on the delivery pipe. There are no valves to adjust on

ROPER CIRCULATING OIL PUMPS

The surplus and overflow are automatically taken care of and the flow is kept at a constant pressure. These simple, efficient pumps can be readily attached to any machine. Plain suction and delivery pipes only are required. One-way and reversing styles. Capacities from 4 to 46 quarts per minute. Circulars on request.

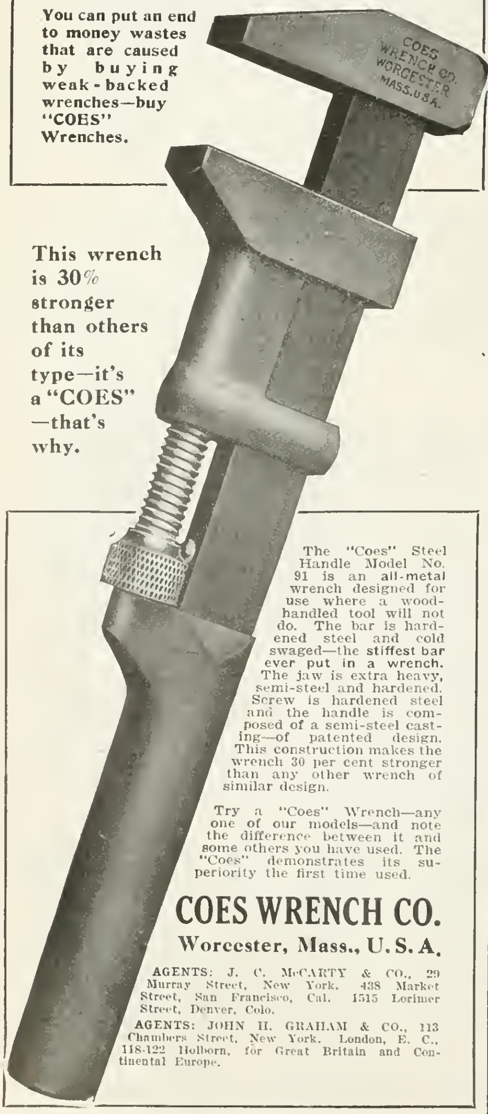
C. F. ROPER & CO., Hopedale, Mass.

Building a Wrench to Last

requires knowledge of modern manufacturing practices—of conditions that test the strength and service of any tool.

"Coes" Wrenches have a place in the line with the tools of highest quality—they are not made to look at, but to serve with durability hard to attain in a wrench of any other name.

You can put an end to money wastes that are caused by buying weak-backed wrenches—buy "COES" Wrenches.



This wrench is 30% stronger than others of its type—it's a "COES"—that's why.

The "Coes" Steel Handle Model No. 91 is an all-metal wrench designed for use where a wood-handled tool will not do. The bar is hardened steel and cold swaged—the stiffest bar ever put in a wrench. The jaw is extra heavy, semi-steel and hardened. Screw is hardened steel and the handle is composed of a semi-steel casting—of patented design. This construction makes the wrench 30 per cent stronger than any other wrench of similar design.

Try a "Coes" Wrench—any one of our models—and note the difference between it and some others you have used. The "Coes" demonstrates its superiority the first time used.

COES WRENCH CO.

Worcester, Mass., U. S. A.

AGENTS: J. C. McCARTY & CO., 29 Murray Street, New York. 438 Market Street, San Francisco, Cal. 1515 Lorimer Street, Denver, Colo.

AGENTS: JOHN H. GRAHAM & CO., 113 Chambers Street, New York. London, E. C., 118-122 Holborn, for Great Britain and Continental Europe.

NICHOLSON Expanding Mandrels

Speed—

this Mandrel gives it!

There is no delay, no hesitancy, no doubt, when you use this mandrel. There is no measuring, no calipering. You are always positive that it will fit perfectly. The principle on which the Nicholson is built—and that it is appreciated and fully understood is evidenced by the huge number of shops that have made it a standard tool—does not allow of doubt or imperfect fits. The tapered grooves in the arbor, the corresponding tapers in the jaws, give an infinite range of sizes between the limits of the mandrel.
We will gladly loan you one of these high-speed mandrels for test. Send for yours today. No obligation.

W. H. Nicholson & Co.
112 Oregon St. Wilkes-Barre, Pa.

Gerstner Tool Cases

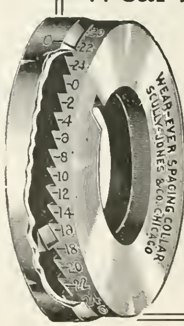
Complete line described in catalog

Are the choice of workmen who appreciate orderly methods and good workmanship. "Gerstners" are practical in design, light in weight, but very strong and durable; are handsomely finished and unsurpassed for convenient arrangement.

H. Gerstner & Sons 11-21 Columbia St., Dayton, Ohio

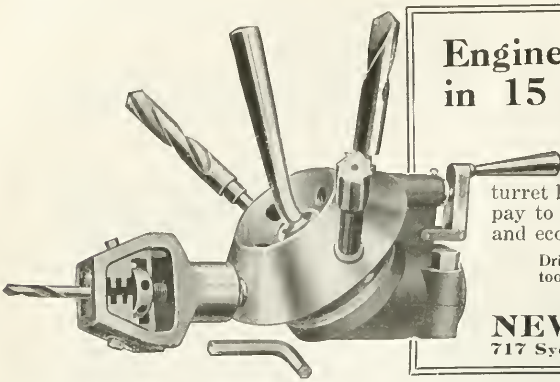
Wear-Ever Spacing Collar

Saves Time in Setting Up Milling Cutters



Don't waste time picking out and measuring spacing collars. Use a "Wear-Ever" and get the *exact* spacing instantly. Twelve adjustments of 0.002" each. Doesn't lose its accuracy through wear. For a quick milling set up, the "Wear-Ever" is the logical collar to use. Write for circular.

SCULLY-JONES & COMPANY
647 Railway Exchange Building
CHICAGO U. S. A.



Engine Lathe to Turret Lathe in 15 Seconds—Cost, Trifling

Attach a *Newman* Multiple Rotary Chuck to the tailstock of an engine lathe—presto—you have all the advantages of a practical turret lathe. Handles the odd jobs, where it doesn't pay to set up a turret lathe, with surprising speed and economy.

Drills, counterbores, reams, taps, etc., without changing tools. Try it for 30 days free. Write for our Bulletin M.T.

We also make Tool Post Turrets and Drill Press Turrets

NEWMAN MFG. COMPANY
717 Sycamore Street CINCINNATI, OHIO

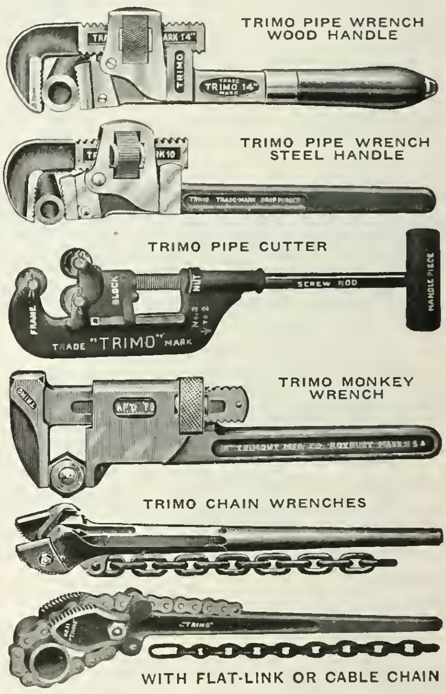
TRIMO TOOLS

Nut with Nut Guards

Be sure to ask for the Trimo Wrenches, both Pipe and Monkey. They are equipped with Nut Guards that prevent the accidental turning of the adjusting nut in close quarters, and in the principal sizes with Steel Frames that will not break.

Send for Catalog No. 38

Trimont Manufacturing Company
55-71 AMORY STREET
ROXBURY, MASS., U.S.A.



Need a Set of Figures?

To prove that S & L steel stamps, as a result of 20 years' experience, have unusual qualities to recommend them, we will send you a set of figures 1/16, 3/32 or 1/8", prepaid, for $1.50. We feel it's merely a question of your trying them—after that we will not have to sell them—you'll *buy* them.

S & L stamps are made of the best stock, carefully treated by experts to stand the knocks. It'll pay to investigate.

Catalog for full details

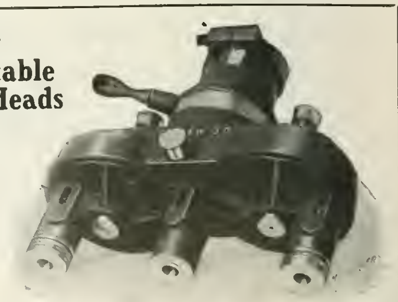
SCHODER & LOMBARD STAMP & DIE CO.
INCORPORATED
Canal and Lafayette Sts., NEW YORK CITY

Sellew Adjustable Drill Heads

Save Money

Three Holes at once instead of one

Write for details.



SELLEW MACHINE TOOL CO., Pawtucket, R.I., U.S.A.

Here's Common Sense Steel Furniture

—UHL—
Steel Tool Trays and Steel Factory Stools

Construction is a safe guide to service in factory furniture. You wouldn't buy upholstered stools, for instance. **UHL Steel Stools** are sensible stools; they give life-time service, never break, and really cost less than other stools, because replacements are unnecessary.

Write us for prices and circulars.

UHL Steel Portable Tool Trays are just as sensible in *their* way, and give practically double service, as the trap can be reversed to form a smooth, level table top when desired. Constructed of pressed steel, they are considerably lighter than cast-iron trays, are mounted on strong, easy-running 3″ steel wheel casters, and can be furnished in various combinations.

THE TOLEDO METAL FURNITURE COMPANY
3309 DORR STREET TOLEDO, OHIO, U. S. A.

The "Boehm" Die Head

The Two Locking Pins

No cramping strain on the die when two locking pins are used—nor can the die catch on one pin and spring out of size or cut a poor thread. *Important points, these.* Also floating the lock on two pins in this manner provides a means of compensating cutting pressure when the spindle on which the Die Head is used is not in exact alignment with the work.

The catalogue explains this and other features of the "Boehm" Die Head fully. Let us send a copy. (See also the next issue of MACHINERY).

Rickert-Shafer Co.
612 West 12 St. Erie, Pa., U. S. A.

EAGLE

SAFETY SET SCREWS

It's All in the Way they're Made

We might have made the hole in the Eagle Hollow Safety Set Screw a different shape, but we didn't—because the square hole provides the greatest advantages for strength and economy.
We might have made the Screws of ordinary steel but every Eagle Set Screw is made of specially hardened bar steel. Eagle Set Screws never bind or jamb, stand all strains, and meet mechanical requirements as well as those of safety.

If you are interested, let us send you samples for a trial—be sure to mention size.

Catalog on request

THE PROGRESSIVE MANUFACTURING COMPANY, TORRINGTON, CONN.

CAMDEN

These men are sitting on a

CAMDEN FORGING

which everybody concedes to be a big one, and they are holding what is fairly termed a little one, which goes to show the variety of work we put through our shops. We can make forgings and make them right. We'll rough it out or completely machine it if you wish. We can help you, as we have helped hundreds of other concerns with their forging problems.

Let's talk it over and show what we can do for you

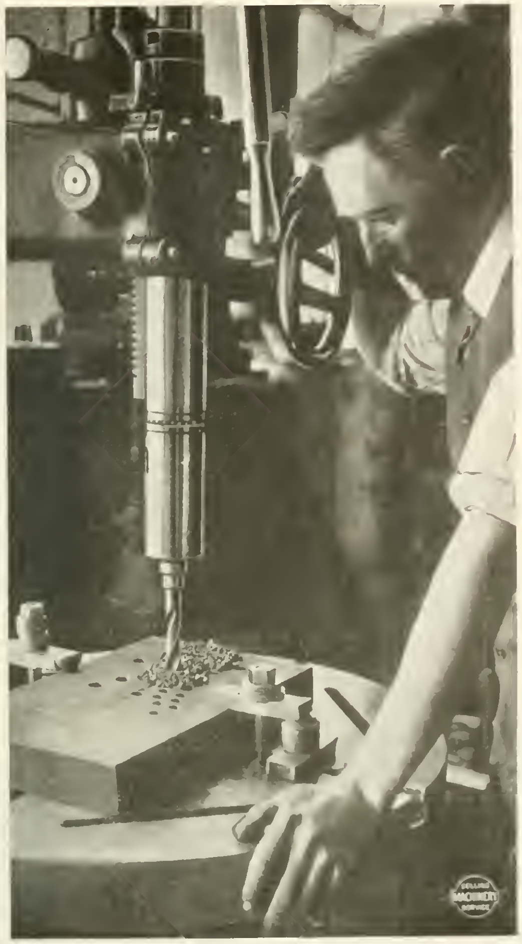
Forgings

As Large or as Small as You Need Them

Camden Forge Co.

8th & Bulson Ave.
Camden, N. J.

Heat Treated Carbon Steel Drills—



VINCENT
DETROIT

A Story Worth Reading

The National Automatic Tool Company, Richmond, Indiana, asked us a few weeks ago if we could heat treat a carbon steel drill and what could be expected from a drill so treated. We answered by asking the Natco people to send us any drill they wished to experiment upon; we to heat treat it and they to test it out. We have just received the figures—they may interest you. Supt. Baker (Natco) set up the drill as soon as it reached Richmond and conducted the tests himself. The test blocks were cast iron, 0.2″ thick, the drill ¾″, speed 267 R. P. M., feed 0.018″. At the time the photograph was taken this drill had completed 10 holes and showed no signs of wear whatsoever.

We are now heat treating more drills for Natco, orders which are proof positive that this concern is satisfied.

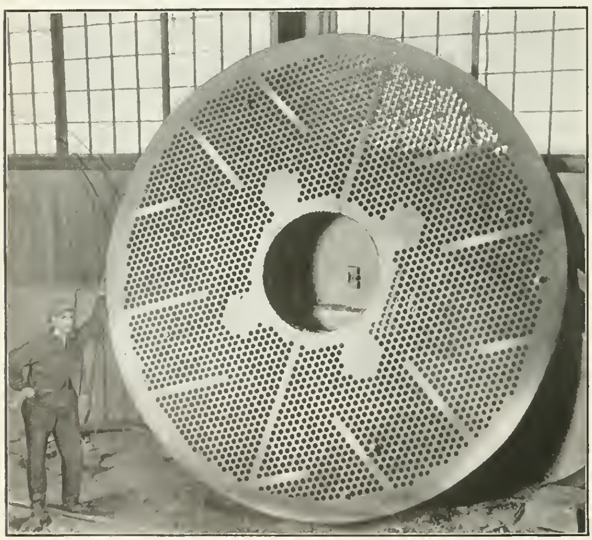
Our cards are face up on the table—no tricks to pull off. We know how to heat treat all manner of work and are doing great quantities of it for concerns everywhere. We do it economically because we do it right—without waste. May we do something for you?

VINCENT STEEL PROCESS COMPANY

751 Bellevue Avenue DETROIT, MICHIGAN

Welding a Big Job Requires Dependable Apparatus

Davis-Bournonville Welding Apparatus



The Treadwell Engineering Company, Easton, Pa., had a contract for tube sheets for sugar mills. Specifications called for ¾″ sheet ingot iron, 13 feet in diameter. Single sheets of this size could not be obtained so two half sections were welded together.

It was an out of the ordinary welding job—a 13-foot weld—and once the weld was started it had to be kept up until the piece was completed, because allowance had been made for expansion.

Davis-Bournonville equipment was selected and for six hours on each piece it gave a steady, even flame, without over-heating or fluctuating—a satisfactory record on a difficult job.

If your welding requirements are exacting there is every reason why you should use Davis-Bournonville apparatus. Consider it from the viewpoint of safety, economy, dependability and positive results and you will find a host of superior features. Give us a chance to show you.

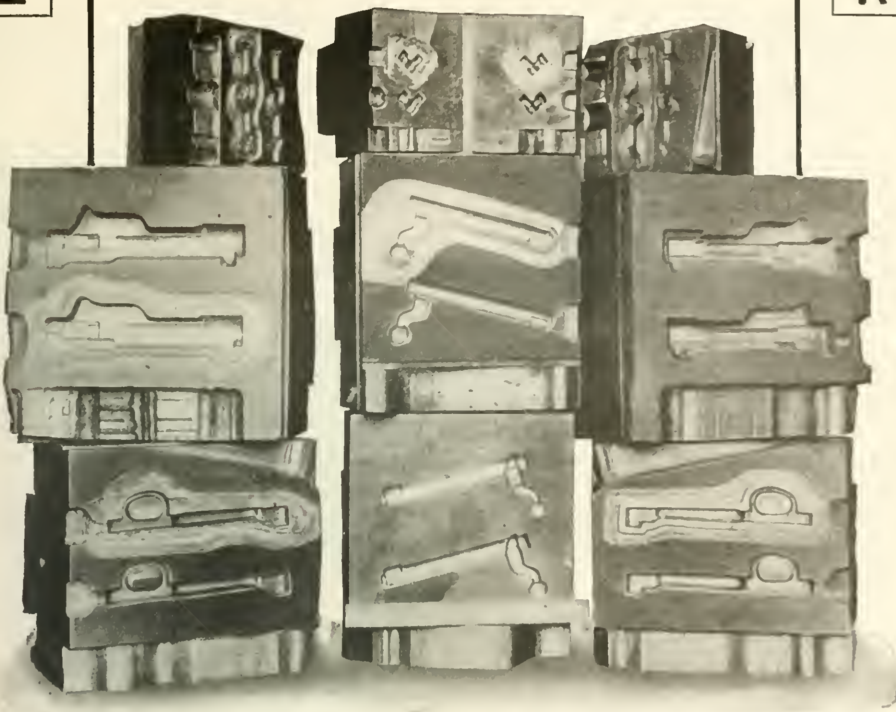
DAVIS-BOURNONVILLE CO.
DAVIS
APPARATUS
NEW YORK - CHICAGO

Leads the world in range, efficiency, and number of outfits in use.

DAVIS-BOURNONVILLE COMPANY

NEW YORK General Offices and Factory: Jersey City, N. J. **CHICAGO**

Sales Offices: New York Chicago Detroit Cleveland Pittsburgh Philadelphia Boston

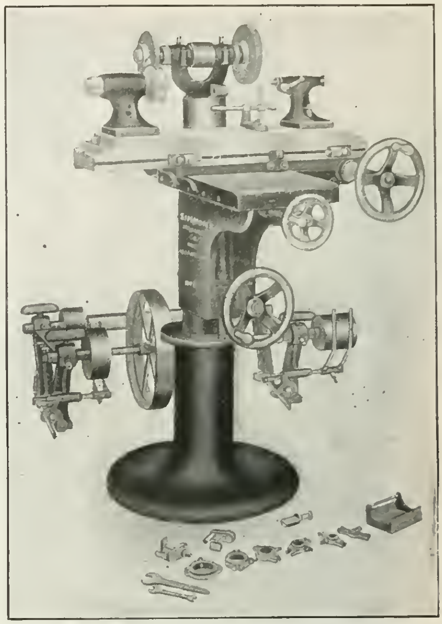


Need a Tool Grinder?

Look This One Over

It has features which recommend it —the large diameter of the column, for example, also the length of the column bearing, the heavy construction of both head and tail stock, our improved double countershaft, the convenient location of all handles within the natural working position of the operator.

These features all contribute to the speed and accuracy with which work can be handled. Range covers all tool and cutter grinding and similar work. Write for the circular.



902 Singer Bldg.
New York City **SIMMONS MACHINE CO., Inc.,** 985 Broadway
Albany, N. Y.

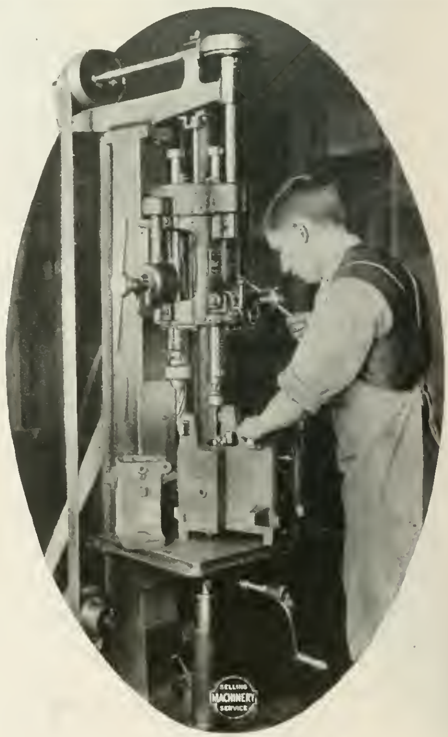
The TURNER TURRET

Pays even on Short Run Work

A Turner Turret is profitable on runs of work shorter than most machines can be set up for *because the tooling is simple and easily applied.*

Consider the job shown herewith, for instance. These parts are slides for lathe carriages. There is drilling on five faces of the work, the holes ranging from $\frac{1}{4}''$ to $\frac{7}{8}''$ diameter; there are reaming and tapping operations also—seventeen operations in all. All that was required in the line of special tools was the jig. Two spindles are used for the two largest drills and the smaller drills are used as needed in the other two spindles.

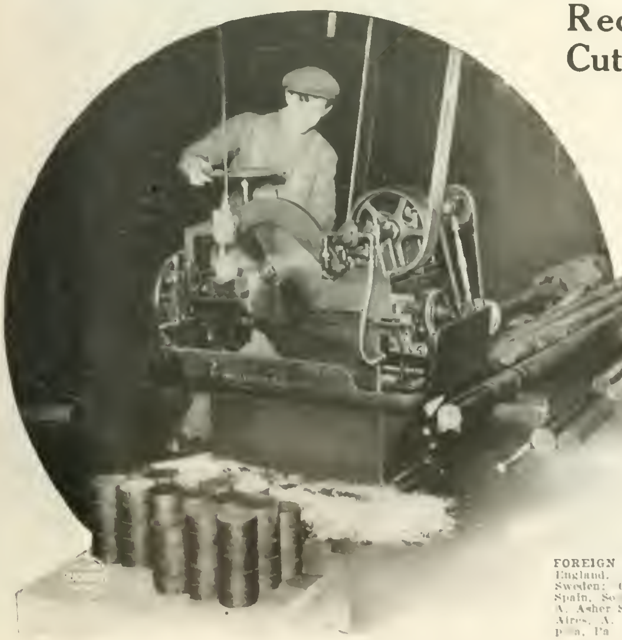
Let us tell you more about the Turner Turret and its advantages—the machine of "Drill Press Simplicity—Turret Lathe Output."



TURNER MACHINE COMPANY

DANBURY, CONN. and Newark, N. J. **U. S. A.**

Incorporated with Turner, Atherton & Co., Ltd., Denton, Manchester and Stockport, England.



The Earle Single-Purpose Lathe

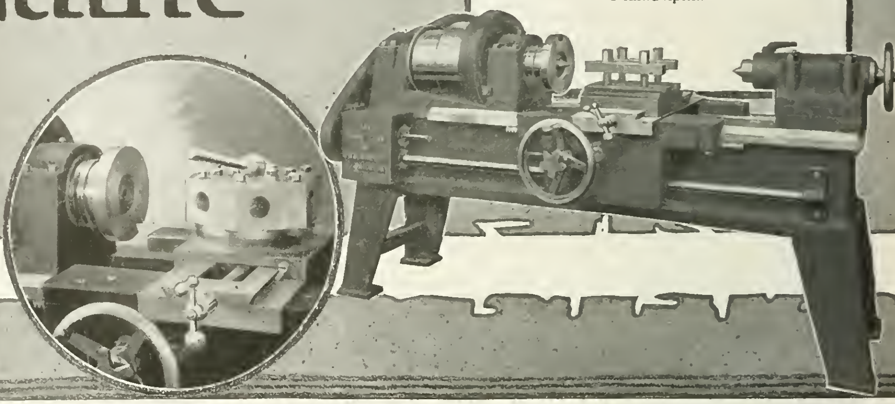
FOR plain turning in high-output manufacturing, these 18" high-duty, back-geared lathes, with 6" belt capacity and quick-change feed box, are replacing 24" machines, because they have practically equivalent cutting capacity.

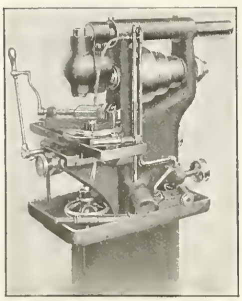
Frequently they are fitted with turrets for boring.

We have an interesting folder analyzing the manufacturing possibilities of these lathes.

May we mail you your copy now?

The Earle Gear & Machine Co.
105 East Wyoming Avenue
Philadelphia





The BICKFORD MILLING MACHINE

among its many advantages has one that eliminates chatter and vibration in cutting. It is

Something New in a Rack Feed

By using a quarter section screw as a rack we have a simple mechanism which gives a smooth, direct drive. This machine is unequaled for producing small and medium size duplicate parts. Simple, speedy and handy. Vertical attachment takes power direct from spindle. A weight returns the table when cut is finished.

Send for further information

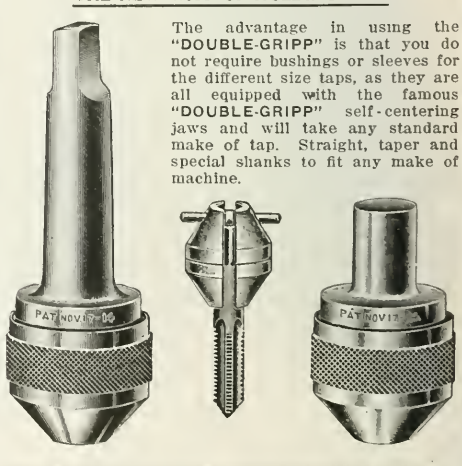
Bickford Machine Company
Greenfield, Mass.

TAPPING REVOLUTIONIZED WITH THE "DOUBLE-GRIPP" TAP HOLDER

THE DOUBLE GRIPP — WILLIAM L. PROCUNIER — CHICAGO, ILL.

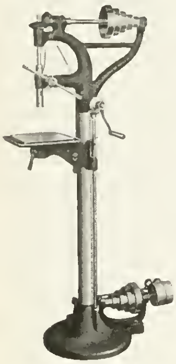
THE NEW WAY OF HOLDING TAPS

The advantage in using the "DOUBLE-GRIPP" is that you do not require bushings or sleeves for the different size taps, as they are all equipped with the famous "DOUBLE-GRIPP" self-centering jaws and will take any standard make of tap. Straight, taper and special shanks to fit any make of machine.



WILLIAM L. PROCUNIER
208 N. FIFTH AVENUE CHICAGO, U. S. A.

The Lindgren
13-INCH HIGH SPEED DRILL

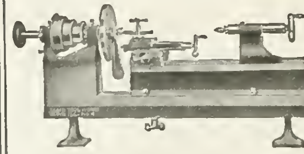


All bearings are bronze bushed and provided with ring oilers. The spindle has ball thrust bearings. The sleeve is graduated in inches.

New lubrication features
No leakage of oil.

F. W. LINDGREN CO.
ROCKFORD ILLINOIS, U. S. A.

Elgin Precision Lathes



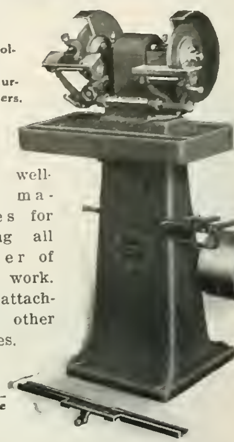
have been built for years and supplied to an exclusive list of very particular lathe users. They are superior in design and workmanship and especially adapted for the tool-room, laboratory or experimental room where super-accurate work is a necessity. If you want a lathe made like a watch, buy an Elgin. Write for details.

THE ELGIN TOOL WORKS
ELGIN, ILLINOIS

ENGINE LATHES
18" to 48" Swing
The Boye & Emmes Machine Tool Company Cincinnati, Ohio

ANDERSON GRINDERS

Handy tool-room or manufacturing grinders.



Sturdy well-built machines for grinding all manner of small work. Bevel attachment; other features.

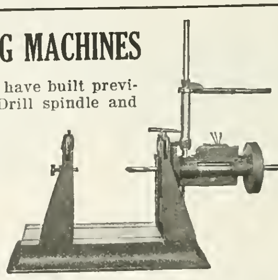
Ask for complete details.

Worcester Pattern and Model Co.
93-95 Foster St., Worcester, Massachusetts

SOMETHING NEW IN BALANCING MACHINES

It is a more universal machine than any we have built previously. Obtains its power from a motor. Drill spindle and motor adjustable up and down. Takes fly-wheels 10" to 18" diameter and handles shafts 30" long between the tool standards. We have just sold eight of these tools to the Ford Company.

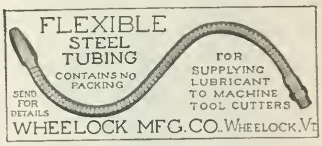
Can you use one?



Rockford Tool Company
ROCKFORD, ILLINOIS

BALL AND ROLLER BEARINGS

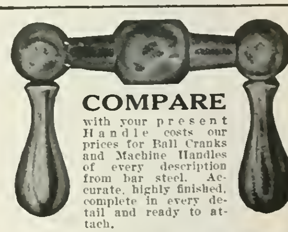
The New Departure Service Station
THE GWILLIAM COMPANY
New York 253 W 58th Street Philadelphia 1314 Arch Street



White Metal Die Castings

PARKER WHITE METAL & MACHINE CO.
ERIE, PENNSYLVANIA

FRANCKE FLEXIBLE COUPLINGS
FOR DIRECT CONNECTED MACHINERY
Any Size Shaft, Power or Speed
SMITH-SERRELL CO., Inc.
General Sales Agent for THE FRANCKE CO.
144 CEDAR STREET NEW YORK CITY



COMPARE
with your present Handle costs our prices for Ball Cranks and Machine Handles of every description from bar steel. Accurate, highly finished, complete in every detail and ready to attach.

The Cincinnati Ball Crank Company
Cincinnati, Ohio
Successors to this dept. of the Schacht Mfg. Co.

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"KNOWING HOW SINCE '81"

SPECIAL STAMPINGS

More than thirty-four years' experience in drawing, spinning and stamping metals, and a plant covering more than fifteen acres of floor space enable us to do difficult work right. Send blueprints or samples for estimates.

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EXCLUSIVELY

12" to 32" Stroke

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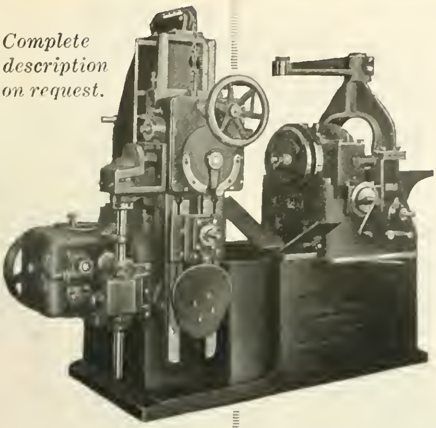
Four compact books covering this important subject completely. *No. 1—Worm Gearing. No. 15—Spur Gearing. No. 20—Spiral Gearing. No. 37—Bevel Gearing.* All units in MACHINERY'S Reference Series, 25c. each.



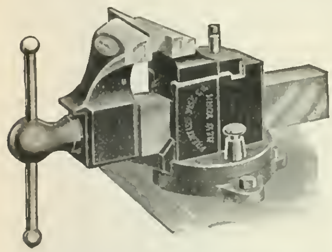
Complete description on request.

Simplified Cam Cutting

The **Rowbottom Universal Cam Milling Machine** does work that formerly required two types of machines to handle, cuts any style cam up to 28 inches diameter, and does its work at extremely low cost.

The "Rowbottom" differs in principle from all other cam cutting machines. Cutter is mounted on a head that operates vertically through a roller against the master cam—no chance for backlash—the weight of the cutting head is always in compression. Other interesting features.

THE ROWBOTTOM MACHINE CO.
WATERBURY CONNECTICUT, U. S. A.
FACTORY: Waterville, Connecticut



Machinists' Swivel Vise

with self-adjusting jaw that is as strong and durable as any solid jaw, and a Swivel Bottom that gives any desired adjustment to right or left, and is solid and firm at any angle. We make all sorts of good vises, and have been leaders in this line for forty years. Send for catalogue and price list.

PRENTISS VISE COMPANY
106-110 Lafayette St. NEW YORK
Sole Agents for Canada
A. MACFARLANE & COMPANY
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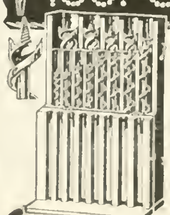
High Speed Spiral Mills
Cutters
Circular Tools
Special Small Tools

An inquiry may enlighten you.

WINDAU TOOL COMPANY
Cleveland, Ohio, U. S. A.

A Set of Bits for Your Tool Chest



A Box of Bits at a Bargain Price - $3.40

A full set of 13 of our popular Lakeside Solid Center Stem Auger Bits. Double cutter two spurs, standard [illegible] thread screw. Bore fast and true. Finest steel, correctly shaped, well tempered, finely polished. One each 1-4, 5-16, 3-8, 7-16, 1-2, 9-16, 5-8, 11-16, 3-4, 13-16, 7-8, 15-16, 1 inch, in handy, upright wood box, [illegible] cover, nicely varnished. Shipping weight [illegible]

One of the [illegible] bargains from our big stock of tools. May we send you our Tool Book? It's FREE. Buy tools at wholesale prices.

Montgomery Ward & Co.
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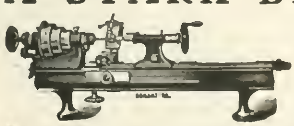
Ft. Worth Portland Ore.
Order from [illegible]

THE SCHWERDTLE STAMP CO.
STENCILS—BURNING BRANDS
STEEL STAMPS & DIES
SEALS—MACH. PLATES—CHECKS
BRIDGEPORT, CONN.

A STARK BENCH LATHE



Will soon show its worth in the shop where accurate work is essential.

STARK PRECISION TOOLS
are made from finest materials, by skilled workmen and from up-to-date designs.
Ask for Catalogue B.

STARK TOOL COMPANY, Waltham, Mass., U. S. A.

PEERLESS
High Speed Steel

Also full line of Regular Crucible Steels and Steels for special needs.

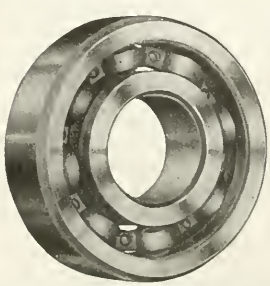
Write us for particulars.

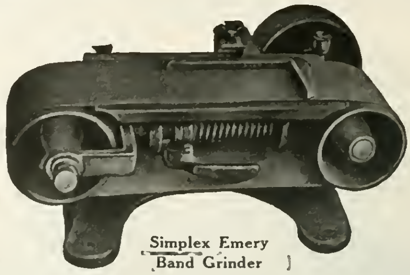
HELLER BROS. CO.
NEWARK, N. J.

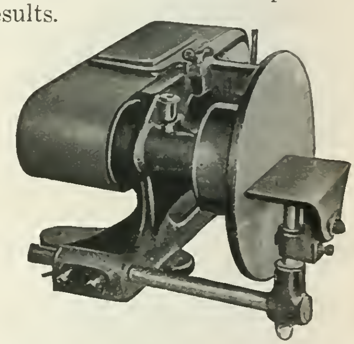
W & P

—it stands for progressiveness. We have just added the Hy-Speed Accelerating Cut Planers to our standard planers and reversing motor planers. *Particulars, if you'll write*

Woodward & Powell Planer Co.
WORCESTER, MASS., U. S. A.







THE CARROLL FACTORY
A Modern Plant for Modern Work

Just One Reason Why We Should Make *Your* Tools

It's a sound business-like reason—we can make them cheaper. That doesn't mean that we slight quality. Oh, no. They are cheaper because they are better—you get economy through quality.

We can do your tool work more cheaply because we have the specialized equipment for handling it—the machines, the tools, the men. In our long experience we have found better methods, the little time-saving kinks that cut off the minutes here and there and yet produce an A-1 job.

A number of manufacturers make regular use of our service. They find that it pays to turn their tool work over to us, not because they can't do it themselves, but because we do it quicker and better. Our representative can show *you* how to save money. When shall he call?

THE CARROLL ENGINEERING COMPANY, Dayton, Ohio, U. S. A.

Prompt Deliveries

HEAVY VOLUME

Automatic Screw
Machine Products
up to One Inch

SEND US YOUR BLUEPRINTS
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SEARS-CROSS COMPANY

Contract Department

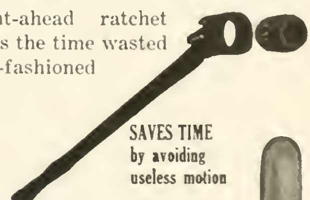
BUSH TERMINAL, BROOKLYN, N.Y.

CUT THE EXPENSE

on assembling and repair work by doing the nut turning with a

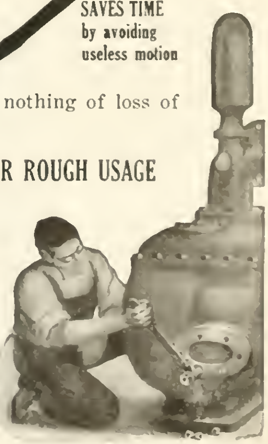
FAVORITE REVERSIBLE RATCHET WRENCH

Quick straight-ahead ratchet movement saves the time wasted by the old-fashioned wrenches.



The socket form of head prevents slipping and injury to nut, to say nothing of loss of time.

SAVES TIME
by avoiding
useless motion



BUILT STRONG FOR ROUGH USAGE

Let us give you full particulars.

Greene, Tweed & Co.
Sole Manufacturers
109 Duane St.
New York

Second-Hand Machinery, Tools and Accessories

NEW, REBUILT AND USED MACHINERY

MACHINE TOOLS NEW AND REBUILT

LATHES

2—No. 5½ Sloan & Chase Bench Lathes, Three-step Cones. Complete set collets by 16ths.
1—26" x 10' Ames, PCF, complete.
1—28" x 10' Ames, PCF, chuck, complete.
2—16" x 8' South Bend PCF complete.
1—18" x 6' Porter compound rest, PCF.
1—20" x 8' Pond, PCF compound rest, chuck.
2—16" x 6' Lodge & Shipley compound rest, PCF.
1—P. & J. Semi-Auto. Turret Lathe, 3" hollow spindle—complete.
1—14" x 6' Lodge & Shipley Pat. QCG chuck, complete.
1—P. & J. Semi-Auto. Turret Lathe, 4½" hollow spindle, complete.
1—34" x 22' New Haven Lathe, block to 44", with 34" chuck, complete.
1—40" x 14' Harris, PCF, chuck, J. & L. geared head.
1—60" x 10' New Haven Boring and Facing Lathe, power feeds in all directions.
1—18" x 10' American, quick-change gear—with chuck.
1—20" x 8' LeBlond PCF, 5-step cone, hollow spindle—complete.
1—26" x 10' Pond extra heavy—compound rest—power cross feed.
12—22" x 8' American QCG, DBG, turret tool post, complete.
1—30" x 12', L. & S. Sing. Pulley Drive, triple geared, QCG.
1—68" x 16' Bed Pond, C. R., P. C. F., H. S. 4½" hole, 5" belt, complete.
3—14" x 6' Bed Hamilton Tool Room Lathes, complete with taper attach.; pan bed.
1—13" x 6' Bed Worcester Lathe, C. B., P. C. F., H. S., complete.

MILLERS.

1—Van Norman Bench Miller, complete.
1—No. 2 Kempsmith Plain Miller, perfect condition.
1—No. 24 Oesterlein Heavy Plain Miller.
1—No. 3 Kempsmith Plain Miller.

SHAPERS.

1—16" American High Duty Shaper, motor drive.
1—25" Smith-Mills Back Geared Shaper, complete, New.

GRINDERS.

No. 6 Standard Universal Cutter-Reamer Grinders.

PLANERS.

1—24 x 24 x 6 Gray, excellent condition.
1—30 x 30 x 16 Bement Extra Heavy, perfect condition.
1—24 x 24 x 8 Cincinnati Planer, good as new, 1 head.

MISCELLANEOUS

1—3" Hurlbut-Rogers Cutting-off Machine.
1—15" Bement Slotter—good condition.
1—4' Niles Radial Drill.
9—No. 53 National-Acme Drills, 4 spindle, used 3 months.

SIMMONS MACHINE CO., Inc.

985 Broadway, Albany, N. Y.
902 Singer Bldg., New York City

FOR SALE

6—13" Gisholt Semi-Automatic Lathes, July 20th, delivery
10—21" Gisholt Semi-Automatic Lathes, July 31st delivery
6—13" Gisholt Semi-Automatic Lathes, Aug. 10th delivery
10—21" Gisholt Semi-Automatic Lathes, Aug. 15th delivery

These machines have been in use one year.

TRAYLOR ENGINEERING & MFG. COMPANY, Allentown, Pa.

TOOLS

Reamers — Milling Cutters
Mandrels — Gauges
Flat and Circular Form Tools

ADVANCE TOOL CO., Canal and Jackson Streets CINCINNATI, OHIO

1—28 x 28' Fitchburg Standard Change Engine Lathe, Swing over bed 30", with Compound Rest and Countershaft, Change Gears, etc.

Price, $1,600.00 f.o.b. Toledo.

1—48 x 30' Fitchburg Standard Change Engine Lathe, Swing over bed 50", with Compound Rest and Countershaft, Change Gears, etc.

Price, $1,100.00 f.o.b. Toledo.

Machines in fair shape and for immediate shipment.

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TOLEDO, OHIO

Second Hand Machine Tools For Sale

30 in. x 17 ft. Lodge Shipley Lathe Motor Drive.
24 in. x 10 ft. Schumaker Lathe Taper Attachment.
24 in. x 25 ft. Thayer Lathe Screw Cutting
Two 20 in. x 8 ft. Johnson Lathes Quick Change Gears.
Two 20 in. x 8 ft. Schumaker Taper Attachment.
18 in. x 6 ft. Bullard Taper Attachment
Ten 16 in. x 6 ft New Wickes Lathes Quick Change.
Two 14 in. x 16 ft. Bradford Screw Cutting Lathes.
60-pound Bradley Helve Hammer
2000-pound Chambersburg Steam Hammer.
Three V & O No. 3 Presses, 2 in. stroke.
Two Cold Metal Saws cut to 6 in.
Two Bulldozers.
Garvin & Kempsmith Milling Machines.
8 in. and 16 in. Bement Slotters
Three New 20 in. Drill Presses B. G
One 52 in. x 52 in. x 11 ft. Betts Planer.
12 in. Alligator Shear, cuts 2 in. square

WICKES MACHINERY CO., JERSEY CITY, N. J.

FOR SALE

FOR IMMEDIATE SHIPMENT

8 ft. Poole Vertical Boring and Turning Mill

GOOD AS NEW

Under belt for demonstration only. 84" table, 100" between housings, one head arranged for slotting, 24" stroke.

For further information and specifications see

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Good Tools for Immediate Delivery

1—Plain Miller, Kempsmith No. 1 with vise arbor and counter.
1—Universal Miller, B & S No 1, with Div. Head, centers, arbor, gears, chuck and counter.
3—Power Hammers, Bradley Helve type, 15-, 25-, 75 lbs. Belt driven. Perfect condition

J. L. LUCAS & SON
4 Fox Street, Bridgeport, Conn.

MACHINE TOOLS — The Very Best

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- Two (2) 14 x 72 Norton, plain, excellent condition, modern type, each $2500
- Two (2) 10 x 72 Norton, plain, excellent condition, modern type, each 2200
- 12 x 36 Cincinnati Universal 1250
- No. 3 Brown & Sharpe Universal, 12 x 50 2000
- No. 60 Heald Cylinder 1000
- Landis, plain, 8 x 38 1400
- Springfield Universal, 16 x 40 850
- Two (2) No. 5 Rivett, each 550
- No. 3 Brown & Sharpe Cutter Grinder 300
- No. 7 Geo. Gorton, double end disc grinder with wheel chuck on one end, steel discs and tilting table 300
- Diamond Side Type Shop Face Grinder, working surface of table 9" wide x 2' long, cup wheel 14" dia 300
- Wells Cutter Grinder 75
- No. 1 Peerless Surfacing Machine, 10" belt 75
- Plain Grinders, Wet Tool Grinders. Polishing Machines, large and small.

HAND MILLING MACHINES

- Two Chicago, each $200
- Pratt & Whitney No. 2 175
- Four Pratt & Whitney No. 1, each 125
- Two No. 2 Garvin, each 150
- Two No. 3 Garvin, each 175
- Six Pratt & Whitney, No. 1½, each 175
- Two Pratt & Whitney Hand Millers ....
- Reed 150
- Pratt & Whitney 150
- Pratt & Whitney, with vise 150
- Two Pratt & Whitney ....

HORIZONTAL BORING MACHINES

- No. 2 Beaman & Smith Combination Boring, Drilling and Milling Machine, good as new $5000
- Beaman & Smith No. 8, 5" spindle 3500
- Bement & Dougherty No. 3, Knee Type, 3¾" bar 1450

PLANERS

- 48 x 48 x 20' Putnam, 2 heads on rail, excellent condition $3500
- 36 x 36 x 14' Powell, 2 heads on rail 1750
- 32 x 32 x 10' Gleason, single head, good as new 700

LATHES

- 60 x 28' Fifield, raising blocks to swing 75", double back geared, face plate drive, dia. of face plate 56" x 8"; good as new $5000
- 50 x 20' Fifield, Massive Pattern, 48" four jawed chuck 2750
- 52 x 16' Gleason, heavy triple geared, face plate drive 2500
- 24 x 18' Lodge & Shipley, quick change gear, taper, motor driven, carriage control 2000
- 16 x 8' Pratt & Whitney, quick change gear, taper attachment, H.S., C.R., good as new, latest type 1000

MULTIPLE SPINDLE DRILLS

- Bausch 8 spindle, 1¼ joints $1150
- Foote-Burt 8 spindle, spindles adjustable on rail, center to center outside spindles 6' max 800
- Snyder 28" 4 spindle, back geared, sliding head, table 30" long, 16½" wide 300
- Five (5) Gardam 4 spindle, each 250
- No. 11 Pratt & Whitney 15 spindle 325
- Two 14" Barr 3 spindle Sensitive, each 90
- No. 11 Pratt & Whitney 10 spindle 325
- 2 spindle Barr 60
- Baush 16 Spindle 750
- Three 4 spindle Fenn Sensitive, adjustable heads, each 150
- Allen 4 spindle 200
- Henry & Wright 3 spindle 200

Remember these are only Samples! **MACHINE TOOL DEPT.** **Write for our Stock List**

THE CO-OPERATIVE USED MACHINERY COMPANY

50 CHURCH STREET TELEPHONE CORTLANDT 665 **NEW YORK**

Warehouse, 408 Claremont Ave., Jersey City, N. J.

Do You Want to Let Out Part of Your Work ?

If so, we can help you out. We especially want to build grinders, automatics, or special machines. We have a modern shop for contract work, and our present crew are trained machine tool builders. We will now consider taking on additional contracts.

GIDDINGS & LEWIS MFG. CO.
FOND DU LAC WISCONSIN

Machinery For Sale

- 1—No. 12 Pratt & Whitney 10-spindle Multiple Drill with 9 x 18-in. rectangular head.
- 1—8-spindle Western Machine Tool Co.'s Multiple Drill with 18-in. circular head.
- 1—6-in. Bilgram Bevel Gear Planer.
- 1—24-in. Fellows Gear Shaper.
- 1—40-lb. Bradley Cushion Helve Hammer.
- 1—24 x 12 Porter Lathe, with compound rest.
- 1—26 x 12 New Haven Lathe, with compound rest.
- 1—32 x 16 New Haven Lathe, with compound rest.
- 1—34 x 12 Fitchburg Lathe, with compound rest.
- 1—30 x 30 x 8 Putnam Planer.
- 4—4¼-in. Cleveland Automatic Screw Machines.
- 1—24-in. Stroke Morton Draw-cut Shaper.
- 1—No. 3 Garvin Single-spindle Profiling Machine.
- 1—No. 20 Oesterlein Plain Back Geared Milling Machine.
- 3—No. 3 Burke Bench Milling Machines.
- 1—No. 3 Burr Circular Cold Saw.
- 1—No. 12 Higley Cold Saw.

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GILMER BELTS—Woven endless, uniform thickness, strength and pliability. Minimum stretch, maximum efficiency. Necessary for high speed, advisable for all speeds. Made for grinders, drill presses, motors, light and heavy power transmission, polishing, conveying and special machinery.

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Reclaim Your High Speed Scrap

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ONONDAGA STEEL CO., Inc., Syracuse, N. Y.

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GRINDING MACHINES

1—Wilmarth & Morman Universal Tool & Cutter Grinder (New)
2—Wells No. 160 Universal Tool & Cutter Grinders (New)
1—Wilmarth & Morman Style B-X Universal Cutter & Drill Grinder (New)
1—10"x36" Landis Plain Grinder (New)
1—10"x20" Landis Plain Grinder (Good Condition)
2—12"x24" Modern Plain Grinders (Nearly New)
1—14"x50" Norton Plain Grinder (Nearly New)
2—16"-30"x96" Norton Gap Grinders (Nearly New)
2—Landis Internal Grinders with No. 75 Heald Heads (Nearly New)
1—No. 70 Heald Internal Grinder (Fine Condition)
2—No. 60 Heald Cylinder Grinders (Nearly New)
1—16"x66" Landis Crank Shaft Grinder (16 Months Old)
2—14" Swing Special Internal Grinders, capacity $\frac{1}{2}$" to 14" dia., straight or taper (Fine Condition)
1—New Yankee Style L Drill Grinder (New)
1—No. 6-M Besly Double Disc Grinder (Fine Condition)
1—No. 300 Safety Emery Wheel Ring Wheel Grinder (Nearly New)

TURRET LATHES

68—Potter & Johnston No. 6-A Automatic (New)
8—Potter & Johnston No. 5-A Automatic (Nearly New)
12—13" Gisholt Semi-Automatic (One Year Old)
20—21" Gisholt Semi-Automatic (One Year Old)
5—J. & L. two spindle
1—J. & L. 2x24 with bar equipment, motor driven (Fine Condition)

MILLING MACHINES

1—No. 3 Garvin Universal (New)
1—No. 6 Becker Duplex (New)
1—No. 2 Rockford Hand Miller (Nearly New)
3—No. 0 Bristol Hand Millers (Nearly New)
1—Newton Duplex with 72" Table Feed (Good Condition)
1—No. $3\frac{1}{2}$ Becker Vertical with Dividing Head (Nearly New)
1—Small Duplex Miller (Good Condition)
1—No. 4 Hendey type Lincoln Miller (Nearly New)

DRILLING MACHINES

1—6 Spindle Baush Multiple 1" capacity (Old machine but fine condition)
1—12" Spindle Gardam $\frac{1}{2}$" capacity (Fine Condition)
6—Barnes 24", 2 Spindle, All Gear Drive (New)
1—24" Hoefer Sliding Head (New)
4—Henry & Wright No. 1 Style K (Nearly New)
12—Colburn Heavy Duty Size D-2 (New)
27—Colburn Heavy Duty Size D-4 (New)
1—26 Rockford Sliding Head (Fine Condition)
3—4 Spindle Dwight Slate 14" Swing $\frac{1}{2}$" Capacity (Good Condition)
2—Peerless 20" (New).
1—20" Mechanics (New)
1—20" Buffalo (New)
1—26" Hamilton Sliding Head (Fine Condition)
11—Burke No. 1 Bench (New)
1—25" Kern Sliding Head with Tapping Attachment (Fine Condition)
362—Paragon High Speed Drills $1\frac{3}{4}$" x 14" Flute 21" over all (New)

RADIAL DRILLS

1—36" Dreses with Quick Return Tapping Attachment (Fine Condition)

ENGINE LATHES

38—16" x 0' Fairbanks Morse Heavy Duty (Nearly New).
1—16"-36" x 8' Fay & Scott Extension Gap (Good Condition).
1—30" x 12' LeBlond (Good Condition)
1—12" x 6' American (Good Condition)
1—26" x 14' Fifield (Good Condition)
1—14" x 4' Blaisdell (Good Condition)
1—No. $4\frac{1}{2}$ Barnes (Good Condition)
1—26 x 10' Bradford (Good Condition)

MARKING MACHINES

2—Noble & Westbrook No. 1 (New)

PROFILERS

1—No. 3H Becker (Nearly New)

PLANERS

1—30" x 30" x 10' Ohio with two Heads (New)
1—44" x 44" x 12' L W Pond with three Heads (Fine Condition)
1—40" x 40" x 12' New Haven with one or two Heads (Fine Condition)
1—36" x 36" x 12' Sellers widened to 72" (Fair)

AUTOMATIC GEAR CUTTERS

1—No. 3 Brown & Sharpe 26" (Old Machine—Fair Condition)
1—36" x 4" Fellows Gear Shaper (Fine Condition).
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UNITED STATES AGENTS: Laughlin-Barney Machinery Co., Pittsburgh, Pa.; Brownell Machinery Co., Providence, R. I.; The W. M. Pattison Supply Co., Cleveland, Detroit, Dayton; Syracuse Supply Co., Syracuse, Buffalo; Sheritt & Stoer Co., Inc., Philadelphia; Colcord-Wright Machinery & Supply Co., St. Louis; Pacific Tool & Supply Co., San Francisco. **CANADIAN AGENTS:** A. R. Williams Machinery Co., Ltd., Toronto, Winnipeg, St. John, New Brunswick; Williams & Wilson, Montreal. **EUROPEAN AGENTS:** Chas. Churchill & Co., Ltd., London, Glasgow, Birmingham, Manchester, Newcastle; Iznosskoff, Suckau & Co., Petrograd, Moscow, Ekaterinburg, Russia; Alfred H. Schutte, Barcelona, Bilbao; Schuchardt & Schutte, Stockholm. D. Drury & Co., Johannesburg, S. Africa.

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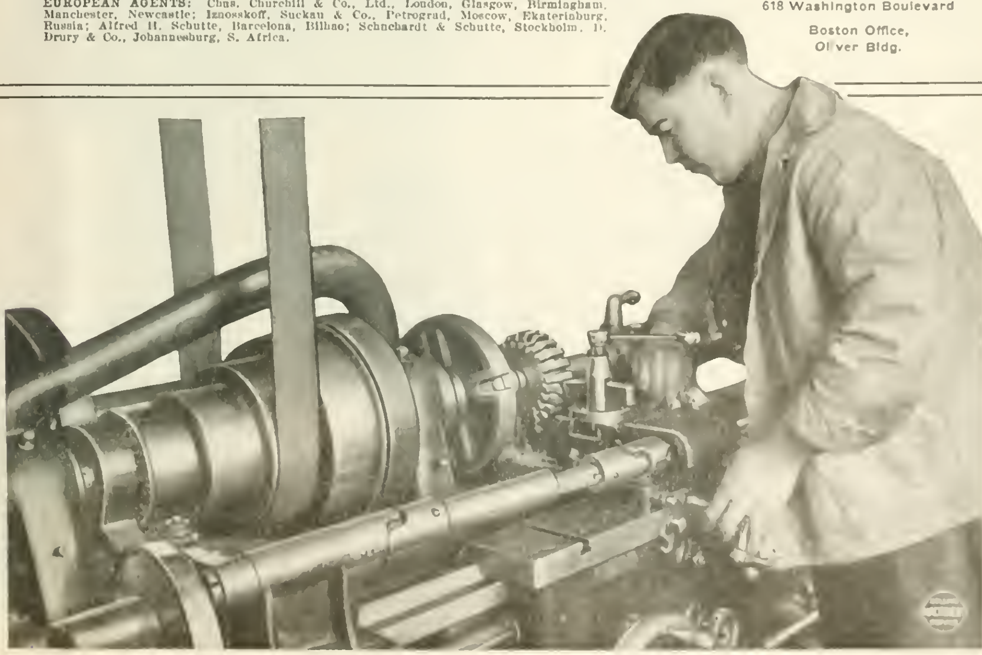
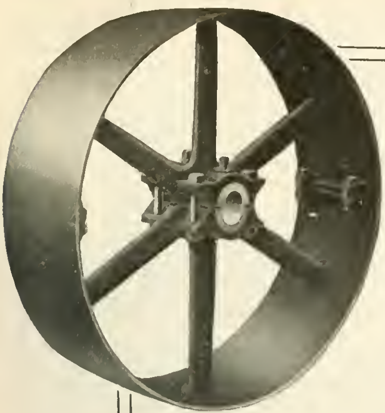


MACHINERY'S PRODUCT INDEX



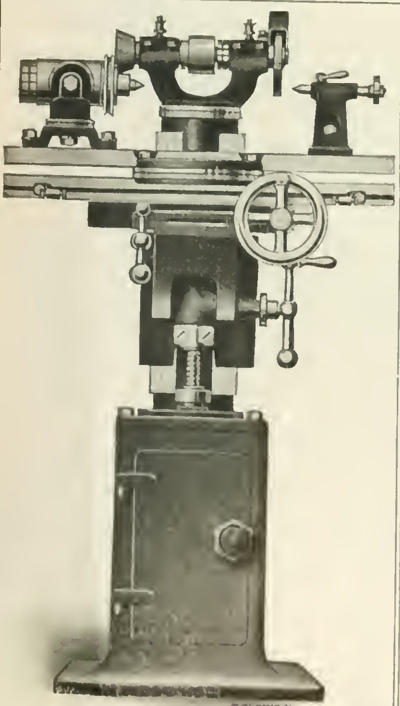
Are There Any Power Thieves in Your Plant?

The idea of stealing power sounds odd, but that is virtually what poorly designed or unsuitable transmission does in a factory. It is a constant insidious drain on your profits, hard to detect and often costly to remedy.

But there is no necessity for such a condition. Power can be transmitted with maximum efficiency if the right transmission machinery is used. If you are equipping or remodelling a plant or if you have reason to believe there are power leaks in your present equipment, put the problem up to us. With years of experience to aid us, we will go into the matter thoroughly and advise what we consider the best equipment. From our complete line we can furnish everything necessary for the economical transmission of all kinds of power.

T. B. WOOD SONS COMPANY, Chambersburg, Pa.

Makers of the most complete line of Power Transmission Machinery made by any one manufacturer



If You Want to Make Sure, Make it "Sterling"

If you are contemplating the purchase of a grinder for small work, you will find it good business to buy a machine to handle a practically universal range of work—a machine which can be adapted to tool and cutter, surface, internal and cylindrical grinding. The

Sterling Universal Tool and Reamer Grinder

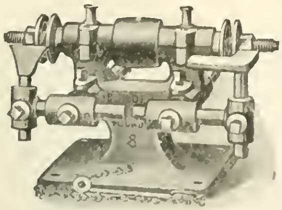
was developed to meet just such requirements. It is completely universal in all movements. The table revolves entirely around the head, permitting the use of the wheel at any desired angle. Gibbed slides take the travel of the knee, which revolves around a center column, and which can be locked securely in position before moving the knee. This feature is very important on work requiring close accuracy. It will pay you to look into some of the possibilities of this busy little machine.

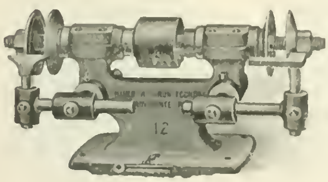
Write us about it.

YOUNG, CORLEY & DOLAN, Inc.
115 BROADWAY NEW YORK, N. Y.

BUILDERS IRON FOUNDRY
PROVIDENCE R. I., U. S. A.

How Are You Fixed for Grinders?





Good grinding facilities and sharp tools go together.

Builders Grinding Machines

conveniently placed, will enable your men to keep tools in cost-cutting condition with minimum loss of time. They are reliable grinders, in which there is nothing to get out of order. Being made in large lots, they are moderately priced. Tested in actual service before shipment, they are safe to buy.

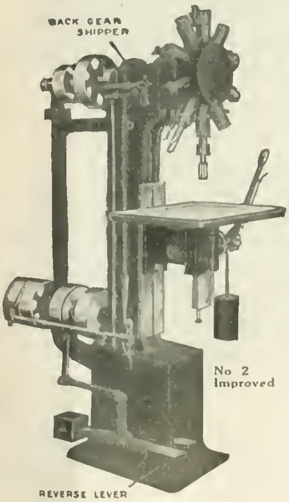
An equipment of these efficient grinding machines costs less than you would think.

Write for catalog "D".

BUILDERS IRON FOUNDRY, Providence, R. I.

"When I was an Apprentice"

said the foreman in a large textile machinery manufacturing plant, "I used to watch my chance to work on this



QUINT IMPROVED TURRET DRILL

You see I could do *all* the boring, drilling, tapping and reaming on a casting at *one* setting of the work and tools, and when you've got big, unwieldy castings *one* setting or *three* makes a lot of difference. I've been here sixteen years and the Quint was used over a year before I came and it's as popular today as ever."

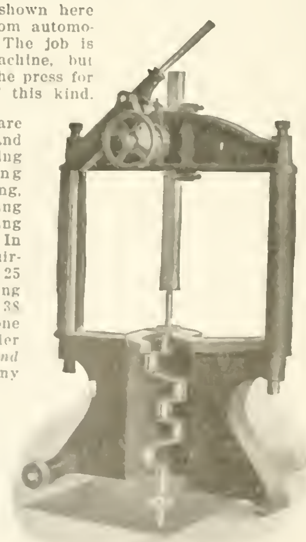
MADE WITH FROM 4 TO 12 SPINDLES.
WRITE FOR CATALOG

A.E.QUINT, Hartford, Conn.

FOREIGN AGENTS: The Moscow Machine Tool and Eng. Co., Moscow, Russia. C. W. Burton, Griffiths & Co., London, England. Ph. Bonvillain & E. Ronceray, Paris, France.

A Powerful Press Built for Extra Capacity and Permanent Hard Service

No. 26 Press is shown here removing gear from automobile crankshaft. The job is easy for this machine, but note capacity of the press for handling work of this kind.

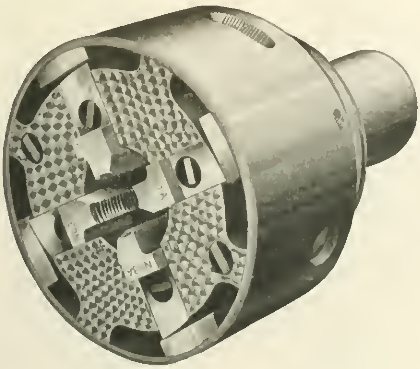


Atlas Presses are built in all sizes and types for driving mandrels, bending and straightening, broaching, embossing with dies, setting bushings, etc. In fact all work requiring pressure up to 25 tons and centering capacity up to 38 inches may be done quicker and easier on our *Compound Presses* than by any other method

Let us send you our catalog matter.

ATLAS PRESS CO.
323 No. Park Street
KALAMAZOO, MICH.

Demonstrating the Practicality of the NAMCO *Die and the* GRIDLEY *Automatic for Dependable Screw Cutting*



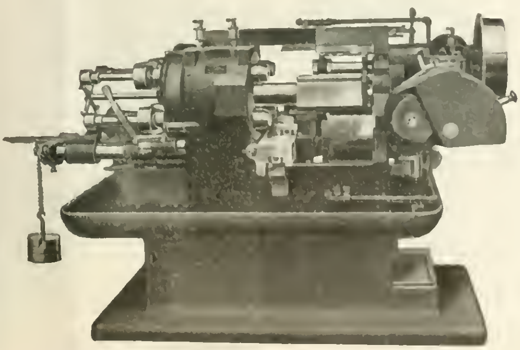
AS applied to the Gridley Multiple Spindle Automatic, the NAMCO Self-Opening Die represents a down-to-the-minute economy in the production of clean-cut, accurate threads.

You can rely on the Gridley principles of construction — the weight and strength of the frame, the method of holding the tools and the fully automatic operation are the points responsible for accurate, rapid and continuous production.

Likewise the NAMCO Automatic Die Head is well built—it is simple in the number of parts required, has the proper support for chasers directly over cutting edges and a positive opening action. Chasers are carefully hobbed and hardened, and a thorough flush of oil thru the head, keeps the tool clean and cool while cutting.

The Gridley Automatic, equipped with simple closing attachment and NAMCO Self-Opening Die, forms a combination that saves Time and Cost in producing dependable screw machine work.

Complete data upon request.



THE NATIONAL-ACME MANUFACTURING CO.

CLEVELAND, OHIO

NEW ENGLAND PLANT WINDSOR, VT. — CANADIAN PLANT MONTREAL, P. Q.

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FOREIGN REPRESENTATIVES

Makers of Gridley Single and Multiple Spindle Automatics at Windsor, Vt., and Acme Automatics, Threading Dies and Screw Machine Products at Cleveland, Ohio

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